Becoming green together

The case of SAENZ

Figure 1: Renewable energy electricity scheme (Petovarga, 2021).

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Abstract

To reach the Dutch renewable energy (RE) targets of 2030, the entire Netherlands has been investing in solar energy, electric vehicles and other systems based on RE. This increase of electricity use does not come without problems and the most pressing one is that of network congestion. Due to this, businesses are no longer able to expand their electricity connection or even start their business to begin with. This has the effect that businesses cannot continue their sustainable efforts and in the worst cases it causes power to go out and stopping businesses from operating completely. A proposed solution to this problem is the introduction of a community energy system (CES). This concept and how it can be used in practice will be explored in this research in the context of an industrial park and with the support of business energy cooperative, SAENZ. They have already developed an industrial community energy system (InCES) in the form of a collective energy contract, and there is an opportunity in increasing the participation of their members. Through interviews and surveys, business owners are asked about three InCES scenarios and their more general opinion on InCES. To obtain a comprehensive view of the situation, two other stakeholders in this system are interviewed as well. These are the distribution systems operator (DSO) and the local government. The results show that business owners are willing to increase their participation in an InCES but give clear terms for doing so. They need transparent and complete information about the project and all its financial and juridical aspects. Besides, it should be easy to participate. The DSO highlighted that they support businesses organizing themselves like this and comments on how an InCES could help solve network congestion as it ensures efficient management of the energy system. The local government representative believes that they have little influence on the development of an InCES but that they do have an impact in motivating businesses to participate in an InCES. The research also shows the importance of an energy cooperative or any kind of group collaboration between businesses to organize an InCES. It is helpful in obtaining contact with stakeholders but also enhanced the group feeling between business owners and in turn their willingness to increase participation in an InCES.

Key concepts: industrial community energy system (InCES), network congestion, local energy cooperative, industrial park

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List of abbreviations

Abbreviation	Description
CES	Community Energy System
DER	Distributed Energy Resources
DES	Distributed Energy Systems
DSO	Distribution Systems Operator
ESP	Energy Sharing Platform
EV	Electric Vehicle
GTO	Groepstransportovereenkomst (Group Transportation Agreement)
GTV	Gecontracteerd Transport Vermogen (Contracted Transport Capacity)
ICES	Integrated Community Energy System
IE	Industrial Ecology
InCES	Industrial Community Energy System
LAN	Landelijk Actieprogramma Netcongestie (National Actionprogram Network congestion)
PV	Photovoltaic (solar energy)
RE	Renewable Energy
SME	Small Medium Enterprise
TSO	Transmission Systems Operator

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1. Introduction

Over the years, humans have improved their welfare and social living standards. However, this came at a price for the biophysical state of the earth and boundaries regarding the limits to which the Earth's resources can provide this lifestyle (O'Neill et al., 2018). Our current way of living cannot be sustained for future generations. As the planet is increasingly getting warmer, adverse climate impacts become more frequent. Heatwaves become more frequent and in 2023 the hottest summer ever was recorded in Europe (C3S, 2023). Due to the warming of the oceans, coral reefs experience bleaching and there are increasingly more flood and extreme precipitation events (IPCC, 2023). Meinshausen et al. (2022) argue that even when all the goals and measures of the Paris Agreement pledges are achieved and executed within the suggested time limit, it will only limit global warming to just below 2°C. Thus, the time for change is now.

In order to navigate towards a more sustainable world, the European Union introduced the Renewable Energy Directive in 2009 as part of the transition to clean energy (European Commission, 2023). To speed up this transition the directive has become legally binding since June 2021 and countries should adhere to a renewable energy (RE) target of at least 42,5% by 2030. In the Netherlands, the share of renewable energy was between 12-13,4% in 2021 (CBS, 2022), which means there is still a long way to go until the target of 42,5% is reached. Unequivocally, this raises the question how the Netherlands will be able to increase their renewable energy share by thirty percent within 6 years. The Dutch government focuses mostly on homeowners to reduce their energy consumption and increase their use of renewable energy (MBZK, 2022; MEZK, 2022). While these efforts are important, it seems that they overlook business owners. This is starkly highlighted by the fact that at the moment of writing, 85% of the 30 million euros allocated to the subsidy for Renewable Energy Transition (HER+) is still available (RVO, 2017). The industry in the Netherlands uses 40% of the total amount of energy, whereas households account for only 14% (CLO, 2022) . The Netherlands has around 3.800 industrial parks which means that the impact of making these industrial parks more sustainable could be exceptionally large (IPO, 2022). The question thus remains, how these parks can become more sustainable to help the Netherlands reach its renewable energy target as quickly as possible.

