The potential role of energy communities in Sweden

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Abstract

To combat the ongoing climate change, a sustainable energy system is essential. In recognition of this, Sweden has set a national goal of 100% renewable energy by the year 2040. However, to reach this goal, it is important that efficient tools are utilized. The EU suggests that energy communities can act as one such tool. While research has shown that energy communities can entail several opportunities for the transition towards more renewable energy, there is a lack of studies conducted in a Swedish context. To help fill this gap, this study investigated the following topics: Opportunities and challenges coupled to the communities, important enablers for the communities and what views different actors in the energy system have on the role of energy communities. Lastly, the results were used to comment on the relevance of energy communities from a Swedish context. The information was collected through a review of existing scientific literature, as well as through interviews with actors in the Swedish energy system. The results of the study highlight that while there are opportunities coupled to energy communities in a Swedish context, the challenges outweigh them. This view is shared by the majority of the interviewed actors, even though some see more opportunities than others. Furthermore, Sweden has already invested in individual micro production, which fulfills a role competing with energy communities. However, if energy communities are to be implemented, it is essential to establish enabling measures such as a transparent regulatory framework. Ultimately, this study predicts that the impact of energy communities in the Swedish energy system will be limited.

Är energigemenskaper ett lämpligt verktyg för att nå 100% förnybar energi till 2040?

Den överhängande klimatförändringen innebär att människan står inför hennes kanske viktigaste vägskäl någonsin. Det börjar låta som en trop, men om vi inte börjar leva mer hållbart kommer våren kanske tystna för evigt.

Energisystemet är en fundamental del i övergången till ett mer hållbart samhälle. Därför har den svenska regeringen beslutat att vi behöver fasa ut användningen av fossila bränslen samt kärnkraft, för att istället nyttja 100% förnybar energi vid år 2040. Men liksom pollinatören är beroende av blomman, så är dagens samhälle beroende av en stabil tillförsel av energi. Övergången måste därför ske med rätt verktyg. Energigemenskaper föreslås av EU som just ett sådant verktyg. Förenklat kan energigemenskaper beskrivas som: olika aktörer som agerar kooperativt för att erbjuda icke-vinstdrivna energitjänster i närområdet. Ett exempel på detta skulle kunna vara ett villaområde som går ihop för att producera el. Dock består EU av många länder som har kommit olika långt i övergången mot mer förnybar energi. Därför undersöker den här studien hur energigemenskaper lämpar sig i en svensk kontext. För att svara på detta använder sig studien av en genomgång av akademisk litteratur i kombination med intervjuer av nyckelaktörer i det svenska energisystemet.

Baserat på den insamlade informationen kommer studien fram till att energigemenskaper troligen inte kommer att få en stor betydelse i det svenska energisystemet. Man ska inte sticka under stol med att gemenskaperna innebär flera fördelar, men gemenskaperna är även förknippade med flertalet utmaningar. Det är dessutom möjligt att tyngden av utmaningarna blir extra påtaglig då det redan finns verktyg som bidrar med liknande miljötjänster, vilket kan agera konkurrerande.

De intervjuade nyckelaktörerna framhöll generellt sett åsikter som liknande varandra. En viss skillnad kunde ses i att energiföretagen såg fler utmaningar medan intresseorganisationerna var mer optimistiska.

Till syvende och sist upplever författaren att även om energigemenskaperna kanske inte upplever en ”boom” så är det viktigt att hålla alla dörrar öppna. Det framkommer även att förekomsten av energigemenskaper kan öppna upp för framtida hållbara verktyg. Men om vi vill ge energigemenskaperna chansen att bidra är det viktigt att skapa en marknad där de har samma förutsättningar som andra aktörer. För att göra det, och övervinna vissa utmaningar, har det visats att faktorer så som ett tydligt regelverk och samarbete med externa organisationer är av stor vikt.

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Abbreviations

CEC - Citizen energy communities

CEP - The Clean Energy for All Europeans Legislative Package

CES - Community energy storage

DSO - Distribution system operator

EU - European Union

IEMD - The revised internal electricity directive (EU) 2019/944

PV - Photovoltaics

REC - Renewable energy communities

REDII - The revised renewable energy directive (EU) 2018/2001

WTP - Willingness to pay

Introduction

1.1 Context

The energy system has a substantial impact on the climate. In Sweden, during 2019, the production of electricity and district heating made up approximately 9% of the total national greenhouse gas pollution (Naturvårdsverket, 2020). Because of the environmental impact of the energy system, it is vital that the system is designed sustainably. In 2018, Sweden's electricity mix consisted of approximately 66% renewable energy (Energimyndigheten, 2020), which is the largest national share in the EU-28 (Eurostat, 2020). Out of the remaining 34%, nuclear power constitutes the absolute majority. The EU is considering labeling nuclear power as a sustainable energy source (Abnett, 2021), nevertheless, nuclear power is not renewable and gives rise to pollution in the form of nuclear waste. To decrease the level of pollution the Swedish government has established a national goal of 100% renewable energy by 2040 and a goal to increase the efficiency of energy consumption by 30% in 2030 compared to 2005 (Ministry of the environment, 2020).

The transition to 100% renewable energy entails both challenges and opportunities. A technological shift from the stable but non-renewable nuclear power to the fluctuating nature of intermittent energy sources, such as wind and solar, in combination with an increasing demand puts a high amount of stress on the energy system (Bartolini et al., 2020; Hahnel et al., 2020). To ensure that the energy system remains stable during the transition, measures to handle different challenges are essential (Gährs & Knoefel, 2020). Besides the more technical aspects, the transition also means that our society needs to reevaluate some of its structural components, where economical focus today outweighs social and environmental aspects (Van Der Schoor, 2016). With that said, renewable energy typically reduces market prices on electricity (Burger et al., 2020), and the operating cost for PV is almost negligible (Quiggin, 2020).

The rise of more decentralized energy systems with citizen engagement are seen in several European countries, both through individual micro production and through the use of communities (Van Der Schoor, 2016). This trend of a more engaged consumer is supported by the EU, which has identified numerous benefits linked to local renewable energy production (EU Directive 2018/2001 of the European Parliament and of the Council Rec. 65). This transition towards a more decentralized system indicates a shift from a one way transactional relationship, with focus on the passive consumer, towards a more dynamic relationship where the consumers produce and own their own electricity (Coy et al., 2021). This encourages more conscious

consumption of electricity and might break the status quo (Rogers et al., 2012). Consequently, a more decentralized energy system will also affect the roles of the classic energy companies who now face new challengers on the energy market (Dalhammar & Hjärne, 2018).

Energy communities consist of private actors, mainly citizen led, that initiate collective energy actions to then share the benefits (Caramizaru & Uihlein, 2020). This can, for example, be done through collaboration with the neighborhood or by buying a share in a local wind park (Energikontor sydost, 2020). These communities are often formed with the ideology of a smaller system governed by democracy where the projects are sustainable and revenues are reinvested in the local community (Van Der Schoor. 2016). Consumers that produce their own electricity, so-called prosumers, have a potential to be of great importance to make the transition towards a more sustainable energy system a successful one (Lowitzsch et al., 2020). By the year 2050, energy communities in the EU are estimated to have a potential of generating approximately 250 TWh of renewable energy per year, which would represent 16% of the total production of renewable energy, see Figure 1 (REScoop & MECISE, 2020).

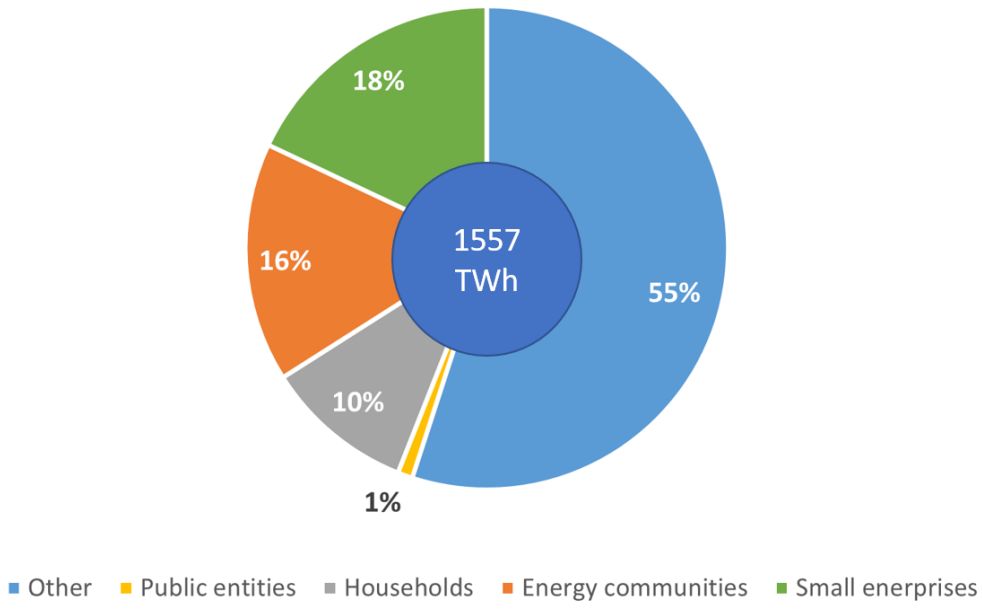

Figure 1: Estimated share of renewable energy produced in EU-28 by 2050, separated by sector type. Data from REScoop & MECISE (2020).

Complementary to the production of energy, CES is projected to have a wide array of benefits, for the prosumer as well as the DSO (Dong et al., 2020). Such benefits could include an enhancement of the possibility for self consumption and an alleviation of the energy grid during peak loads (Gährs & Knoefel, 2020). Without some form of energy storage, the conventional unidirectional energy grid can become overloaded at times since the supply can exceed the demand (Burger et al., 2020).

Traditionally, Sweden has been using a centralized energy system with little contact between supplier and consumer, instead relying on a few dominant actors (Magnusson & Palm, 2019). The Swedish energy grid is monopolized with different DSOs responsible for their defined region and consequently, electricity transferred between different properties has to go by a main grid (Energikontor sydost, 2020). Furthermore, the Swedish market has been dominated by two different electricity sources: hydro- and nuclear power (Kooij et al., 2018). This has started to change with Sweden enacting different incentives for decentralized micro production. These include tax reduction on the revenues from selling surplus electricity, meant to engage households in generating and consuming their own electricity. (Skatteverket, n.d.a).

While Sweden incentivizes individual households of prosumers and has a substantial share of renewable energy in their electricity mix, energy communities have been neglected. To fulfill the requirements for receiving a tax relief as micro producers, the generated electricity must not traverse the concession covered energy grid (Solelkommisionen, 2020). However, the requirement of not traversing the main grid is not feasible when sharing the energy in a community consisting of different inputs. Naturskyddsföreningen (n.d.), a Swedish NGO, argues that this creates energy injustice since not all people have the same prerequisites for generating energy, for example people living in apartment housings. The EU states that legal and commercial factors that hinders the development of energy communities in a disproportional way are to be removed (On common rules for the internal market for electricity and amending Directive 2012/27/EU, Directive 2019/944).

Some general subsidies regarding production of renewable energy do exist, such as electricity certificates (ministry of the environment, 2020). Nevertheless, as it is today, electricity produced for self consumption is more monetarily beneficial than electricity sold to the energy grid (Winkler, 2021). This is because electricity sold to the grid has a lower monetary value for the prosumer compared to bought electricity. A reason for this may be that the sale price does not make up for fixed fees and taxes, creating value erosion. Electricity produced for self consumption bypasses the cost of fees and taxes, which means that consumed electricity is worth as much as the electricity otherwise bought. In addition to the general subsidizing, private energy storage systems are subsidized by a tax reduction of 50% on the cost for installation and material since the beginning of 2021 (Skatteverket, n.d.b). Despite the lack of support structures, there were around 140 communities in 2018, but this is still a low number compared to many other countries (Magnusson & Palm, 2019).

1.2 Existing research

There has been several studies regarding energy communities conducted in different European countries. For example by Seyfang et al. (2018) who studied 354 communities in the UK, and by Bauwens et al. (2016) who examined wind cooperatives in Denmark, the UK, Germany, and Belgium. Questions such as the role of energy communities and what drivers and barriers they are facing has been studied. Contrary to the rise of energy communities in Europe, the movement is still at an early stage of development in Sweden. Consequently, only a handful of studies regarding energy communities has been conducted encompassing the Swedish context. Magnusson & Palm (2019), for example, mapped different cooperatives existing in Sweden and how they have developed over time. Thus, there is a research gap regarding energy communities in a Swedish context. While the results from the European studies can comply to Swedish energy communities, there are national differences characterizing Sweden that needs to be taken into account. For example, a cultural individuality and trust in governmental authorities (Kooij et al.,2019).

1.3 Aim and research questions

The purpose of this paper is to research what role energy communities might play in the Swedish transition towards the goal of 100% renewable energy, and thereby a more sustainable energy system by 2040. This transition is deemed essential by the government to decrease the pollution of the Swedish energy system. The member states of EU are obligated to facilitate energy communities and since Sweden is inexperienced in the use of them, there exists a need to map the different opportunities and challenges that the communities entails. The aim is also to identify if there are any enabling factors of importance for the development of energy communities, thereby creating a basis to better understand and optimize the implementation in the Swedish system. The energy system is of concern to a wide array of actors. It is therefore of importance to map what expectations different key actors in the system have on the role of energy communities and if there are any substantial differences. The study questions of this thesis are as follows:

- What opportunities and challenges will the role of energy communities entail on the transition towards 100% renewable energy in the Swedish energy share, and will energy communities act as an efficient tool in reaching it?
- What are the perceptions of energy communities by different actors (i.e. the business sector, municipalities, governmental authorities and expert organizations) in the energy system?
- What important enablers for energy communities to emerge in Sweden can be identified in earlier research and by the informants?

Background

2.1 Legal framework

2.1.1 The EUs definition of energy communities

Energy communities have been defined in two different ways by CEP. REC are defined through REDII and CEC by IEMD (Caramizaru & Uihlein, 2020). The member states have the option to adapt the definitions as they are stated by CEP, or by combining them into one definition (bridge Horizon, 2019). The two definitions share the following characteristics (Bridge Horizon, 2019 ; Caramizaru & Uihlein, 2020; European Commission, 2020):

1. Participation must be open and voluntary.
2. The focus of the operation is to primarily gain environmental, economic and social benefits for its members and/or the local community, this rather than a pure financial profit.
3. Actors in the energy sector are not allowed to exert control in the communities.
4. Both types of energy communities may engage in a wide range of activities, see table 1.
5. The communities are to remain autonomous from the private interests of its members.

While CEC and REC share several characteristics, they are also distinguished by noteworthy differences. Bridge Horizon (2019) states that REC are characterized by more rights and privileges than CEC, but also by stricter criteria to follow. Other noteworthy differences between the two definitions highlighted by Bridge Horizon (2019), European Commission (2020), Friedens et al. (2019) and Husblad et al. (2020) can be seen in Table 2. In addition, figure 2 illustrates the difference between controlling members and shareholders of the different two definitions.

Table 1: Activities that the different definitions of energy communities are allowed to partake in. Data from European Commission (2020).

	REC	CEC
Generation	X	X
Consumption	X	X
Energy sharing	X	X
Supply	X	X
CES	X	X
Aggregation	X	X
Energy efficiency services		X
Charging services (vehicles)		X
Cross-border participation		X

Table 2: Differences between CEC and REC. *It is up to the member states to define the definition of proximity.

	REC	CEC
Membership	Natural persons, local authorities small and medium enterprises as long as the community is not their primary commercial activity. REC excludes large enterprises and has an extra focus on the participation of vulnerable households and public authorities.	Natural persons, local authorities and small corporations. Large enterprises and actors from the energy sector can participate as long as they do not have effective control.
Geographical limitations	Members exerting control in the community have to be located or work in proximity* of the operation	None
Technology	Limited to renewable energy	Technology-neutral
Allowed operation	The whole energy sector	Limited to the electricity sector

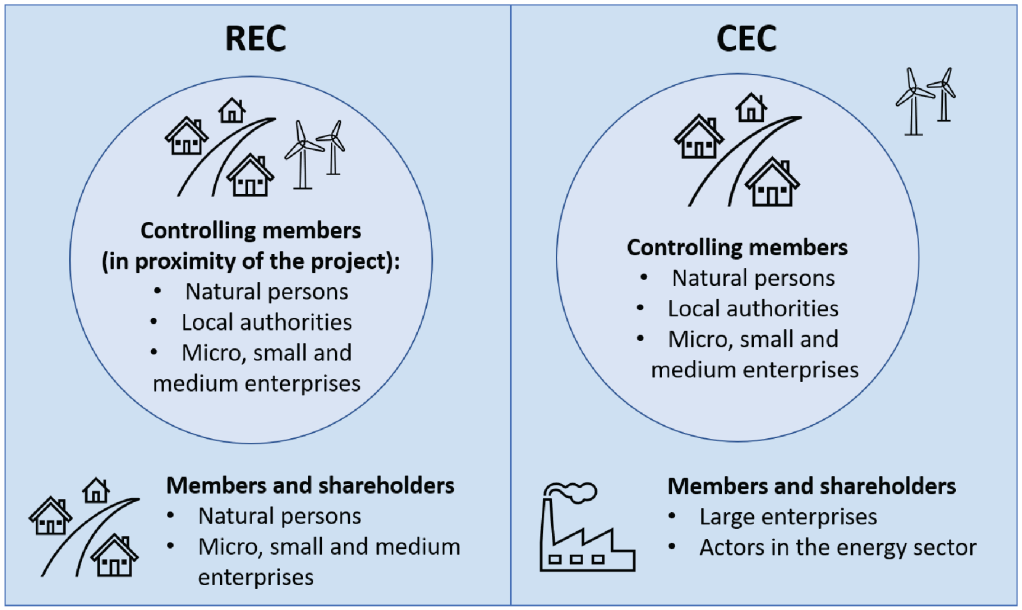

Figure 2: Criteria for controlling members regarding REC and CEC

2.1.2 The EUs framework

To meet the responsibilities and goals of the Paris Agreement, the EU has adopted CEP, which consists of 8 legislative directives with a focus on a transition towards a sustainable energy system (Bridge Horizon, 2019; European Commission, 2019). CEP puts substantial weight on the role of citizens and communities in the energy transition, which indicates a shift towards a more decentralized European energy system (Bridge Horizon; 2019; Lowitzsch et al., 2020).

Community energy is subjected primarily through REDII and IEMD. The directives state that member states are obligated to secure non-discriminatory rights and a leveled playing field on the electricity market through national legislation to enable the development of communities (Husblad et al., 2020; Lowitzsch et al., 2020). Furthermore, the communities are to have rights, but also obligations, that are similar to the other actors on the electricity market (ibid.). It is recommended, however, that some administrative requirements are made more easily accessible for the communities, to support their value-over-profit mentality (European Commission, 2020). In addition, models of governance and the right to the option of energy consumption are described through the different directives (Lowitzsch et al., 2020). It is also stated that an individual participant of an energy community is to keep the rights and obligations of an end user (Husblad et al., 2020). Rights such as being able to leave the energy community under fair conditions (European Commission, 2020).

The EU member states are obligated to have legislated the intents of REDII by June 30, 2021, and IEMD by December 30, 2020 (Rescoop, n.d.). However, according to Energimarknadsinspektionen (personal communication, April 26, 2021), the directives will most likely not be implemented earlier than autumn 2021. Progress for the implementation of a regulatory framework in different EU-28 countries can be seen in figure 3.

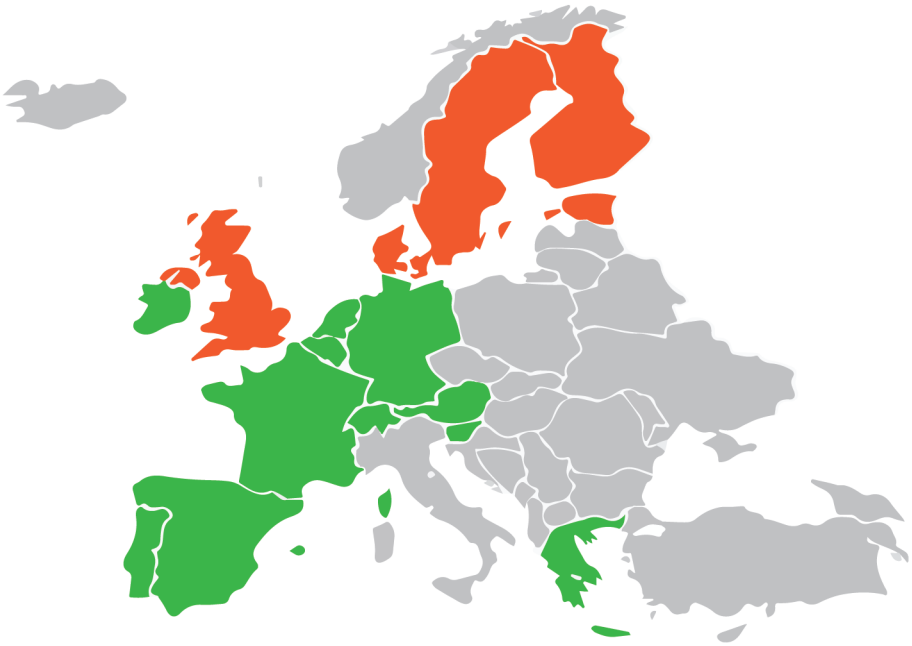

Figure 3: Progress for implementation of a regulatory framework concerning energy communities and collective self consumption of electricity in EU-28 as of year 2019. Green: Has implemented a regulatory framework. Orange: Lacking a regulatory framework. Gray: No information. Data from Bridge Horizon (2019) and Frieden et al. (2019).

2.1.3 The Swedish framework

There is no Swedish framework specific for energy communities at the writing moment. However, general frameworks regarding private production and self consumption of electricity do exist. As a response to the lack of Swedish regulation concerning energy communities, Husblad et al. (2020) analyzed CEP and released a statement of suggestions regarding what actions Sweden needs to undertake to fulfill its obligations.

Husblad et al. (2020) concluded that the proposed Swedish framework does not contravene CEP regarding the obligatory non-discriminatory treatment of energy communities. However, this non-discriminatory treatment also entails that the com-

munities are to follow requirements proportionally to the other actors, such as paying related fees and taxes (Husblad et al., 2020). Concerning their legal status, Husblad et al. (2020) suggest that energy communities are to be defined as an economic association and that they therefore will be applicable to the Swedish law: "Lagen (2018:672) om ekonomiska föreningar".

As of today, sharing electricity on a community owned grid between different residential properties is not possible in Sweden (Frieden et al., 2019). The revised internal electricity directive (EU) 2019/944 states that it is up to each member country to decide if the energy communities are to be allowed to act as DSOs, thereby owning and managing an energy grid. But while it is up to each member state, the European Commission does recommend it (European Commission, 2020). In Sweden, the use of an internal grid is only allowed for specific exceptions which can be seen in 5-22 b §§ IKN-förordningen. Distribution between residential properties is not included in the exceptions (Energimarknadsinspektionen, 2019; solelkommissionen, 2020). However, sharing and collective self consumption of electricity by an internal grid is allowed in an apartment building, if all the apartments in question are connected to the same input (Husblad et al.,2020). To allow separate residential properties to manage an internal grid, Husblad et al. (2020) state that a revision of the energy legislation would need to be undertaken and that the responsibilities of the communities would have to be updated to fulfill the role of a DSO. Husblad et al. (2020) therefore argue that energy communities are not to be allowed to own and manage their own grids (ibid.). Nätkoncessionsutredningen (2019), on the other hand, concluded that there is a need to review the energy legislation. The review should, among other things, propose a consideration regarding an exception that enables sharing renewable energy between different properties. This possible exception should, according to the Nätkoncessionsutredningen (2019), with advantage, be coordinated with the implementation of a regulatory framework concerning energy communities.

The European Commission (2020) states that the cooperation between energy communities and the DSOs are of great importance. Article 22 in REDII states that the DSOs are required to cooperate with REC to facilitate for the energy sharing of renewable energy in the community (Bridge Horizon; 2019; Husblad et al., 2020). Furthermore, the DSO is required by law to connect a producer to the energy grid, but it is the producer that has to pay for any necessary expansion of the grid (Energikontor sydost, 2020). In addition to this, the electrical suppliers are required to accept electricity from a micro producer, and also to pay a reasonable price for it (Husblad et al., 2020). However, this only applies to energy communities that fulfill the prerequisites of micro production (ibid.).

2.2 CES

Dong et al. (2020) define CES as:

> "Energy storage system located at the consumption level with the ability to perform multiple applications with a positive impact for both the consumer and the Distribution System Operators (p.1)."

Energy storage is an essential tool in the transition towards an energy system of renewable energy since it can compensate for the intermittency linked to sources like PV and wind (Dong et al., 2020). This compensation can be achieved by storing energy produced when the demand is low, to then discharge it when the need arises, for example during a cloudy wind-still day (Corson et al., 2014). CES can also smoothen out fluctuations that create instability in the generating infrastructure by absorbing spikes and compensating dips. Storage through different kinds of batteries, often lithium-based, is the most common method (ibid.).

Method

3.1 Scope

This study will use the definition of energy communities described through REDII, REC. This is because of the criteria of only using renewable energy, which is in line with the aspiration of 100% renewable energy in Sweden by 2040 (Energimyndigheten, 2020). However, this means that the potential role of CEC will not be taken into account. All scientific literature does not specifically use the definition of energy communities set by the EU, thus this study will assume that studies regarding energy communities and renewable energy fall under REC if nothing else is specified. Energy communities exist both with and without the option of energy storage and CES will therefore be examined as a complementary option in this paper. Furthermore, while energy communities might provide social benefits, this study will mainly focus on the environmental and energy aspects.

3.2 Literature review

A literature review has been conducted to determine challenges and opportunities linked to the implementation of energy communities, as well as what role energy communities can have to increase the share of renewable energy. The literature review also examined what measures can be undertaken to facilitate the implementation of the communities. The search for literature was conducted through Scopus, the search variables used can be seen in the appendix (A1), Figure 8.

A so-called "snowball search" was also conducted to identify relevant studies left out of the primary search. The snowball search was performed by looking for relevant references found in the literature from Scopus, in an article from "Nature", "Community versus local energy in a context of climate emergency" (Devine-Wright, 2019) and in a report made by the European commission, "Energy communities: an overview of energy and social innovation" (2020). The article from Nature was chosen based on its relevance to the subject. The report by the European Commission was chosen since it was commissioned to consolidate the position of energy communities in CEP.

Resulting material from Scopus and the snowball search was first screened by reading the title and abstract to make sure that the articles were about energy communities. The articles that passed the selection were then screened a second, more thorough time, by reading the introduction, result, discussion and conclusions. Notes were taken continuously throughout the screening process. A summary of the process can be seen in Figure 4.

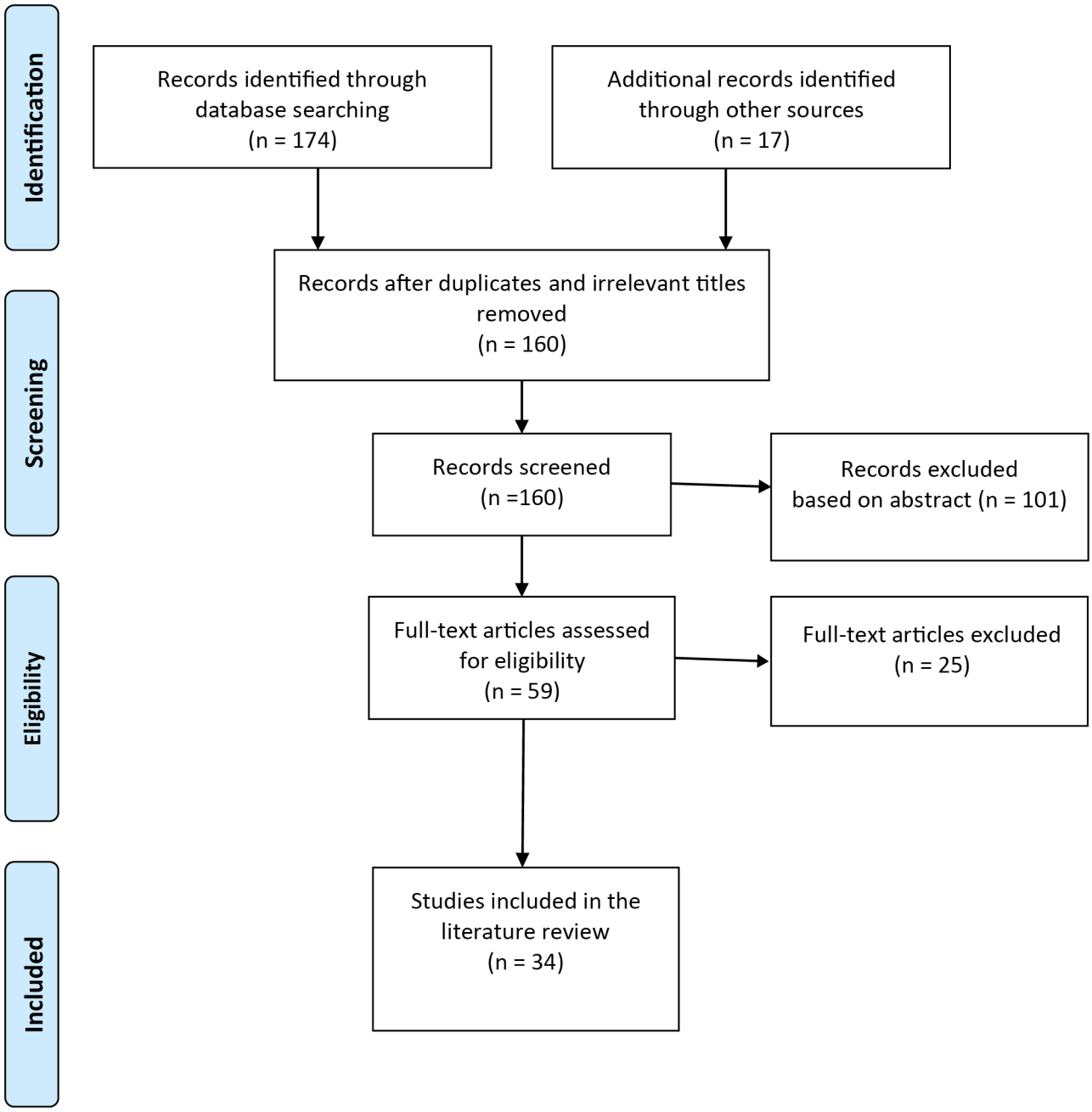

Figure 4: The evaluation process of the literature review based on the Prisma flow diagram. Inspired by Moher et al., (2009).