Historically, the European energy sector has been an economically important, highly regulated but mostly traditional sector (Wolsink, 2020). However, with the current climate crisis also this sector has been subject to radical changes. Where innovations within the field used to be incremental and top-down, a new trend is seen due to the energy transition where innovations are more disruptive and bottom-up (Hoppe et al., 2018). Over the last years the entire Netherlands has been investing in photovoltaic (PV) panels to generate solar energy in an attempt to become more sustainable. This resulted in an impressive 30% increase of solar energy use in 2022 (RVO, 2023). However, this ambition to use more solar energy creates a new problem, namely congestion of the electricity grid (Braat et al., 2021; Ghaemi et al., 2023). Congestion of the electricity grid is "a situation in which a power line has reached the limits of safe operation, as a result of which requests for deliveries (transactions)... cannot be physically implemented" (van Blijswijk & de Vries, 2012, p.917). The increase of solar energy use demands too much from the electricity grid and the amount of electricity cannot be safely managed anymore. Not only the use of PV-panels put this strain on the grid, the use of electric vehicles (EVs) also contributes to network congestion (Deb et al., 2020; Ghaemi et al., 2023; Yu et al., 2022). Just like the increase of solar energy use, the use of EVs has grown a lot over the past years. This leads to increased peak load demand which in turns leads to network congestion (Deb et al., 2020). Network congestion leads to a lot of problems for Dutch business as businesses are unable to request a higher electrical connection and new businesses cannot start as they will not get an electrical connection to begin with (SAENZ, 2023b). Besides, it is no longer possible to invest in renewable energy technologies as the grid will not be able to support them. This raises the question how the sustainable ambitions of the Netherlands can be sustained while the infrastructure is incomplete.

Several solutions are being proposed: from simply increasing the capacity of the electricity grid by making it bigger to energy contracts that allow use of electricity only during off peak periods (Stedin, 2023). Another often discussed solution is energy sharing through a community energy system (CES) (Bauwens et al., 2022). In this system local communities are no longer supplied through a centralized energy system, but they develop solutions using renewable energy technologies to support their local energy needs (Koirala et al., 2016). This can mean that they combine things such as PV-panels, small wind turbines, smart energy storage solutions, energy management and district heating to fulfil the energy needs of their community (Koirala et al., 2016). These CESs are a kind of disruptive innovation, and several authors argue that in order to speed up the energy transition these community energy systems are of utmost importance (Knox et al., 2022; Koirala et al., 2018; Milchram et al., 2020). Interestingly, this idea is not new at all. Already in 2007, Künneke & Fens argued that unbundling electricity distribution could be promising in restructuring the energy sector.

Most literature on CES has a focus on residential areas. Acosta et al. (2018) did this by researching how the Socio-Ecological Systems framework works in the context of an integrated community energy system (ICES). They used the case study of an energy cooperative for a residential area in Haarlem, the Netherlands. Dall-Orsoletta et al. (2022) conducted a review on social innovation in terms of community energy transition. They mentioned that CES can help in decarbonization and decentralization of energy for households. Koirala et al. (2016, 2018) looked into community energy storage and how citizens can make it a part of CES. They also looked into trends and issues in shaping ICESs by doing a systematic review of 1285 articles. Both of these papers discuss community in a broad sense; however, examples always relate to households and never to industrial parks. Li et al. (2022) found that cost allocation between households is also a difficulty with the application of ICES. The paper of Nizami et al. (2019) researched how home energy management systems could help solve network congestion. Thus, the application and benefits and difficulties of CES in residential communities has been well researched by different authors. Eslamizadeh et al. (2022) are the first to acknowledge the potential of CES for industrial parks and rename it an industrial community energy system (InCES). They take the basic concept of community energy systems where a local community arranges its own energy needs and apply this concept to an industrial park. An InCES is described as a community energy system for "industrial companies located in a geographically defined industrial cluster" (Eslamizadeh et al., 2022, p. 2).