3.3 Semi-structured interviews

The study conducted a series of semi-structured interviews with actors from four different sectors: the business sector, governmental authorities, municipalities, and advocacy groups. Interviews were chosen over other methods, such as surveys, since they excel in evoking in depth answers while still providing the interviewer the ability to steer the conversation (Eliasson, 2018; Johannessen & Tufte, 2003). Depending on the flow of the interviews, questions were sometimes added or skipped based on relevance, a trait characterizing semi-structured interviews (Bryman & Bell, 2017; Johannessen & Tufte, 2013). Bryman (2011) states that semi-structured interviews are fitting for a study that has a focus but still wants to remain flexible and open. This possibility for open and more in depth answers suited this study which strived to examine the opinions of experts regarding different themes without imposing strict limitations. However, a drawback with the usage of interviews is that they are highly time-consuming (Bryman, 2011). Another aspect that characterizes interviews is that the interviewer and the setting can affect the interviewee, both negatively and positively (Johannessen & Tufte (2003).

The question form that all interviews, except for the first interview, followed can be seen in the appendix (A2). After the first interview was conducted, two alternative question branches were added, see question 4-6 and question 7-8 in the appendix (A2). The main section of the form was concerning what role and future the interviewees expected of energy communities, for example relevant challenges and opportunities. The interviewees were also asked if they believe that energy communities will be an efficient tool in a Swedish context and how the communities can be facilitated for. Another discussion point was the possible interaction of energy communities with either the business sector or with municipalities. The same form was used for all actors since the main part of the questions were of a general nature and a comparison of different views was to be conducted.

All interviews, except for one, were conducted distantly using Skype because of the restrictions during Covid-19. By doing the interviews via Skype instead of telephone, some body language was preserved. Furthermore, Johannessen & Tufte (2013) suggests that by letting the interviewees be in an environment of their own choosing, a more comfortable atmosphere is created. The interviewees were offered the questions in advance of the interview to be able to prepare more in depth answers.

The interviews were recorded with permission of the participants. The interviewees were also offered personal anonymity but asked to preferably not be anonymous regarding the name of the organization they represent. Among the interviewees, none of them claimed the right to remain anonymous. The recordings were then transcribed and used for the analysis.

The interview with Energimarknadsinspektionen was undertaken through email. Because of the limitations of email, the author of this study chose not to use all

the questions from the form, omitting questions of high similarity and questions meant to establish a connection with the interviewee. Consequently, the interview with Energimarknadsinspektionen was not as in depth as the other interviews. The author still chose to include the result from the interview in the study based on the high relevance of Energimarknadsinspektionen in the Swedish energy system.

3.4 Selection of interviewees

The interviewees were based on four different sectors representing actors of interest for energy communities. Initially, universities were planned as a 5th sector. However, since the literature review represents academia, this sector was deselected. The selection of interviewees was based on actors that had provided a statement of opinion on Energimarknadsinspektionens report regarding, amongst other things, the implementation of energy communities in Sweden: "Ren energi inom EU - Ett genomförande av fem rättsakter Ei R2020:02". The actors were contacted via email and asked for an interview. The resulting selection was a bit disproportional towards the business sector, where more actors agreed to being interviewed than in the other sectors. It is therefore worth to mention that the business perspective might influence the end result more heavily. Albeit several asked actors either declined or did not answer, the resulting selection of actors were of high relevance and should be able to portray the four different sectors fairly. The actors that agreed to an interview can be seen in table 3.

3.5 Analysis

When analyzing the transcriptions, "sentence analysis" ("meningsinnehållsanalys") as described by Johannessen & Tufte (2013) was used. The analysis was performed through four main steps as follows:

1. The transcription was read in its entirety to create an overall picture of relevant themes. Parts deemed not relevant were cut.
2. The abridged version of the transcription was read more thoroughly, relevant themes were highlighted by fitting code words.
3. Summarizing categories were formed based on the themes highlighted through the code words.
4. The sifted result was summarized in text.

The original transcription was read several times during and after the analysis to make sure that the end result did not diverge from the opinions of the interviewee. Furthermore, by rereading the results in parallel to the progressing study, it was possible to see similar themes in the different interviews.

Table 3: Information regarding the interviewees and what date the interviews took place. The different colors indicate what sector the interviewee represents: red = business, blue = governmental authority, yellow = municipality and green = advocacy group.

Name of interviewee	Position	Organization	Date
Adam Engström	Business developer	E.ON	24/03
Maria Andersson Iseppi	External analyst	Göteborgs energi	25/03
Håkan Skarrie	Business developer	Kraftringen	15/03
Catherine Lillo	Senior advisor retail electricity market	Energiföretagen	31/03
Marie Knutsen-Öy	Director of energy policies	Svenskt näringsliv	31/03
Nora Smedby	Environmental economist	Naturvårdsverket	05/03
Claes Vendel Nylander	Lawyer	Energimarknads-inspektionen	26/04
Fredrik Lundström	Sustainable innovation	Energimyndigheten	31/03
Erik Ormegard	Climate and energy strategist	Malmö municipality	22/03
Jan Johansson	Project leader, City planning	Örebro municipality	11/03
Anna Werner	CEO	Svensk solenergi	29/03
David Larsson	Consultant	Solisten	23/03

3.6 Ethical reflection

The study was conducted in line with ethical principles expressed by Vetenskapsrådet (2002). These principles include that the scientist is to provide relevant information to the participant, ask for their consent, provide confidentiality and only use the provided information for scientific purposes.

One of the main ethical aspects in this study occurred in the usage of interviews. The interviewees were provided information regarding the purpose of the study, offered anonymity, and the option to read relevant results before the study is published. The option for participants to read relevant parts of the study ensures that they will not feel misquoted or misunderstood.

A major ethical aspect is the fact that the study is undertaken in cooperation with E.ON, one of the largest businesses in the Swedish energy sector. Direct influence from E.ON can be seen in that they had a say in the subject of the study,

where energy communities was one suggestion to potentially provide information for a project named SCA+. E.ON also had some input on the question form for the interview to make it of relevance for SCA+. Since E.ON has stated a possibility of this study being used in the SCA+, there is a possibility that the conclusions of the study will entail a real impact for the Swedish implementation of energy communities. It is therefore of great importance that the author provides well based and unbiased arguments. Aside from this, E.ON provided a supporting and supervising role with no direct influence over the result or the analysis. By doing the study in collaboration with E.ON, the author can receive payment if the study is approved by the University and is of relevance for E.ON, thereby creating risk for bias to please the company. However, while the risk for bias exists, this author believes that the study has been able to refrain from it. The author has for example treated the interview from E.ON in the same way as the other interviews and has conducted the analysis without influence from E.ON. Additionally, E.ON has not tried to influence with any desired end results, instead staying open to the author's own thoughts and wanting scientific objectivity and legitimacy. To consolidate the rights of the interviewees and upholding the scientific principles, E.ON will not get access to the recordings or the transcripts.

Literature review results

Investigating energy communities, several factors need to be taken into account. The results from the literature review have been divided into four overarching categories of aspects: Social, technological, economical and organizational. The main categories were established since they represent four broad themes that are present throughout the literature. Similarly, the subcategories are meant to summarize the aspects that had the most prominent role in the themes. The subcategories present different opportunities, challenges as well as important enablers coupled to energy communities. The technological subcategory "CES" examines CES as a complementary tool for the use of energy communities. Lastly, the review also examines energy communities specifically in a Swedish context. This is done to take possible national traits into consideration. A visualization of the structure of the chapter can be seen in figure 5.

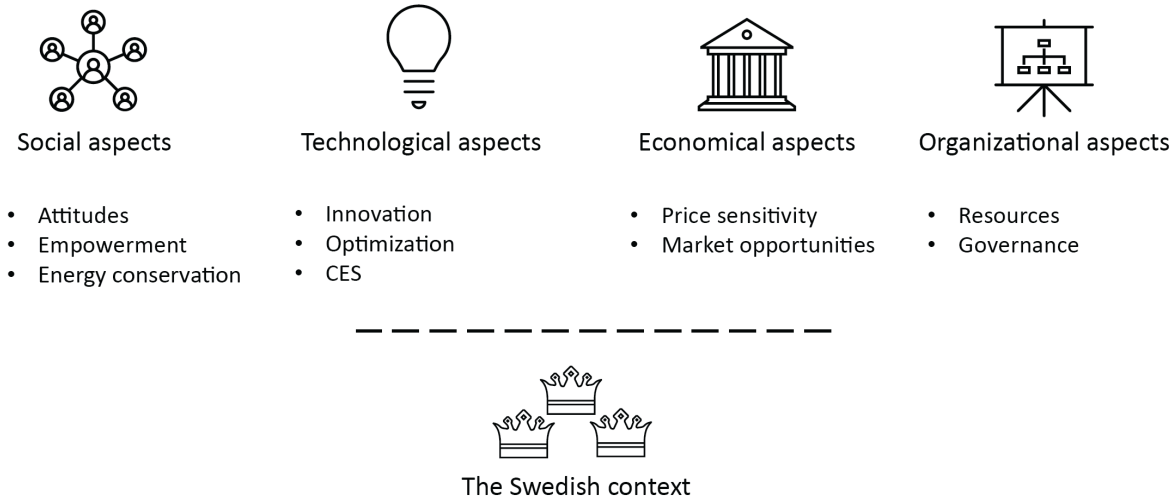

Figure 5: The structure of the literature review results.

4.1 Social aspects

4.1.1 Attitudes

The implementation of local energy communities can raise the local acceptance for projects regarding renewable energy (Bauwens & Devine-Wright, 2018; Ghorbani, 2020; Rogers et al., 2012; Soeiro & Ferreira Dias, 2020; Yildiz et al., 2015). Adding to this, by interacting in and with an energy community, there is a potential to affect individual behavior by altering social norms (Soeiro & Ferreira Dias, 2020). Furthermore, the participation in different energy projects has been seen to increase when a high degree of trust is present, which generally favors decentralized organizations such as communities rather than larger companies who often lack public confidence (Soeiro & Ferreira Dias, 2020). This phenomenon was seen in a study by Warren & McFadyen (2010) conducted on two different villages in Scotland, one with a community owned wind farm and one with a commercial wind farm. The village with their own farm was proud of it, while the locals in the village with the commercial wind farm felt disconnected and almost alienated to the project (Warren & Mcfayden, 2010).

An alteration in attitudes can for example be seen in a higher local acceptance for a transition towards renewable energy when exposed to PV-systems (Azarova et al., 2019). A higher degree of acceptance can be of extra importance for the development of wind energy, which usually is subject to local opposition (Mignon & Ebers Broughel, 2020). Additionally, Capellán-Pérez et al. (2018) noticed that a high degree of acceptance lessened the "not in my backyard effect". However, while the acceptance for renewable projects are higher with members of energy communities, the degree of acceptance still differs between different renewable energy sources (Bauwens & Devine-Wright, 2018; Walker & Devine-Wright, 2008). Wind, for example, showed a lower rate of acceptance than other renewable sources (Bauwens & Devine-Wright, 2018). Interestingly, non-members of communities do not necessarily feel more negative towards renewable energy, instead they feel more indifferent concerning it (Bauwens & Devine-Wright, 2018). Similarly, Warren & McFadyen (2010) concluded that involvement with wind farms in the Scottish highlands often did not change the local views from negative to positive, rather it amplified the positive ones and suppressed the negative ones.

4.1.2 Empowerment

A community is not empowered by default and historically cooperating with other actors has meant a top-down process where the communities have had difficulties in attaining power (Coy et al., 2021). However, a top-down scheme might alienate possible participants from the communities (Roby & Dibb, 2019). Coy et al. (2021) show that a higher sense of empowerment in a community, such as an energy community, creates the feeling of inclusiveness. The sense of being included helps turn the passive consumer into an active one, with a higher level of engagement and feeling of responsibility (ibid.). This in turn can change the behavior of the consumer, which can aid in replacing social norms and thereby in escaping a potential carbon lock-in (Dóci, 2021). The facilitation of the empowerment is therefore, according to Coy et al. (2021), of uttermost importance in the transition towards a goal of zero emissions. However, cooperation with external actors is often necessary since most communities are in need of external resources, such as expertise (Coy et al., 2021).

4.1.3 Energy conservation

A change in the behavior of the consumer can result in a higher degree of energy savings (Akizu et al., 2018). Approximately 40% and 65% of the members in two different energy communities considered themselves more conservative in their use of energy after joining the respective community (Hoppe et al., 2019). Around 50% of the participants that estimated that they saved more energy merited this to actions taken by the community, overall members saved more energy than non-members. In the aforementioned communities, information spreading actions were executed regarding energy conservation to raise the knowledge of the participants (ibid.). However, Hoppe et al. (2019) concluded that higher environmental awareness in itself does not necessarily entail a higher engagement, instead social factors such as the length of membership and interactions with other members were the most significant in contributing to the change of behavior.

4.2 Technological aspects

4.2.1 Innovation

As organizations diverging from the market norm of making the most profit, energy communities can act as important hubs for innovation (Capellán-Pérez et al., 2018). In Denmark, for example, wind communities were one of the main contributors in reducing the cost of wind turbines, showing the potential of community driven innovation (Wierling et al., 2018). Furthermore, the need for innovations is amplified when trying to survive in an environment dominated by other actors (Capellán-Pérez

et al., 2018). At the same time, cooperation with other business actors can stimulate innovation as well (Kooji et al., 2018).

4.2.2 Optimization

Energy produced by a decentralized system entails reduced transmission distances of electricity since electricity produced for self consumption skips the transmission step and instead feeds directly into the distribution system of the community (Brown & Lund, 2013). As a consequence, this can relieve the transmission grid of congestion and thus reducing system costs for the DSO (ibid.). By providing flexibility, energy communities can support the already existing energy system (Roby & Dibb, 2019).

4.2.3 CES

In a comparison between different energy scenarios in apartment buildings, Minuto et al. (2021) showed that the level of self consumption was the highest when the option of energy storing was present. The level of self consumption could reach up to 90% when combined with additional outlets, such as charging stations for electric vehicles and an electrical heating system. Another study found the self consumption rate to be 26% higher in PV-systems when storage was available compared to without (Dong et al., 2020). Minuto et al. (2021) concluded that storing through batteries was associated with the highest environmental score out of the different scenarios studied, with indicators such as energy efficiency and amount of energy generated by renewable sources. In addition to a higher degree of self consumption, CES also boosts the communities' rate of self-sufficiency (Bartolini, 2020; Dong et al., 2020; Gährs & Knoefel, 2020). Dong et al. (2020) showed that the energy savings are substantially higher for a PV-system with storage compared to a PV-system without. Furthermore, CES can provide important services to the energy system. Energy storage is, for example, a fundamental complement to intermittent energy sources since a discrepancy usually exists, where an excess amount of electricity is produced during some periods while it can be at a standstill at other times. CES helps in mitigating the fluctuations by storing the excess electricity for later use and thereby shaving the peak demand (Bartolini, 2020; Dong et al., 2020). This alleviation of fluctuations is beneficial both for the community and the main energy system (ibid.).

CES is shown to be more efficient and economically feasible than individual home storage, making it easier for communities to invest in it than for individual prosumers (Gähr & Knoefel, 2020). CES has additional advantages compared to individual home storage such as a higher resource efficiency, which leads to a lower CO2 footprint. Furthermore, a higher amount of PV in relation to users usually create a bigger opportunity for storage (Abada et al., 2020).

While apartment buildings with storage had the highest environmental score, they were associated with a lower economic score than the scenarios without storage (Minuto et al., 2021). This is because of economical challenges such as the initial cost and the running maintenance cost (Gähr & Knoefel, 2020; Minuto et al., 2021), which means that the pay-back of the investment can take several years (Minuto et al., 2021). Consequently, the cost of investment and a lack of supporting frameworks are pointed out as the biggest barriers today. However, the price of batteries is expected to decrease in the future (Dong et al., 2020). Furthermore, Mirzania et al. (2019) showed that electricity generation in combination with storage is more cost-effective than transporting the electricity to the main energy grid.

Different storing systems vary in performance, which has a noteworthy effect on the environmental aspect. This in combination with a legal complexity and technical jargon often means that a community needs professional assistance for the development and implementation of CES (Dong et al., 2020; Mirzania et al., 2019). To facilitate for CES, national supporting measures and cooperation with intermediary organizations are essential (ibid.). Additionally, Dong et al. (2020) conclude that subventions such as energy tariffs are fundamental to make CES economically feasible for communities.

4.3 Economical aspects

4.3.1 Price sensitivity

Economic incentives have a substantial effect on the formation of energy communities. High prices on electricity as well as high grid connection fees has been shown to bolster the amount and size of energy communities (Abada et al., 2020; Dóci, 2021; Capellán-Pérez et al., 2018). Consequently, a low price on electricity can act as a barrier (Kooij et al., 2018). The formation of an energy community can entail savings on grid connection fees for the members of the community, if they are able to use less inputs to the main grid (Abada et al., 2020).

4.3.2 Market opportunities

A development of energy communities, and thereby also a more decentralized energy market, can create opportunities of entrance for new actors who challenge the old system (Roby & Dibb, 2019). New actors such as specialized aggregators, who in turn can expand the market for decentralized energy and increase the commercial viability of small-scale renewable energy production (ibid.).

Azarova et al. (2019) showed in their study that there is a demand for renewable electricity, with a WTP of approximately €10 extra per month for wind and €30 per

month for solar. In contrast, gas power lowered the WTP (ibid.). Adding to this, Sagebiel et al. (2014) noticed a higher WTP when the electricity was produced with the possibility for participation and in proximity of the receiver. Interestingly, democratic governance, a characterization of energy communities, could not be linked to a significant increase in WTP (ibid.). This leads to Sagebiel et al. (2014) concluding that the relevance of energy communities lies more in that they produce renewable energy, rather than in what way they do it. Even so, electricity produced by local energy communities is linked to a slightly higher WTP than centralized production (Sagebiel et al., 2014).

4.4 Organizational aspects

4.4.1 Resources

Since most energy communities are citizen-led, there is often an inherent challenge in the lack of funding and a reliance on volunteers (Dóci, 2021). The reliance on volunteers can create a vulnerability since the participants take risks on a personal basis, such as in invested time and money. Furthermore, there is also a risk that relevant members quit and some members join without contributing, creating a free rider problem. If combined with an unstable environment with changing policies and market, this can lead to a feeling of powerlessness for the involved individuals (ibid.).

Ambitious individuals are needed as leaders to start the communities and they in turn need to find people interested in joining the organization (Dóci, 2021). The competence of the leadership is therefore vital for the development of the community, and the leaders can often constitute a bottleneck (Ghorbani, 2020). Even though leaders are of importance, a majority of the households questioned by Rogers et al. (2008) stated that while they were interested in participating in an energy community, the role as a leader was not an option. When asked why, the lack of skills and knowledge came out as a significant factor (Rogers et al., 2008). Even if not taking the role of a leader, joining a community, especially in the start-up phase, often demands a substantial amount of time and effort from the volunteers (Schoor et al., 2016). According to Rogers et al. (2008), the seen preference of participating while not wanting to take an active role can be seen as an example of the "value-action gap", where the values of an individual does not necessarily induce actions. Since leadership is of great importance to facilitate a successful community, policies should encompass measures targeting individuals with leadership potential (Ghorbani, 2020).

Financial issues are one of the main barriers and energy communities usually rely heavily on favorable subsidies (Bauwens et al., 2016). Because of this dependence, they are highly susceptible to policy changes and an unstable political climate (Nirzania et al., 2019; Seyfang et al., 2013). According to Wierling et al., (2018),

the majority of communities in Germany that failed did this because of financial reasons or legislative changes. Incentives that guarantee a specified amount of economic support, such as feed-in tariffs, has been of critical importance to stimulate a growth in the amount of energy communities in several European countries (Mirzania et al., 2019; Wierling et al., 2018). When policies instead change in favor of market mechanisms, a clear decrease in communities can be seen as a result. This was for example seen when Denmark made major changes in their feed-in tariff schemes (Bauwens et al., 2016; Bauwens & Devine-Wright, 2018; Wierling et al., 2018). Additionally, Energy communities are vulnerable to competition from corporate actors with larger financial budgets (Wierling et al., 2018). As a response to the competitive market and changed subsidies, many initially local communities were forced to adapt to survive by transitioning into larger regional networks (Bauwens et al., 2016). Brown & Lund (2013) argue that the fact that energy communities rely so heavily on financial support indicates that it is a less cost-effective way of producing renewable energy compared to centralized actors.

4.4.2 Governance

Factors such as reliance on voluntary labor and a lack of initial expertise can be of major hindrance for the formation of energy communities. To alleviate some of these challenges, external actors acting as intermediaries can be important since they bring the relevant expertise that many communities are lacking (Mignon & Rüdinger, 2016; Seyfang et al., 2013). Magnusson & Palm (2019) concluded that one common denominator for all the successful PV-communities examined in their study were good contacts with energy companies. Sebi & Vernay (2020) predict that this forces communities towards more of a hybrid structure, consisting partly of volunteers and partly of hired professionals. A hybrid solution was also noted by Dóci (2021), who saw that the majority of communities she studied hired an external manager to aid in the development of the communities. Utilizing a hybrid structure has several benefits, it combines the trustworthy and engaging aspect of the bottom-up movement with professional management and the scalability that characterizes top-down schemes (Roby & Dibb, 2019). However, since the energy sector primarily is centralized, the experience of working with communities is still limited and new adaptive business models might be needed. Hargreases et al. (2013) point out that intermediaries generally need to take the role of the flexible enabler, creating an opportunity for the communities to develop by mutual learning, rather than providing them with a single set template to follow. In addition, current energy policies primarily reflect the centralized energy system and therefore need an overhaul to include the bottom-up perspective (Roby & Dibb, 2019; Heldeweg & Séverine, 2020).

Roby & Dibb (2019) suggest that businesses that seize the opportunity to engage

in symbiosis with decentralized actors will have a stronger foothold in the future market. A hybrid model can also be beneficial for local authorities, with communities helping them to reach low-carbon targets (Roby & Dibb (2019). In addition to interaction with intermediaries, such as businesses and local authorities, co-operation and exchange of information between different energy communities has been shown to correlate with a favorable effect for the communities (Capellán-Pérez et al., 2018; Mirzania et al., 2019). Interestingly, Capellán-Pérez et al. (2018) state that the trend of energy communities utilizing a hybrid structure means that they risk losing their non-profit and cooperative identity, instead becoming more market driven. A similar effect can be seen when energy communities scale in size. While a bigger community means the opportunity of enrolling more members and producing a higher amount of renewable electricity, it might run into problems in engaging its members since the effect of the social cohesion decreases (Schoor et al., 2016).

Even if REC produce renewable energy and have a focus on the environment, the reasons that participants join are of heterogeneous character (Bauwens, 2016; Capellán-Pérez et al., 2018). Consequently, the main motivation in a community might change over time (Bauwens, 2016). This imposes a risk that members choose economic gains over environmental, which in turn can lead to an environmentally sub-optimal business model or participants leaving the community for a more financially attractive opportunity (ibid.). Minuto et al. (2021), for example, saw that the scenario with the highest environmental score in their study also scored the lowest economically. However, in a study on motivators for joining an energy community, Soeiro & Ferreira Dias (2020) found to their surprise that the financial motivation was rather insignificant compared to environmental and social motivators.

4.5 The Swedish context

Contrary to other European countries such as the UK and Denmark, Sweden lacks the tradition of citizen-led initiatives regarding energy. Swedish municipalities have a high degree of self-governance and work closely with environmental aspects. As an effect of this, several municipal energy companies are running projects which share the characteristics of energy communities (Magnusson & Palm, 2019). Because of this, the citizens generally have not felt the need to act themselves, instead adopting a passive citizenship relying on the welfare state. However, Sweden has seen a rapid rise in individual prosumerism of home owned PV-systems, which can act competitively to the role of communities (Kooij et al., 2018). In addition, Swedish culture is characterized by a high degree of individuality, with a low demand for collectives and communities (ibid.). The Swedish energy system is also highly centralized with dominant actors in hydro- and nuclear power, making it difficult for bottom-up movements to enter the market (ibid.). Ultimately, Kooij et al. (2018) conclude that grass

root innovations, such as energy communities, generally has a low impact on energy systems characterized by strong vested interests. To be able to compete, the communities have to adopt a more commercial or businesslike attitude (Kooji et al., 2018).

The price of electricity in Sweden has been low for the last decade, which means that energy communities find it hard to earn a feasible revenue from the sales of electricity (Magnusson & Palm, 2019). This can be seen in a decrease of communities engaging in wind power (Magnusson & Palm, 2019).

There are communities in Sweden that produce electricity, but in quantitative terms they have had quite a modest impact (Magnusson & Palm, 2019). The lack of impact is partly because the development has been limited as a consequence of a lack of support structure (Magnusson & Palm, 2019; Mignon & Rüdinger, 2016). As in other countries, the communities rely heavily on financial support and help from external actors. The history of an unstable policy environment has therefore lead to several wind farms being discontinued (Magnusson & Palm, 2019). Still, even though the number of communities in Sweden is quite small, they do contribute with a production of local renewable energy and can act as a source of inspiration. However, the existing communities have rarely been restricted to one geographical domain, instead having members join from all over the country (Magnusson & Palm, 2019; Mignon & Rüdinger, 2016). To expand, a regulatory framework and legal recognition of energy communities are essential (Magnusson & Palm, 2019).

4.6 Summary of the literature review

The results of the literature review show that energy communities can be linked to several opportunities for the transition to a larger share of renewable energy. Energy communities can, for example, engage the consumer and thereby affect social norms regarding renewable energy. The communities have also been shown to correlate with positive effects for the energy system in a wider perspective by: contributing with flexibility to the energy grid, stimulating innovation, and creating new roles on the market. Additionally, the use of CES has been shown to contribute beneficially to the aforementioned aspects and negate some negative effects coupled to renewable energy. However, the literature also brought several challenges to light. The most significant theme revolves around the access to resources. This often means that the communities rely heavily on enabling factors such as favorable policies and cooperation with external actors. A summary of the most prominent opportunities and challenges coupled to energy communities and CES can be seen in table 4

Complicating matters, by looking in a Swedish context, several aspects to take into account are added, see table 4. Swedish people generally are characterized by individuality and a trust in the well-fare state, consequently rarely taking matters

into their own hands. Adding to this, Sweden is dominated by a few energy sources and has experienced a relatively low price on electricity the last decade which further lowers the incentive. As a consequence, there are only a few communities in Sweden and the decentralized production that exists is generally performed on an individual basis instead. To enable the formation of more energy communities, it is important to develop a transparent regulatory framework.

For further analysis, it will be of interest to see if the opinions of the different interviewed Swedish actors coincides with the aspects brought forward by the scientific literature. Similarly, if the result from the interviewees accentuates or diminishes the relevance of the aspects specifically characterizing Sweden.

Table 4: Overview of the main benefits and challenges linked to energy communities and CES in the literature review. "Opp." indicates opportunities.

Topics	
Social opp.	- Raises acceptance of renewable energy - Linked to high levels of trust and participation - Affects social norms - High degree of empowerment and inclusiveness - Engages the consumer - Higher energy conservation
Technological opp.	- Reduces grid transmission costs - Increases flexibility in the energy grid - Acts as hubs for innovation
Economical opp.	- Creates new market opportunities
Challenges	- Lack of resources - Reliant on volunteers - Highly dependent on favorable subsidies - One template does not fit all - Dependent on aid from external actors
Opp. of CES	- Increases self consumption - Increases self-sufficiency - High environmental score - Reduces stress on the energy grid
Challenges of CES	- Highly expensive to invest in - Low economic score - Dependent on favorable subsidies - Technical jargon and legal complexity
Swedish traits	- Lack of cooperative culture - Low price on electricity - Energy market dominated by hydro and nuclear - Individual micro production acting competitively - Lack of support structure

Interview results

The results from the interviews begin with a table presenting a summarized view regarding what the different interviewees predict concerning the impact of energy communities in the Swedish energy system, table 5. The main results from the interviews has then been divided into five overarching categories: Social, Technological, Economical, Organizational and System. These five categories were chosen based on the main themes encountered during the interviews. These, in turn, contain different subcategories representing what the interviewees brought up as the most important aspects. The aspects consist of opportunities, challenges and enablers coupled to the potential use of energy communities in Sweden. If several actors agreed with an aspect, not all were mentioned explicitly through the text. Instead, the exact opinions can be seen in table 6 and table 7. Similarly, some actors are present in aspects contradicting each other, this is because the actors mentioned both opportunities and challenges regarding that aspect. Figure 6 visualizes how many (n) of the actors stated the different aspects, in descending order. The chapter then ends with a short summary.

Different quotes are used in this paper to reflect the personal thoughts of the interviewees. The original quotes are in Swedish, but the author has translated them to English for the sake of this study. The quotes are marked with [number], which corresponds to the original Swedish quote in the appendix (A3).

Table 5: Summarized view on the potential impact of energy communities according to the interviewed Swedish actors. The different colors highlighting the abbreviation indicate what sector the interviewee represents: red = business, blue = governmental authority, yellow = municipality and green = advocacy group. Energy communities is abbreviated to EC.