Apart from innovations that are more focused on the technological side of energy systems, social innovation is important in the energy transition as well. Hoppe & de Vries (2018) discuss that in the context of energy transitions, social goals such as community empowerment and alleviation of energy poverty are key to make new energy systems successful. Next to adhering to these social goals, the implementation of Distributed Energy Systems (DES) requires changes in the social behaviour of energy users as the original system changes fundamentally (Wolsink, 2020). A DES provokes this change within the energy system as it inquires not only a change in terms of hardware, but also in terms of institutional structures (Wolsink, 2020). These changes are worthwhile as Gerlach et al. (2023) highlight that introducing a DES in a community has the power to achieve the social goals set by the community. DES are similar to CES, but they came from the specific idea of distributed energy generation. Other than that, the idea is similar. This was also highlighted by Koirala et al. (2016) who showed that there are many different terms for this roughly similar concept. This research assumes the definition of Eslamizadeh et al. (2022), InCES, as it is most appropriate for this context.

One way of keeping social goals in mind while developing a new energy system, is making use of a cooperative. Wierling et al. (2018) proved with statistical evidence that energy cooperatives are important players within the energy transition. This is explained by van der Waal et al. (2018) as these cooperatives develop systems that are a perfect fit with their own needs, which causes innovations within the field. There are several definitions of energy cooperatives. In the specific case of the Netherlands, Maqbool et al. (2023, p. 1) describe them as "citizen groups who have set a goal to produce energy for themselves or for other cooperatives and who are committed to an efficient, affordable and reliable renewable energy system". Boon (2012, p. 26) describes them as local energy initiatives and gives the following definition: "initiated and managed by actors from civil society, that aim to educate or facilitate people on energy use and efficiency to enable the collective procurement of renewable energy or technologies, to provide, generate, treat or distribute renewable energy derived from various renewable resources for consumption by inhabitants, participants or members who live in the vicinity of the renewable resource or where the renewable energy is generated". This study will focus on industrial parks. Industrial parks are defined as a dedicated area where distribution centres, factories and offices are grouped together (Chen, 2022). The definitions of Maqbool and Boon need slight adaptations to better fit the situation of an industrial park. For this study, the following definition is used: an energy cooperative is a group of business owners that aim to collectively generate renewable energy and in turn share this energy amongst themselves while they are committed to invest in and investigate the opportunities for a community energy system.

In 2022 there were 705 citizen energy cooperatives (Hier, 2022). These cooperatives are instituted and run by citizens of municipalities, residential areas, or neighbourhoods. These cooperatives allow members to join in the collective energy contract, to buy renewable energy from solar energy fields or to invest and obtain shares in renewable energy technologies such as solar energy fields or wind energy parks (deA, 2024; ValleiEnergie, 2024). It is possible for businesses to join these cooperatives and for example make the roof of their building available for solar panels for the cooperative. In the Netherlands there are only four examples of energy cooperatives that originated from businesses working together. One of these is located in the port of Amsterdam and is called Energie Coöperatie Amsterdamse Haven (ECAH). It was founded in 2022 (Port of Amsterdam, 2024). Another one is located on an industrial park in Utrecht called EnergieCollectief Utrechtse Bedrijven (ECUB) and was founded in 2015 (Schuiling et al., 2021). In the region of IJmond there is another cooperative called GreenBIZ IJmond which was founded in 2020 (Omgevingsdienst IJmond, 2024). In the municipality of Zaanstad, the energy cooperative SAENZ is active. This cooperative is the case study for this research and is elaborated on in section 2.1.