Name	Actor/abbreviation	Summarized view
Adam Engström	E.ON	The main contribution EC will entail is by changing the perspective of the system.
Maria Andersson Iseppi	Göteborg Energi GE	EC will most likely only have a modest impact on the energy system.
Håkan Skarrie	Kraftringen K	The impact of EC will most likely be limited and more of a niche.
Catherine Lillo	Energiföretagen EF	EC will most likely not have a substantial impact in the nearest future.
Marie Knutsen-Öy	Svenskt Näringsliv SN	EC will most likely be of limited impact.
Nora Smedby	Naturvårdsverket N	While EC do have a role to play in the energy system, ultimately they will be of limited importance.
Claes Vendel Nylander	Energimarknadsinspektionen EI	EC will not entail a substantial impact in the short term, but maybe further in the future.
Fredrik Lundström	Energimyndigheten EM	EC will most likely play a limited role, overshadowed by the big industries.
Erik Ormegard	Malmö Municipality M	It is hard to say what impact the EC will have.
Jan Johansson	Örebo Municipality Ö	There is great potential in how EC can be beneficial for its participants as well as the society.

Continuation of Table 5		
Name	Actor/abbreviation	Summarized view
Anna Werner	Svensk Solenergi SS	EC can entail large opportunities for the Swedish energy system.
David Larsson	Solisten S	EC can play a substantial role for the expansion of solar energy and storage of energy.

5.1 Social aspects

5.1.1 Added values

When discussing different opportunities of energy communities, the concept of "Added values" was brought up. By added values, the interviewees mean aspects outside the primary focus of energy communities: environmental, economical and social.

Erik Ormegard (M) concludes that the energy communities impact on the energy system is uncertain. However, he does believe that the mere existence of an option to engage collaboratively through a community entails intrinsic values on its own. Adding to this, Nora Smedby (N) and Håkan Skarrie (K) state that whilst energy communities might not be the most economically rational alternative, it might provide added values such as the feeling of purpose and ownership.

To facilitate the development of energy communities, Nora Smedby (N) and Marie Knutson-Öy (SN) state that it is important to identify incentives in the added values and then communicate them to possible participants.

5.1.2 Citizen engagement

The increased engagement of citizens in the energy system is an important focus of CEP (Caramizaru & Uihlein, 2020). This factor was also reflected upon by the interviewees when asked about the role of energy communities. In addition, justice in the energy system was identified as an important topic, partly in the form of an opportunity, and partly as a challenge.

Jan Johansson (Ö), amongst others, argues that one of the most influential opportunities energy communities can provide is in engaging new actors, such as households, that do not usually have the option to produce energy in a centralized system. When asked about potential benefits coupled to energy communities, Claes Vendel Nylander (EI) brought up the possibility of a more engaged and active consumer:

> "Another aspect is possibly that the engagement and interest among the customers increase [...]" [1]

In addition to this, Nora Smedby (N) suggests that energy communities can increase the possibility for justice in society since an actor no longer needs to own a fitting property to produce energy. Adding to this, Maria Andersson Iseppi (GE) means that energy communities can be greatly beneficial for areas separated from the main energy system, such as islands. Complicating matters, Erik Ormegard (M) emphasizes that while energy communities most likely will act beneficially towards increased justice in the energy system, he does see a risk for the opposite to happen in some cases. This ambivalent view is shared by Catherine Lillo (EF) who suggests that energy communities create extra difficulties for the balancing of the energy system where related costs might unfairly fall upon actors not participating in the communities. Marie Andersson Iseppi (GE) further problematizes that an actor might feel forced to join the community because of social pressure, which would act in conflict with the legislative right to freely choose ones energy provider. Even if the community themselves is not actively trying to force actors in the proximity to join, social pressure acting passively might be hard to circumvent.

5.1.3 Culture

When asked what challenges the communities might face, some interviewees stated the Swedish culture of individuality and trust in the government.

In contrast to several of the countries that already has implemented energy communities, Nora Smedby (N) means that Sweden is characterized by individuality. She therefore believes that if a Swedish consumer would produce energy, they will prefer to do it individually instead of in a community. Several actors, such as Håkan Skarrie (K) and Marie-Knutsen Öy (SN), consequently expressed that there exists a conflict of interest where some actors might prefer to produce energy independently instead of in a community, for example by becoming individual prosumers. Nora Smedby (N) further adds that the Swede generally trusts the governmental authorities, and therefore does not feel the need to take matter into their own hands. To summarize this cultural identity, Nora Smedby (N) stated as follows:

> "[...] what you call statist individualism." [2]

5.2 Technological aspects

5.2.1 Security of energy

To enable a transition towards an energy system of more renewable energy, the question of maintaining security, i.e. that the system never runs out of energy, is essential. This was reflected upon in the interviews by the informants seeing both benefits and drawbacks with using energy communities within the energy system.

Since a decentralized energy system means more options and less reliance on a few but large producers, Anna Werner (SS) believes that energy communities will entail a less vulnerable system. This is supported by Håkan Skarrie (K) and Jan Johansson (Ö) who mean that a rise of energy communities will add resilience to the energy system, for example by alleviating capacity related problems locally as well as nationally. Furthermore, Fredrik Lundström (EM) argues that resilience is added to the participants of the communities since they can sustain themselves if the main system would go down. Contrary to this, Marie Andersson Iseppi (GE) suggests that energy communities can have a hard time handling local security issues, such as black-outs. Adding to this, Marie Knutsen-Öy (SN) states that reliance on renewable energy leads to less margins of error in the main energy system and consequently a more vulnerable system. Marie Knutsen-Öy (SN) further argues that the smaller margins might even act counterproductive towards the transition to a sustainable energy system because of fossil fuels being the primary replacement when the renewable energy is not enough. Exemplifying this statement, Marie Knutsen-Öy (SN) brought up a recent scenario where Sweden had to make up for a deficit of renewable energy:

> "[...] Since we needed to start up an oil fueled power plant in Karlshamn [...] that we do not have enough energy in our running operation [...]" [3]

5.2.2 Excelled use of CES

CES, or just energy storage, can act as a complementary tool to renewable energy. Several of the interviewees stated its importance coupled to energy communities, and reciprocally, the potential importance of energy communities for the development of storage.

David Larsson (S) firmly states that the most influential impact of energy communities will lie in its contribution to the excelled use and development of CES. This view is further reinforced when he argues about the potential opportunities of the communities:

> "[...] then I see that batteries are like the holy grail in that situation." [4]

In addition, David Larsson (s) suggests that since storage is more efficient when performed in proximity to the production, a more resource effective energy system will follow. Adam Engström (E.ON), amongst others, agrees with the potential for excelled use of CES. Anna Werner (SS) further suggests that CES is of importance to fully utilize the potential of the produced energy. Additionally, Anna Werner (SS) believes that energy communities and CES can have a positive effect on the consumption patterns of the participants by making them act more efficiently. David Larsson (S) adds that to fully implement the potential of CES, it is important that the communities are allowed to add complementary cables to the existing grid.

5.2.3 Expanded use of renewable energy

Since renewable energy is part of the definition of REC, the expanded use of it is an aspect of great importance. This view was shared by the majority of the informants when asked about the role and future of energy communities.

One of the major aspects brought up by the interviewees is that energy communities contribute to an expanded use and local production of renewable energy. Anna Werner (SS) and David Larsson (S), for example, mean that a development of energy communities can be of great importance for the future of solar energy. Consequently, Jan Johansson (Ö) states that energy communities can be helpful in reaching different climate goals, both locally and nationally.

5.2.4 Innovation

The emergence of energy communities entails an opportunity for more elaborate projects, new services, and products. Consequently, a couple of the informants stated that energy communities have the potential to incentivize innovation.

According to Marie Knutsen-Öy (SN), the emergence of energy communities can stimulate the energy market and give rise to innovations in the form of new services and products. David Larsson (S) adds that as a consequence of the development of energy communities there will be opportunities for the expansion of new and emerging roles on the energy market that support the smaller producers. Additionally, Nora Smedby (N) proposes that energy communities enable larger projects of renewable energy compared to individual micro production. For example, wind power is such a project which normally demands assets that few have access to on their own

5.2.5 Optimization

Several of the informants saw a potential for optimization of the energy system coupled to an implementation of energy communities. However, the risk of the opposite, sub-optimization, was also stated.

By facilitating for energy communities and local self consumption of energy, Anna Werner (SS) means that capacity-related bottlenecks upstream in the system can be alleviated. Additionally, Anna Werner (SS) and Fredrik Lundström (EM) point out that it is more cost-efficient to produce energy in proximity to the point of consumption. Håkan Skarrie (K) and Catherine Lillo (EF) further add that the communities can provide added flexibility to the system. This, Håkan Skarrie (K) argues, can as a consequence lead to lowered cost for the DSO, in turn lowering costs for the end consumers.

Maria Andersson Iseppi (GE), on the other hand, states that energy communities risk sub-optimizing the energy system. By utilizing a high degree of self consumption

of electricity, there might be a shift from district heating to electrical heating in the communities. Problematizing this possible trend, Maria Andersson Iseppi (GE) emphasizes that this would mean a wasteful allocation of resources. Additionally, Catherine Lillo (EF) and Marie Knutsen-Öy (SN) point out that energy communities can entail balancing difficulties on the main grid.

5.3 Economical aspects

5.3.1 Lack of incentive

When asked about potential challenges, the informants identified that the communities are lacking incentives for participation.

Because of the low prices for electricity Sweden is experiencing, Nora Smedby (N) and David Larsson (S) argue that there might not be a particularly strong incentive for the regular citizen to engage in an energy community. Adding to the lack of economic incentive, Fredrik Lundström (EM) states:

> "[...] if there are big costs if we transport the electricity back and forwards multiple times, then we will not be able to use it [the electricity] because it is not economically feasible." [5]

Fredrik Lundström (EM) therefore emphasizes that large transmission related costs of the electricity produced by communities makes the sharing of it economically unreasonable. Adding to this, Jan Johansson (Ö) states that costs from taxes and fees entail an even lower economic incentive to independent production of energy. Accentuating the lack of economic incentive even further, energy communities by definition is supposed to act as a non-profit organization, which Catherine Lillo (EF) and Håkan Skarrie (K) argue will dissuade many actors from joining. Adding to the lack of incentives, Maria Andersson Iseppi (GE) suggests that we already have a well functioned fossil free energy system in Sweden, making the benefits of energy communities less noticeable compared to other countries in the EU. When asked about the role of energy communities in the Swedish context, Maria Andersson Iseppi (GE) stated as follows:

> "The EU consists of many different countries and regions with different prerequisites, so it can bring about more benefits in some part of the EU and less in another [Sweden]." [6]

To mitigate the lack of economic incentive, Marie Knutsen-Öy (SN) states that it is vital that energy communities are allowed to consume the produced energy. If the communities have to sell and then re-buy energy from the market at different

prices, it will not be economically sustainable. Another potential solution to the lack of economic incentive, stated by Fredrik Lundström (EM), is if the communities are guaranteed a set price for the produced energy for an agreed period of time, for example by a bilateral agreement or through feed-in tariffs.

5.3.2 Policies

When asked how to best enable the implementation of energy communities, the usage of policies came out as a controversial theme.

Erik Ormegard (M) states that there is a need to make the communities more attractive for the participants. This, he adds, can be done by implementing different supporting policies, for example a tax relief. Anna Werner (SS) agrees with this and argues that energy communities should not have to pay tax for energy produced for self consumption. Continuing on this theme, Fredrik Lundström (EM) means that the current tax laws will impose a challenge for energy communities, since the existing laws are based on a centralized system. Further, emphasizing the importance of the taxation, Fredrik Lundström (EM) concluded:

> "[...] we also need to look at the taxation on energy in another way, that is my conviction." [7]

Catherine Lillo (EF) and Marie Knutsen-Öy (SN) on the other hand urges that whether energy communities succeed or fail, it should be decided by free competition on the market instead of measures such as subventions. Marie Knutsen-Öy (SN) further states that the implementation of supporting policies would lead to unfair costs for the ones that have to pay for it, which usually is the regular consumer.

5.4 Organizational aspects

5.4.1 Difficult to operate

The management of the communities was brought forwards as a substantial challenge throughout the interviews.

Nora Smedby (N) states that it generally has proven difficult to cooperate with others and that the cooperation adds a layer of bureaucracy compared to individual micro production:

> "Buying solar cells is large enough on its own, to then organize yourself with others and allocate risks, profits and such, that is a lot of work." [8]

Catherine Lillo (EF) and Adam Engström (E.ON) share the opinion that the internal cooperation of the communities might prove difficult. Adam Engström (E.ON) and Maria Andersson Iseppi (GE) further mean that the role of producer or distributor demands sector-specific knowledge, which the communities generally lack. Adding to the layer of bureaucracy, Jan Johansson (Ö) and Erik Ormegard (M) are of the opinion that the regulatory framework of today can be confusing for the communities to navigate. Agreeing with this, David Larsson (S) states that measures such as labeling energy communities as economic associations only provides unnecessary confusion. Instead, David Larsson (S) suggests a simpler approach:

> "A simple agreement would suffice to handle it, not that you should like, have an economic association with annual meetings." [9]

5.4.2 Resources

Similarly to the scientific literature, the lack of resources was brought up as a possible Achilles heel for the communities. To mitigate for this, external actors can provide a supporting role.

Adam Engström (E.ON) and Catherine Lillo (EF) emphasizes that the large requirement for resources, such as time and money, is a substantial challenge for energy communities. Furthermore, Catherine Lillo (EF) states that the demand for monetary resources is extra challenging for the communities since they are supposed to be non-profitable. Several actors, such as Adam Engström (E.ON) and Håkan Skarrie (K), further add that the management of the communities requires sector-specific knowledge, which few have access to. In addition to the lack of resources, Erik Ormegard (M) states that energy communities generally rely on voluntary work from its participants, meaning that the workforce is rather unreliable.

To mitigate for the lack of resources, cooperation with external actors is brought up as an important solution. Fredrik Lundström (EM), among others, argues that these actors can provide necessary services:

> "If you get multitudes of energy communities, each one of them will not invent their own measurement system internally." [10]

5.5 System aspects

5.5.1 Inexperienced system

Based on the lack of communities in Sweden, several of the informants point out that the Swedish market and energy system is inexperienced. This inexperience risks hindering the development of the communities.

Since energy communities are a new phenomenon in Sweden, Jan Johansson (Ö) suggests that it will take some time getting used to. Most actors are not used to cooperating over matters such as energy, but Jan Johansson (Ö) believes that this mostly is a matter of habit. Furthermore, Adam Engström (E.ON) argues that since energy communities is a new concept, the inexperience of the energy system means that there is a lack of support structure for the communities. David Larsson (S) further adds that the inexperience of the lawmakers can prove to be detrimental for the development of the energy communities since this might make them act too conservative when putting a legislation in motion. Another challenge stated by Anna Werner (SS) is the political system of Sweden. She argues that it is heavily influenced by lobbyism and that the future regulatory framework regarding energy communities therefore is in risk of facilitating the actor that pays the most rather than caring for the climate and renewable energy.

5.5.2 New perspective

Independent of whether the Swedish energy communities succeed or fail, the communities entail an alternative to the centralized system. By constituting an alternative, they can facilitate for a new way of thinking.