In the Netherlands, a lot of discussion has been going on about how to solve the network congestion problem (Energy Storage NL, 2023; Netbeheer Nederland et al., 2022; PBL, 2023; Stedin, 2023). In the National Actionprogram Network congestion, Landelijk Actieprogramma Netcongestie (LAN), multiple solutions are investigated to solve the current problems with the electricity grid in the Netherlands (Netbeheer Nederland et al., 2022). One of these is the introduction of a group transportation agreement, groepstransportovereenkomst in Dutch (GTO). This means that businesses no longer have an individual capacity contract with the distribution systems operator (DSO), but that the connections of multiple businesses are grouped together (Netbeheer Nederland, 2023). The specifics of how this works can be seen in Figure 2. Three businesses and their energy consumption during the day are shown on the left of the figure. GTV stands for the transport capacity each business has agreed to with the DSO.

The graphs show that their energy peaks never reach the GTV and there is a lot of room. On the right of the figure, these graphs are combined. It becomes clear that these three businesses would also have enough room if they had 3,7 MW as opposed to the 5,5 MW that they had in the situation on the right. Thus, smarter management of the electricity grid would in this case free up 1,8 MW. Smart energy management is one element that can be included in a CES (Koirala et al., 2016). The introduction of a GTO is being proposed as a solution to network congestion; however, it is still unclear what businesses think of this kind of contract and whether they would want to participate.

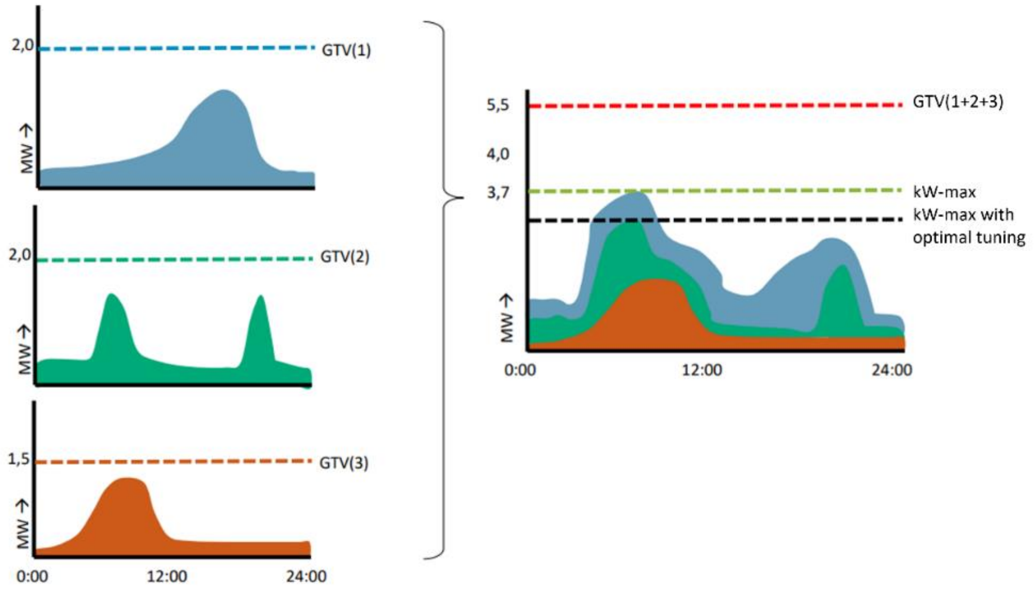

Figure 2: Description of a group transportation agreement from Netbeheer Nederland (2023).

The problem of network congestion is hindering the sustainable efforts of businesses and in turn halting the renewable energy goals of the Netherlands. Without a solution to this problem, the capacity for sustainable energy cannot be increased, and making the industry sector sustainable becomes more and more difficult which in turn means that reaching the RE goals becomes more unattainable as well. A possible solution to this problem is the introduction of a GTO. However, this would require participation of the businesses. To figure out how the businesses can be convinced to participate, the following research was developed: *How can business participation in an industrial community energy system be increased?*

To help answer the main research question, two sub questions have been developed. The first sub question is: *What drives or hinders businesses to increase participation in an industrial community energy system?* It has been developed to get an overview to what the business owners struggle with to increase participation in an InCES. To get a complete picture of what the businesses are dealing with, other stakeholders are also asked about their view on things. This is reflected in the second sub question: *What role do other stakeholders have in increasing participation in an industrial community energy system?*