Fredrik Lundström (EM) suggests that perhaps the most important aspect energy communities can contribute with is by acting as an alternative to the centralized energy system, thereby creating a discussion. By creating a discussion, Fredrik Lundström (EM) argues that energy communities can act as an enabler in the transition towards a more decentralized energy system:

> "This can be one of those puzzle pieces that you look back on and say, it was sort of the first step which we did not understand at the time." [11]

Similarly, Jan Johansson (Ö) states that energy communities can make us look beyond the limits of private properties and Adam Engström (E.ON) further states that the communities can shift focus from thinking in separate solutions to a wider system perspective.

5.5.3 Regulatory framework

throughout the interviews, the regulatory framework was identified as a deciding factor for the future of the Swedish energy communities.

The regulatory framework is brought up by several actors as a crucial piece of the puzzle to implement more energy communities in Sweden. Jan Johansson (Ö) means that there are fundamental legislative hindrances, such as the communities not being allowed to both produce energy and distribute it on an internal grid. Additionally,

David Larsson (S) states that one of the most limiting factors in the regulatory framework of today is its focus on property limits. When asked why, he answered as follows:

> "[...] it does not matter if my neighbor uses the electricity, it has the same environmental benefits and should be just as good for the system as if I used it." [12]

Adding to this, David Larsson (S) states that it is essential that we do not limit the size of actors that can participate since we otherwise risk apartment buildings being left out. David Larsson (S) and Adam Engström (E.ON) further state that it is the communities consisting of different consumption patterns where the participants can benefit the most from each other, thereby adding to the importance of diversified actors.

Because of the great importance of the regulatory framework, a majority of the interviewees urge that it needs to be reformed. One change that Erik Ormegard (M) and Jan Johansson (Ö) request is for the framework to be simplified to negate potential confusion. Continuing on this subject, Anna Werner (SS) recommends that one definition is applied to the communities, rather than the two suggested in CEP.

5.5.4 Community grids

When discussing how to best enable for energy communities in a Swedish context, the implementation of local grids came into question.

David Larsson (S) and Jan Johansson (Ö) are of the opinion that energy communities should have the right to both produce energy and distribute the excess energy between the involved properties. Jan Johansson (Ö) argues that this right would not act as a competitor to the main grid, since the two are fulfilling different functions. In contrary, Adam Engström (E.ON) believes that there are more challenges than opportunities when it comes to community owned grids. Strengthening this claim, Adam Engström (E.ON) concludes:

> "[...] this kind of internal grid has been tried in different countries, like that other actors are supposed to manage small local grids, there really is no successful examples of this." [13]

Further complicating the idea of community owned grids, Catherine Lillo (EF) and Maria Andersson Iseppi (GE) state that even if the communities utilizes their own community grids, the main grid still would need to be dimensioned to be able to provide for them.

Table 6: Opportunities and challenges for energy communities according to the interviewed Swedish actors. "Opp." indicates opportunities and "chall." indicates challenges. Note that a missing [x] does not necessarily indicate that the actor in question disagrees with the aspect, rather that it was not explicitly mentioned during the interview. The different colors highlighting the abbreviation indicate what sector the interviewee represents: red = business, blue = governmental authority, yellow = municipality and green = advocacy group.

		E.ON	GE	K	EF	SN	N	EI	EM	M	Ö	SS	S	Total
Social opp.	Added values			X		X	X			X				4
	Consumption patterns											X		1
	Engaging the consumer				X	X		X				X		4
	Justice		X		X	X	X			X	X	X		7
Social chall.	Injustice		X		X					X				3
	Individuality	X		X		X	X			X				5
Technological opp.	Energy security			X					X		X	X		4
	Excelled use of CES	X							X			X	X	4
	Expansion of renewable	X	X	X			X	X		X	X	X	X	9
	Innovation					X							X	2
	Larger projects						X							1
	Optimization	X		X	X				X		X	X	X	7
Technological chall.	Energy insecurity		X			X								2
	Sub-optimization		X		X	X								3
Economical chall.	lack of incentive		X	X	X	X	X	X	X	X	X		X	10
Organizational chall.	Difficult to operate	X	X	X	X	X	X			X	X	X	X	10
	Resources	X	X	X	X					X				5
System opp.	New perspective	X							X		X			3
System chall.	Inexperience	X									X		X	3
	Lobbyism											X		1
	Regulatory framework	X		X			X			X	X		X	6

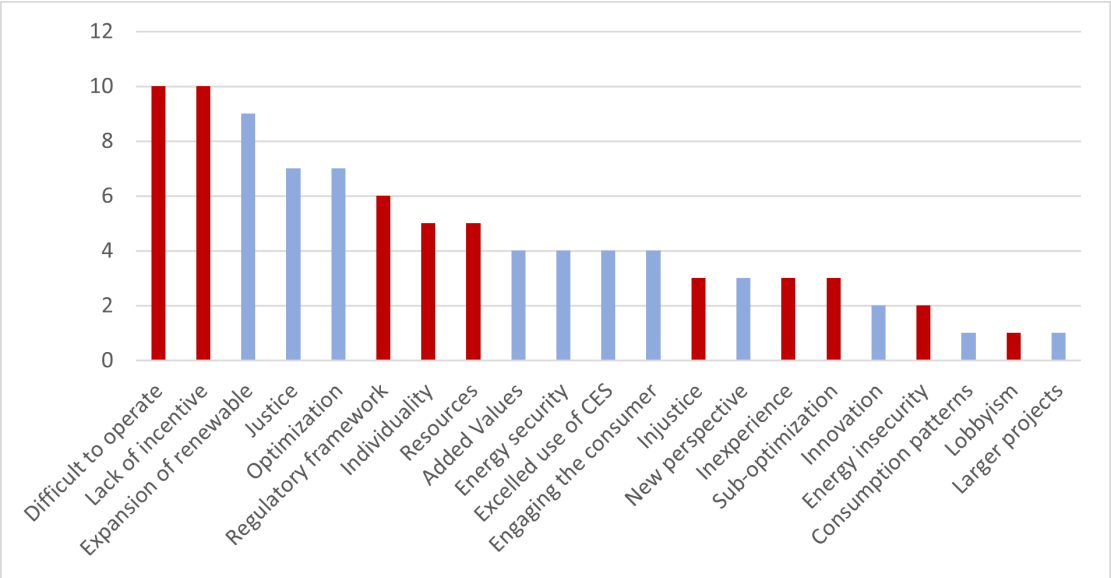

Figure 6: Summary of mentioned aspects, by the interviewees, regarding the implementation of energy communities in Sweden. Red indicates a challenge, blue indicates an opportunity.

Table 7: Important enablers for energy communities brought up by the interviewed Swedish actors. The different colors highlighting the abbreviation indicate what sector the interviewee represents: red = business, blue = governmental authority, yellow = municipality and green = advocacy group.

Actors	Enabler
K, EF, N, EM, M, Ö, SS, S	Reformed regulatory framework
SN, N	Find and communicate incentives
Ö, S	Community grids
E.ON, GE, K, EF, EM, Ö, SS	Cooperation with external actors
M, SS	Support policies
SN, SS	Self consumption
E.ON, S	Diversified actors
E.ON, SS, S	CES
EM	Guaranteed prices through agreement

5.6 Summary of the interview results

The interviews indicate that the opinions regarding what impact energy communities have diverge depending on sector. The business sector, except for E.ON, and the governmental sector state that they foresee a limited impact. In contrary, Örebro Municipality and the advocacy groups see important opportunities coupled to the development of communities. While the interviewed actors saw several opportunities that energy communities can contribute with, the two most mentioned aspects where challenges: "difficult to operate" and "lack of incentive". Additionally, some mentioned opportunities primarily mean social benefits such as added justice in the energy system, rather than environmental. With this said, an expansion of renewable energy as a consequence of energy communities was brought up by 9 of the 12 interviewees. While not all aspects were brought up by all the different actors, three themes showed clear diverging opinions: justice - injustice, energy security - energy insecurity and optimization - sub-optimization. In these three diverging opinions, the business sector is disproportionately represented in the answers indicating challenges.

Regarding enablers for energy communities, there was a clear consensus in what actions were of most importance: a reformation of the regulatory framework, and the cooperation between communities and external actors. Other than those, CES was the only factor that was mentioned by more than two actors.

Discussion and analysis

6.1 Addressing the research questions

First of all, there is a need to address the badly camouflaged elephant in the room, namely the regulatory framework. As Magnusson & Palm (2019) and the informants stated, the future of the Swedish energy communities relies heavily on the outcome of this framework. Some challenges coupled to the communities can turn out more or less impactful depending on the final framework. Since we do not yet know the specific conditions of the up and coming legal framework, it is hard to draw conclusions regarding the future of energy communities in Sweden. Nevertheless, this paper provides a qualified view based on the prerequisites of today. To do this, and thereby simultaneously address the three different research questions of the thesis, this chapter is based on the five overarching categories of aspects that were present throughout the results: social, technological, economical, organizational and system.

In the respective categories, the main challenges and opportunities will be presented in combination with potential enablers. By doing this, the goal is to highlight aspects to take into consideration when implementing energy communities in Sweden. Adding to these categories, the discourse of the Swedish energy system will also be commented upon to untangle if there are any noticeable differences in the opinions of the different interviewed actors.

6.1.1 Social

The social aspect has been portrayed as of big importance for energy communities throughout the literature review. However, there is a clear divergence between the international perspective and what goes in Sweden. The scientific literature, for example Bauwens & Devine-Wright (2018) and Coy et al. (2021), stated that there are great benefits to be found in a higher degree of acceptance of renewable energy and a more engaged consumer. While the aspect of a more engaged consumer was also brought up by the informants from the interviews, it had a less profound presence, and "a higher degree of acceptance" was not mentioned at all. I would argue that this difference in focus can be explained by the national traits of Sweden. Even though Sweden still utilizes a high amount of nuclear energy, Sweden has the largest share of renewable energy in the EU. This indicates that there already is a high acceptance of renewable energy in the population, even if it still can be expanded upon. Furthermore, Kooij et al. (2018) argue that the Swedish population lacks the experience of cooperatives in contrast to, for example, Denmark, and rather prefers to

act on an individual basis. This lack of cooperative experience might be why Sweden has rather focused on individual micro production, which fulfills a similar role as energy communities.

One stated benefit with energy communities and engaged consumers is the possibility to provide them with the ability to affect their own consumption patterns, but this possibility also befalls individual micro production. Furthermore, evidence shows that since individual micro production already has a legislated support structure and might entail less hassle and bureaucracy than the cooperation with others, it can act as a detrimental competitor to the development of energy communities. However, contrary to individual production, energy communities do fulfill a social role and can affect the norms of the participants. Hoppe et al. (2019) concluded that it is social factors rather than environmental awareness that contribute the most to changed consumption patterns. Nevertheless, while the social function could attract some Swedish participants, Kooij et al. (2018) and several of the interviewees state that the Swedish individualistic culture means a generally low demand for cooperative organizations. Thus, I ultimately conclude that the social factor will not increase the attractiveness of the communities in a substantial way.

Another factor that have the potential to favor communities is that not everyone is able to become a micro producer, for example by lacking suitable property. People living in apartments, small municipalities and islands cut of from the main grid are just some examples stated by the interviewees as potential interests where the communities entail new possibilities. This potential interest could mean that the energy communities to some extent tap into a different market than individual micro production. However, even though many people live in apartments and energy communities could fulfill their demand, the lack of incentive was one of the two most mentioned challenges by the interviewees. Because of the general lack of incentives, I suspect that the potential market of people living in apartments would not be enough to create a "boom" for the development of the communities. I further believe that this risk is accentuated in the case of REC. This is because controlling members are required to live or work in proximity of the operation, which makes it harder to find members.

One thing worth noting is that some aspects, such as increased justice in the energy system and primary social benefits, do not strictly aid the transition towards more renewable energy in themselves. However, while these aspects do not affect the transition in a direct way, they can be used as incentives for participants to join the communities. Furthermore, the aspects do have important values of their own, but this goes beyond the scope of this thesis.

6.1.2 Technological

From a technological perspective, energy communities can bring about several optimizing effects, not only locally, but even extending to a national level. They, for example, provide added flexibility and can alleviate some capacity related stress of the main grid by expanding local self consumption and production. In particular, the relief of capacity related stress could be of national interest since it is a big part of the current Swedish energy discourse (Persson, 2019). Additionally, the informants point out that it is more cost-efficient to produce energy in proximity to the point of consumption. On the other hand, some informants stated that energy communities risk sub-optimizing the system by imposing imbalance costs. Continuing on this theme, it was stated that the utilization of self consumption could potentially lead to regressive effects if the self consumption of electricity replaces more efficient methods. However, similarly to the debate in the previous category, these challenges and opportunities apply to individual micro production as well. Whether the summary of these different aspects ultimately entails more of an optimization or sub-optimization on the system is hard to say.

Another aspect of diverging opinions is the question of security. One benefit brought forward by the informants is that since energy communities, in contrast to the centralized system, consist of many small actors, they can provide added resilience in the energy system. However, this trait characterizes a decentralized system and not only the usage of energy communities, meaning that the communities are not a necessity to gain this effect. Similarly, it is suggested that added self-sufficiency in the communities can entail less vulnerability for its participants. However, it was stated during the interviews that added reliance on energy communities, or other decentralized actors, in the main energy system leads to less margins of error. If these margins are breached, energy from fossil fuel can come into question as a temporary replacement. If this need was to arise often, this could foil the goal of 100% renewable energy. Ultimately, the question of security seems to fall more on decentralization vs. centralization, rather than on energy communities specifically.

To utilize the potential of the produced renewable energy efficiently, Bartolini (2020) and Dong et al. (2020) suggest CES as a complementary tool of great importance. The potential of CES was also mentioned by some interviewees, but not to the same degree. In addition to the added efficiency, CES has been shown to provide flexibility to the energy system by alleviating fluctuations between supply and demand. By providing this stabilizing role, CES can act as a complementary tool for renewable energy. However, this complementary role not only applies to CES, but any kind of energy storage, irrespective of if it is performed on an individual, community or enterprise level. Nevertheless, since batteries scale in efficiency with size, Gähr & Knoefel (2020) argue that communities have an advantage over regular

households because of larger assets. In addition, Abada et al. (2020) mean that a higher proportion of PV creates a bigger opportunity for storage. However, if battery efficiency scale with size, then perhaps the responsibility to maintain different storage units in the grid should lie with, for example, the DSO.

6.1.3 Economical

Anyone familiar with the act of calling to action should agree that incentives for participation are of uttermost importance. Rogers et al. (2008) proposed a value-action gap, meaning that principal values are often not enough for people to act. The fact that both Magnusson & Palm (2019) and the interviewees identified a lack of economic incentive for joining energy communities therefore imposes a major barrier. For one, the spot price on electricity in Sweden is low, lessening the gains from self-consumption. Interestingly enough, however, Azarova et al. (2019) did conclude that there is a high WTP for renewable electricity and Sagebiel et al. (2014) noted that this is further increased when the electricity is produced with the possibility of participation. Nevertheless, the effect from this increase in WTP is probably lessened since the communities are supposed to act non-profit. Adding to the lack of economic incentive, the start-up and management of the communities demand large quantities of monetary resources from its participants. This demand for investments entails risks on a personal level, deterring possible participants.

To mitigate some of the lack of economic incentive, supporting policies have been used to great effect in Europe. The tool most prominent through the scientific literature was feed-in tariffs, which Mirzania et al. (2019) and Wierling et al. (2018) state have been critical for the development of energy communities. By utilizing feed-in tariffs, the communities are guaranteed a fixed price during an agreed period of time. Considering the importance of policies throughout the scientific literature, it came as a surprise that only two of the informants mentioned them as important enablers. On the contrary, some interviewees even argued that supporting policies would be unfair to the other actors on the market and instead advocate free competition. However, Bauwens & Devine-Wright (2018) has shown that the number of energy communities dwindles when market mechanics dominate. Furthermore, by focusing on free competition, a deeper problem of vested interests in hydro and nuclear- power is overlooked, which Kooij et al. (2018) state generally counteracts bottom-up movements. Nevertheless, Brown & Lund (2013) argue that this susceptibility indicates that the communities are less cost-effective compared to the other actors in the energy system. I would argue that support policies should be used to jump-start the implementation, to then be phased out. This would act in accordance with the intentions of CEP, which expresses that the member states are to provide a leveled playing field in the energy system for the communities. In addition, one should have in mind that, for

example, individual micro production is already experiencing supporting policies in Sweden, albeit not through feed-in tariffs.

Another crucial factor to handle the economic incentive is the ability of self consumption, a core aspect of the communities. If the communities are exposed to high fees for the transmission of the produced energy, then sharing will be economically unreasonable. Similarly, this also goes if the communities are not allowed to consume the produced electricity, instead having to sell it to the market to then re-buy it at a higher cost. Without a flexible option for self consumption, I fear that the point of the communities will be missed by the Swedish legislation.

6.1.4 Organizatory

Dóci (2021), among others, state that the management of the communities can be a handful for its participants. The communities rely on voluntary participants, meaning that resources such as money, labor and relevant knowledge can be hard to acquire. This is further accentuated since REC are supposed to act non-profit. Some informants drew a parallel to the management of housing associations but ultimately concluded that the governance of the communities entails more difficulties. I would argue that this lack of resources, a trait often characterizing the bottom-up movements, can be highly problematic since it is hard to circumvent.

Seyfang et al., 2013 suggest that a hybrid-model consisting of partnerships with enterprises and municipalities can aid by contributing with sector-specific knowledge and experience. Strengthening this claim, Magnusson & Palm (2019) concluded that established contacts with energy companies was a common denominator for successful PV-communities in Sweden. Furthermore, Roby & Dibb (2019) argue that this partnership could act beneficially for the businesses partaking in it. Even so, actors from the energy sector are not allowed by CEP to be members of REC. Consequently, this engaged cooperative role of the energy companies was not even brought up by the informants. Instead, the role as a provider of services was emphasized. Furthermore, while it has been shown that communities often need to hire professional assistance, I suspect that the general lack of money could prove this alternative difficult, at least for the smaller communities.

6.1.5 System

While the Swedish energy system does utilize a high degree of nuclear power, it still consists of a high share of renewable energy. Based on the prominent presence of renewable energy, one informant suggests that the environmental benefits of the communities will not be as clear as they perhaps are in countries using more fossil fuels. If this argument stands true, I believe that the high share of renewable energy

could mean that Swedish citizens are less eager to engage personally, feeling that the transition is already on its way.

During the interviews, it emerged that the Swedish energy system is inexperienced concerning energy communities. This inexperience can be seen in that Sweden lacks a regulatory framework and that the number of active communities is low. Problematizing this, the informants state the regulatory framework as a crucial enabler for the future of the communities, since it decides factors such as the possibility for self consumption and bureaucratic accessibility. Consolidating the importance of a regulatory framework, CEP states that member countries of the EU are required to provide an enabling framework (Caramizaru & Uihlein, 2020). However, two informants were concerned that the inexperience of the lawmakers could entail a too conservative framework. Furthermore, one of the informants states that the need for energy communities are less evident in Sweden because of our already high share of renewable energy. I agree that the need might be less evident in Sweden, and would further argue that this in turn can amplify the risk of a conservative framework. The risk of communities being overlooked might be further increased since the Swedish energy system has already vested interests in hydro- and nuclear power.

Several of the informants suggest that the way communities can leave the largest imprint is by providing a new perspective. By acting as an alternative to the centralized system, irrelevant of the success of the communities, the communities can help set the ball into motion. As an effect, one interviewee mentioned the possible transition from thinking in separate solutions to a wider system perspective, which was stated as more efficient. The potential of this scenario should not be overlooked since it means that even if energy communities themselves are not implemented to a large scale, they can help facilitate future tools of decentralization.

6.1.6 The discourse of the Swedish energy system

On a whole, the opinions of the different interviewed actors were of a similar nature in that several opportunities as well as challenges were identified. The opinions diverge regarding: security - insecurity, justice - injustice, and optimization - suboptimization. In this debate, the business sector was overrepresented in identifying the potential downsides. The reason for this could lie in the difference of perspectives between the sectors. Energy companies fulfill a similar role to the communities, they might therefore have first-hand experience regarding challenges that the other actors do not have. Furthermore, energy communities can act competitively to the energy companies, this potential of conflict could mean that the business sector feels more cautious towards the implementation of energy communities than the other sectors. In contrast, when asked about the potential impact of communities, only the advocacy groups and Örebro municipality predicted an impact in the near future. As before, this could be because of the difference in perspectives.

6.1.7 Concluding remarks

Based on the results of this study, it is clear that the implementation of energy communities can entail several opportunities for the energy system. However, I do believe that the opportunities is of a lessened effect in a country like Sweden where the transition towards 100% renewable energy has come relatively far. I further mean that while there are clear opportunities and we need to continue expanding our renewable energy share to reach the Swedish targets, there are too many potential pitfalls connected to the implementation of the communities. In addition to this, Sweden has already invested in individual micro production. While this investment can prove harmful to the development of the communities, it fulfills a similar role to the communities in an environmental context. The similarities suggest that energy communities do not stand out as a tool to reach a higher share of renewable energy.

In accordance with the majority of the informants, I would argue that the impact of the communities will be limited in Sweden. However, I want to emphasize that since Sweden still utilizes an energy system that give rise to nuclear waste, it is vital that we keep all doors open to be able to reach the goal of 100% renewable energy by year 2040. Thus, I believe that irrespective of the predicted presence of the communities, Sweden needs to create a leveled playing field for the communities.

6.2 Discussion of the method

The literature review in this study only encompassed scientific articles. This can be of use to establish a solid basis of knowledge in a Swedish context. However, the focus on scientific articles meant that other documents of interest, such as governmental reports and material from advocacy groups, were excluded from the literature review.

During the study, CES was touched upon as a complementary tool to energy communities. However, this tool was not stated explicitly in the question form for the interviewees. Because of the potential importance of CES, a question about it could have been included.

The selection of the interviewees was based on actors that had published a comment on the report "Ren Energi inom EU - Genomförande av fem rättsakter". However, this report did not only encompass energy communities. While I did make sure that all the interviewed actors had commented upon the subject of energy communities, the focus on it varied. In addition to this, the perspective of the interviewees differed, with some more focused on environmental aspects and some more on the system or legislative aspects. Furthermore, "the business sectors" disproportionately constituted the interviewees. While this distribution happened by chance, it could affect the end result, especially since the business sector majorly identified challenges.

Because of the scale of this study, this paper does not include interviews with

citizens or different existing communities. However, the opinion of the citizens could be highly relevant to appraise a general demand. Furthermore, the study only encompassed REC and not CEC. This was because the focus of REC is on renewable energy while the focus of CEC is on non-commercial actors. However, the exclusion of CEC means that the conclusions from this study do not necessarily apply to all definitions of energy communities.

6.3 Future research

While this study concluded that energy communities probably will have a limited impact in an environmental context, a large part of their role lies in the social factor. It would therefore be of interest to research if there is a demand in Sweden for the social role that the communities can fulfill. Furthermore, since this study did not encompass the perspective of the citizen or the existing communities, their views could be further researched upon.

Lastly, because of the scalability of energy storage, it could be of interest to study the environmental values of CES compared to solutions provided by actors such as the DSO.

Conclusions

The main conclusions of the study are as follows:

- There are several opportunities and challenges coupled to the implementation of energy communities in Sweden. However, the challenges seem to surpass the opportunities. In addition to this, several of the environmental benefits can be fulfilled by other tools, such as individual micro production.
- The opinions of the interviewed actors generally match each other. They diverge in that the business sector tends to see more challenges and the advocacy groups more opportunities.
- To enable for the communities, the regulatory framework is of uttermost importance. Adding to this, supporting policies such as feed-in tariffs and cooperation with external actors has been shown to act beneficially towards the success of energy communities.
- Based on the prerequisites for the Swedish energy communities, they will most likely not act as a tool of impact concerning the Swedish goal of 100% renewable energy. However, the communities can pave the way for future tools of decentralization.

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References

Abada, I., Ehrenmann, A., & Lambin, X. (2020). Unintended consequences: The snowball effect of energy communities. Energy Policy, 143, 111597. https://doi.org/10.1016/j.enpol.2020.111597

Abnett, K. (2021). *EU experts to say nuclear power qualifies for green investment label: document.* May 10, 2021. https://www.reuters.com/article/us-europe-regulations-finance-idUSKBN2BJ0F0

Akizu, O., Bueno, G., Barcena, I., Kurt, E., Topaloğlu, N., & Lopez-Guede, J. (2018). Contributions of Bottom-Up Energy Transitions in Germany: A Case Study Analysis. Energies, 11(4), 849. https://doi.org/10.3390/en11040849

Azarova, V., Cohen, J., Friedl, C., & Reichl, J. (2019). Designing local renewable energy communities to increase social acceptance: Evidence from a choice experiment in Austria, Germany, Italy, and Switzerland. Energy Policy, 132, 1176-1183. https://doi.org/10.1016/j.enpol.2019.06.067

Bartolini, A., Carducci, F., Muñoz, C. B., & Comodi, G. (2020). Energy storage and multi energy systems in local energy communities with high renewable energy penetration. Renewable Energy, 159, 595-609. https://doi.org/10.1016/j.renene.2020.05.131

Bauwens, T. (2016). Explaining the diversity of motivations behind community renewable energy. Energy Policy, 93, 278-290. https://doi.org/10.1016/j.enpol.2016.03.017

Bauwens, T., & Devine-Wright, P. (2018). Positive energies? An empirical study of community energy participation and attitudes to renewable energy. Energy Policy, 118, 612-625. https://doi.org/10.1016/j.enpol.2018.03.062

Bauwens, T., Gotchev, B., & Holstenkamp, L. (2016). What drives the development of community energy in Europe? The case of wind power cooperatives. Energy Research & Social Science, 13, 136-147. https://doi.org/10.1016/j.erss.2015.12.016

Bridge Horizon. (2019). *Energy Communities in the EU - Task Force Energy Communities* (D3.12.d). https://www.h2020-bridge.eu/wp-content/uploads/2020/01/D3.12.d_BRIDGE_Energy-Communities-in-the-EU-3.pdf

Bryman, A. (2011). *Samhällsvetenskapliga metoder* (2., [rev.] uppl. ed.) [Non-fiction]. Liber.

Bryman, A., & Bell, E. (2017). *Företagsekonomiska forskningsmetoder* (Upplaga 3 ed.) [Non-fiction]. Liber.

Burger, C., Froggatt, A., Mitchell, C., & Weinmann, J. (2020) *Decentralised Energy – a Global Game Changer.* Ubiquity Press Ltd.

Capellán-Pérez, I., Campos-Celador, Á., & Terés-Zubiaga, J. (2018). Renewable Energy Cooperatives as an instrument towards the energy transition in Spain. Energy Policy, 123, 215-229. https://doi.org/10.1016/j.enpol.2018.08.064

Caramizaru, A., & Uihlein, A. (2020). *Energy communities: and overview of energy and social innovation*(EUR 30083 EN). Publications office of the European union. https://publications.jrc.ec.europa.eu/repository/bitstream/JRC119433/energy_communities_report_final.pdf

Corson, R., Regan, R., & Carlson, S. (2014). Implementing energy storage for peak-load shifting. January 04, 2020. https://www.csemag.com/articles/implementing-energy-storage-for-peak-load-shifting/

Coy, D., Malekpour, S., Saeri, A. K., & Dargaville, R. (2021). Rethinking community empowerment in the energy transformation: A critical review of the definitions, drivers and outcomes. Energy Research & Social Science, 72, 101871. https://doi.org/10.1016/j.erss.2020.101871

Dalhammar, C., & Hjärne, A. (2018, 2018/01/01/). The use of consumer data to optimize smart grids for electricity and district heating.

Devine-Wright, P. (2019). Community versus local energy in a context of climate emergency. Nature Energy, 4(11), 894-896. https://doi.org/10.1038/s41560-019-0459-2

Directive 2018/2001. *on the promotion of the use of energy from renewable sources.* The European parliament, Council of the European Union. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.328.01.0082.01.ENG

Directive 2019/944. *Om gemensamma regler för den inre marknaden för el och om ändring av direktiv 2012/27/EU.* European Parliament, Council of the European Union. https://eur-lex.europa.eu/legal-content/SV/TXT/PDF/?uri=CELEX:32019L0944&from=SV

Dóci, G. (2021). Collective Action with Altruists: How Are Citizens Led Renewable Energy Communities Developed? Sustainability, 13(2), 507. https://doi.org/10.3390/su13020507

Dong, S., Kremers, E., Brucoli, M., Rothman, R., & Brown, S. (2020). Techno-enviro-economic assessment of household and community energy storage in the UK. Energy Conversion and Management, 205, 112330. https://doi.org/10.1016/j.enconman.2019.112330

Eliasson, A. (2018). *Kvantitativ metod från början* (Fjärde upplagan ed.) [Non-fiction]. Studentlitteratur.

Energikontor sydost. (2020). (*Community energy - Hur man utvecklar förnybar energi tillsammans.* March 17, 2021. https://s3-eu-west-1.amazonaws.com/static.wm3.se/sites/400/media/416933_Co2mmunity-handbook-SE-Handbok-Sverige.pdf?1586239000

Energimarknadsinspektionen. (2019). *Undantag från kravet på nätkoncession - IKN.* April 06, 2021. https://www.ei.se/bransch/koncessioner/undantag-fran-kravet-pa-natkoncession---ikn

Energimyndigheten. (2020). *Energiindikatorer 2020 Uppföljning av Sveriges Energipolitiska mål*(ER 2020:18). https://energimyndigheten.a-w2m.se/Home.mvc?ResourceId=172610

European Commission. (2019). *Clean energy for all Europeans.* Publications office of the European Union. https://op.europa.eu/en/publication-detail/-/publication/b4e46873-7528-11e9-9f05-01aa75ed71a1/language-en?WT.mc_id=Searchresult&WT.ria_c=null&WT.ria_f=3608&WT.ria_ev=search

European Commission. (2020). *ASSET Study on Energy Communities in the Clean Energy Package: Best Practices and Recommendations for Implementation.* Publications office of the European Union. https://op.europa.eu/en/publication-detail/-/publication/4b7d5144-91c9-11eb-b85c-01aa75ed71a1/language-en?WT.mc_id=Searchresult&WT.ria_c=37085&WT.ria_f=3608&WT.ria_ev=search

Eurostat. (2020). *Renewable energy in the EU in 2018.* https://ec.europa.eu/eurostat/documents/2995521/10335438/8-23012020-AP-EN.pdf/292cf2e5-8870-4525-7ad7-188864ba0c29

Frieden, D., Tuerk, A., Roberts, J., D'Herbemont, S., Gubina, A. F., & Komel, B. (2019). Overview of emerging regulatory frameworks on collective self-consumption and energy communities in Europe. http://doi.org/10.1109/EEM.2019.8916222

Ghorbani, A., Nascimento, L., & Filatova, T. (2020). Growing community energy initiatives from the bottom up: Simulating the role of behavioural attitudes and leadership in the Netherlands. Energy Research & Social Science, 70, 101782. https://doi.org/10.1016/j.erss.2020.101782

Gährs, S., & Knoefel, J. (2020). Stakeholder demands and regulatory framework for community energy storage with a focus on Germany. Energy Policy, 144, 111678. https://doi.org/10.1016/j.enpol.2020.111678

Hahnel, U. J. J., Herberz, M., Pena-Bello, A., Parra, D. & Brosch, T. (2020). Becoming prosumer: Revealing trading preferences and decision-making strategies in peer-to-peer energy communities. Energy Policy, 137, 111098. https://doi.org/10.1016/j.enpol.2019.111098

Hargreaves, T., Hielscher, S., Seyfang, G., & Smith, A. (2013). Grassroots innovations in community energy: The role of intermediaries in niche development [Article]. Global Environmental Change, 23(5), 868-880. https://doi.org/10.1016/j.gloenvcha.2013.02.008

Heldeweg, M. A., & Séverine, S. (2020). Renewable energy communities as 'socio-legal institutions': A normative frame for energy decentralization? Renewable and Sustainable Energy Reviews, 119, 109518. https://doi.org/10.1016/j.rser.2019.109518

Hoppe, T., Coenen, F., & Bekendam, M. (2019). Renewable Energy Cooperatives as a Stimulating Factor in Household Energy Savings. Energies, 12(7), 1188. https://doi.org/10.3390/en12071188

Husblad, R., Morén, G., Nordström, J., Nylander, C, V., Tedebrand, L., & Wahlberg, S. (2020). *Ren energi inom EU ett genomförande av fem rättsakter*(Ei R2020:02). Energimarknadsinspektionen. https://www.ei.se/om-oss/publikationer/publikationer/rapporter-och-pm/2020/ren-energi-in om-eu---ett-genomforande-av-fem-rattsakter---ei-r202002

Johannessen, A., & Tufte, P. A. (2003). *Introduktion till samhällsvetenskaplig metod* (1. uppl. ed.) [Non-fiction]. Liber.

Kooij, H.-J., Oteman, M., Veenman, S., Sperling, K., Magnusson, D., Palm, J.,& Hvelplund, F. (2018). Between grassroots and treetops: Community power and institutional dependence in the renewable energy sector in Denmark, Sweden and the Netherlands. Energy Research& Social Science, 37, 52-64. https://doi.org/10.1016/j.erss.2017.09.019

Lowitzsch, J., Hoicka, C. E., & Van Tulder, F. J. (2020). Renewable energy communities under the 2019 European Clean Energy Package – Governance model for the energy clusters of the future? Renewable and Sustainable Energy Reviews, 122, 109489. https://doi.org/10.1016/j.rser.2019.1094 89

Magnusson, D., & Palm, J. (2019). Come Together—The Development of Swedish Energy Communities. Sustainability, 11(4), 1056. https://doi.org/10.3390/su11041056

Mignon, I., & Ebers Broughel, A. (2020). What interests do intermediaries prioritize during wind- and solar project development? Environmental Innovation and Societal Transitions, 36, 393-405. https://doi.org/10.1016/j.eist.2020.01.014

Mignon, I., & Rüdinger, A. (2016). The impact of systemic factors on the deployment of cooperative projects within renewable electricity production – An international comparison. Renewable and Sustainable Energy Reviews, 65, 478-488. https://doi.org/10.1016/j.rser.2016.07.026

Ministry of the environment. (2020). *Sweden's long-term strategy for reducing greenhouse gas emissions.* https://unfccc.int/sites/default/files/resource/LTS1_Sweden.pdf

Minuto, F. D., Lazzeroni, P., Borchiellini, R., Olivero, S., Bottaccioli, L., & Lanzini, A. (2021). Modeling technology retrofit scenarios for the conversion of condominium into an energy community: An Italian case study. Journal of Cleaner Production, 282, 124536. https://doi.org/10.1016/j.jclepr o.2020.124536

Mirzania, P., Ford, A., Andrews, D., Ofori, G., & Maidment, G. (2019). The impact of policy changes: The opportunities of Community Renewable Energy projects in the UK and the barriers they face. Energy Policy, 129, 1282-1296. https://doi.org/10.1016/j.enpol.2019.02.066

Naturskyddsföreningen. (n.d.). *Även lägenheter borde få avdrag för egen elkraft* March 06, 2021. https://www.naturskyddsforeningen.se/nyheter/aven-lagenheter-borde-fa-avdrag-egen-elkraft

Nätkoncessionsutredningen. (2019). *Moderna tillståndsprocesser för elnät.* (SOU 2019:30). Norstedts Juridik. https://www.regeringen.se/4ada75/contentassets/44f30a8f474440adae314f86d43 11f74/sou-2019_30_webb.pdf

Persson, F. (2019). *Uppdrag till Energimarknadsinspektionen om kapacitetsbrist i elnäten* May 07, 2021. https://www.regeringen.se/pressmeddelanden/2019/10/uppdrag-till-energimarknadsinsp ektionen-om-kapacitetsbrist-i-elnaten/

Quiggin, J. (2020) *Too cheap to meter.* January 05, 2021. https://insidestory.org.au/too-cheap -to-meter/

REScoop.EU. (n.d). *Energy communities under the clean energy package.* https://www.rescoo p.eu/uploads/rescoop/downloads/Energy-Communities-Transposition-Guidance.pdf

REScoop.EU,. & MECISE. (2020). *Mobilising European Citizens to Invest in Sustainable Energy clean energy for all Europeans.* https://uploads.strikinglycdn.com/files/d6207111-e449-4d97-957e

-0f89d5ba91fd/Mobilising%20European%20Citizens%20to%20Invest%20in%20Sustainable%20Energy.pdf?id=149770

Roby, H., & Dibb, S. (2019). Future pathways to mainstreaming community energy. Energy Policy, 135, 111020. https://doi.org/10.1016/j.enpol.2019.111020

Rogers, J. C., Simmons, E. A., Convery, I., & Weatherall, A. (2008). Public perceptions of opportunities for community-based renewable energy projects. Energy Policy, 36(11), 4217-4226. https://doi.org/10.1016/j.enpol.2008.07.028

Rogers, J. C., Simmons, E. A., Convery, I., & Weatherall, A. (2012). Social impacts of community renewable energy projects: findings from a woodfuel case study. Energy Policy, 42, 239-247. https://doi.org/10.1016/j.enpol.2011.11.081

Sagebiel, J., Müller, J. R., & Rommel, J. (2014). Are consumers willing to pay more for electricity from cooperatives? Results from an online Choice Experiment in Germany. Energy Research & Social Science, 2, 90-101. https://doi.org/10.1016/j.erss.2014.04.003

Schoor, T. V. D., Lente, H. V., Scholtens, B., & Peine, A. (2016). Challenging obduracy: How local communities transform the energy system. Energy Research & Social Science, 13, 94-105. https://doi.org/10.1016/j.erss.2015.12.009

Sebi, C., & Vernay, A.-L. (2020). Community renewable energy in France: The state of development and the way forward. Energy Policy, 147, 111874. https://doi.org/10.1016/j.enpol.2020.111874

Seyfang, G., Park, J. J., & Smith, A. (2013). A thousand flowers blooming? An examination of community energy in the UK. Energy Policy, 61, 977-989. https://doi.org/10.1016/j.enpol.2013.06.030

Skatteverket. n.d.a. *Mikroproduktion av förnybar el – privatbostad.* January 01, 2021. https://skatteverket.se/privat/fastigheterochbostad/mikroproduktionavfornybarelprivatbostad.4.12815e4f14a62bc048f41a7.html

Skatteverket. n.d.b. *Grön teknik.* February 04, 2021. https://www.skatteverket.se/privat/fastigheterochbostad/gronteknik.4.676f4884175c97df4192860.html

Soeiro, S., & Ferreira Dias, M. (2020). Renewable energy community and the European energy market: main motivations. Heliyon, 6(7), e04511. https://doi.org/10.1016/j.heliyon.2020.e04511

Solelkommissionen. (2020). *Flytt av el.* March 08, 2021. http://www.solelkommissionen.se/flytt-av-el/

Vetenskapsrådet. (2002) *Forskningsetiska principer inom humanistisk-samhällsvetenskaplig forskning.* Elanders Gotab. https://www.lincs.gu.se/digitalAssets/1268/1268494_forskningsetiska_principer_2002.pdf

Walker, G., & Devine-Wright, P. (2008). Community renewable energy: What should it mean? Energy Policy, 36(2), 497-500. https://doi.org/10.1016/j.enpol.2007.10.019

Warren, C. R., & McFadyen, M. (2010). Does community ownership affect public attitudes to wind energy? A case study from south-west Scotland. Land Use Policy, 27(2), 204-213. https://doi.org/10.1016/j.landusepol.2008.12.010

Wierling, A., Schwanitz, V., Zeiß, J., Bout, C., Candelise, C., Gilcrease, W., & Gregg, J. (2018). Statistical Evidence on the Role of Energy Cooperatives for the Energy Transition in European Countries. Sustainability, 10(9), 3339. https://doi.org/10.3390/su10093339

Winkler, C. (2021). *Utveckling av helhetslösning för solel i bebyggelsen - Projekt.* January 12, 2021. https://www.bebostad.se/projekt/teknikutvecklingsprojekt/utveckling-av-helhetslosning-for-solel-i-bebyggelsen

Yildiz, Ö., Rommel, J., Debor, S., Holstenkamp, L., Mey, F., Müller, J. R., Radtke, J., & Rognli, J. (2015). Renewable energy cooperatives as gatekeepers or facilitators? Recent developments in Germany and a multidisciplinary research agenda [Review Article]. Energy Research & Social Science, 6, 59-73. https://doi.org/10.1016/j.erss.2014.12.001

Appendix

A.1 Search variables used in the literature review

Table 8: Variables used for search in the literature review. Number [**X**] marked in bold indicates that the search was used in the study.

Search engine & date	Search blocks	Filters	Results (n)
[1]: Scopus, January 28, 2021	Title: (community* OR "energy cooperativ*" OR rec) AND Topic: ("Renewable energ*" OR "green energ*" OR sustainab*) AND Title: (Opportunit* OR benefit* OR impact* OR effect* OR drawback* OR challenge* OR impact* Energ* OR perform*)	Article, conference paper and review, English	100
[**2**]: Scopus, January 29, 2021	TITLE: ("Community energ*" OR "energy communit*" OR "Community renewable energy*" OR "energy cooperativ*" OR rec OR "RE cooperativ*") AND Topic: ("Renewable energ*" OR "green energ*" OR sustainab*) AND Topic: (opportunit* OR benefit* OR impact* OR effect* OR drawback* OR challenge* OR impact* AND energ* OR perform*)	Article, English	140
[**3**]: January 29, 2021	Topic: "Community energ*" OR "energy communit*" OR "Community renewable energy*" OR "energy cooperativ*" OR rec OR "RE cooperativ*") Topic: (swed*)	Article, English	34

A.2 Question form

intervjufrågor

Personligt

1. Namn, position i organisationen och hur länge har du innehaft positionen?

Grundläggande förståelse

1. Hur arbetar den organisation du representerar med frågan kring energigemenskaper?
2. Har du jobbat med energigemenskaper i ditt arbete?
   (a) Ja) På vilket sätt?
3. Vad karaktäriserar en energigemenskap för dig?

Energigemenskapens roll i Sverige

1. Vad för roll ser du för energigemenskaper i Sverige nu och i framtiden?
2. Hur tror du att efterfrågan på energigemenskaper i Sverige ser ut?
3. Vad tror du krävs för att möjliggöra för implementeringen av energigemenskaper?
   - *Om kommun gå till fråga 7*
4. Hur tror du att rollen för de klassiska elbolagen kommer att påverkas av energigemenskaper?
5. Vilken samverkanspotential finns det mellan de klassiska elbolagen och energigemenskaperna?
6. Vad för roll kan de klassiska elbolagen spela i att underlätta för energigemenskaper?
   - *Gå till fråga 9*
7. Vilken samverkanspotential finns det mellan kommuner och energigemenskaper?
8. Vad för roll kan kommunerna spela i att underlätta för energigemenskaper?

9. Vilka tycker du är de största möjligheterna energigemenskaperna kan innebära för Sverige?

10. Vad för utmaningar tror du kommer vara mest framträdande för energigemenskaperna?

11. Vad, om några, tror du de eventuella konflikterna mellan att ingå i en energigemenskap och att producera energi på egen hand är?

12. Tror du att energigemenskaper kommer att få en betydande roll i det svenska energisystemet?

13. Bör Sverige satsa mer på energigemenskaper?

14. Finns det en risk att arbete med energigemenskaper gör att vi bortprioriterar sådant som egentligen är viktigare för att få ett hållbart energisystem?

15. Finns det något du vill tillägga?

A.3 Quotes

1. En annan aspekt är möjligen att engagemanget och intresset för, hos kunderna ökar

2. det man kallar statsindividualism.

3. eftersom vi har behövt sätta igång oljeeldat kraftverk i Karlshamn [...] att vi inte har tillräckligt med energi i driftläget [...].

4. då ser jag att det är liksom mer batterier som är the holy grail där.

5. men om det är stora transaktionskostnader om vi flyttar den här elen fram och tillbaks flera gånger, då kommer vi ändå inte att kunna använda det [elen] därför att det blir en ekonomisk orimlig lösning.

6. EU består av många olika länder och regioner med olika förutsättningar att det kan innebära nytta i någon del av EU och mindre i någon annan [Sverige].

7. vi behöver också se på beskattningen av energi på ett annat sätt, det är min övertygelse.

8. Det är stort nog att köpa sina egna solceller och att då organisera sig tillsammans med andra och fördela risker och vinster och sådant där, det är ju mycket jobb.

9. Det skulle räcka med ett enkelt avtal tror jag för att hantera det, inte att man ska liksom, ha en ekonomisk förening med årsstämma.

10. du får massor av energiemenskaper så kommer inte var och en av dom att uppfinna sitt avräkningssystem internt.

11. Det här kan vara en sån pusselbit som man tittar tillbaks på och säger att det, ja det var liksom ett första steg, det förstod vi inte då.

12. det spelar ingen roll att min granne använder elen, det blir ju samma miljönytta och det borde bli lika bra för systemet som om att jag använder den.

13. man har ju försökt i andra länder just det här IKN-nät, alltså att andra aktörer ska driva små elnät, det finns ju egentligen inga lyckade exempel på det.

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