Answering these questions will help to take the necessary steps to make industrial parks more sustainable and in turn reach the 42.5% renewable energy target of 2030 of the Netherlands. In the field of Industrial Ecology (IE) tools are used to transform the industry system to a sustainable one (Lowe & Evans, 1995). In this research, CES is the tool proposed to realize a sustainable industry system. At the core of IE is the concept of Industrial Metabolism which focuses on "improving knowledge and understanding the societal uses of natural resources and their total impact on the environment" (Saavedra et al., 2018). Moreover, the field aids in "decision-making about the environmental impacts of industrial production processes" (Duchin & Levine, 2014). By doing this research, more insights are gained on how the CES could be implemented and what its effects could be. Thus, this study will pose a relevant contribution to the field of IE as it helps to gain a better understanding of CES in an industry system.

The next section discusses the methodology of this study and will introduce the case study. Next to this, the research plan is described. In section 3, the results of the study are presented. Section 4, the discussion, takes a critical perspective on the study and its findings. Finally, section 5 describes the conclusions that can be taken from these results and highlights insights that allow future research.

2. Methodology

2.1 Case study: SAENZ

Figure 3: Bird view of Businesspark Wormerveer (Bedrijfsunits.nl, 2023).

To shape this research, a case was selected within the municipality of Zaanstad. This municipality is located in the North-West of the Netherlands in the province North-Holland and has 159.618 inhabitants (CBS, 2024). The case is business energy cooperative SAENZ which considers the interests of all businesses in Zaanstad-Noord (Businesspark Wormerveer (Figure 3) and ABIN), Zaanstad-Zuid (OVZZ) and Wormerland (BVW) (SAENZ, 2023c). In total 118 businesses are members of SAENZ and 82 of these are located on Businesspark Wormerveer. The industries these businesses work in differ from transport to food and from marketing to woodworking and many more (SAENZ, 2024c). Thus, the businesses are quite different from each other.

When a business wants to become a member of SAENZ, they have to pay a one-time fee which is €250 for small consumers and €1000 for bulk consumers (SAENZ, 2024a). Small and bulk in this context refers to the size of their electricity connection. Members can choose to join the collective energy contract. These members pay their yearly membership fee through a surcharge on their energy contract. They pay €0,01 to €0,001 per kWh electricity and €0,045 to €0,005 per m^3 gas. The category they fall into is based on the height of their electricity and gas use (SAENZ, 2024b). It is not mandatory to join the collective energy contract when joining SAENZ. It could namely be that members already have their energy contract through a branch organization or that they are part of an international concern which organizes the energy contract for them (SAENZ, 2024b). These members pay a yearly fee of €300 to €1500, depending on the amount of kWh electricity they use per year (SAENZ, 2024b). The fees and surcharges are determined during the annual general meetings through a democratic voting system amongst the members. In these meetings also other decisions are made, such as the voting in of new board members or determining what the working groups should be working on.

SAENZ is not only responsible for the collective purchasing of energy for (part of) its members, they also help their members with applying for subsidies. An added benefit is that through SAENZ, members are able to get higher subsidies than when they would apply for the same ones by themselves. This is for example the case for the subsidy for PV-panels. In the municipality of Zaanstad businesses receive €25 per PV-panel when applying as a single business, but €50 per PV-panel when applying with a group of businesses (Gemeente Zaanstad, 2024).

Figure 4: The silos from the research of Geerts (2021).

Next to this, SAENZ is a point of contact for any questions about energy and sustainability. This translates to them taking an active role to make the industrial parks of their members more sustainable. They have rolled out research with two master students at Utrecht University and the VU Amsterdam. The Utrecht University research focused on the possibility of transforming silos on the industrial park and using them in some way to generate or store energy (Figure 4) (Geerts, 2021). The research looked into pumped hydro energy storage (PHES), compressed air energy storage (CAES), hydrogen energy storage (HES) and heat storage. The most promising applications were PHES and heat storage. However, as it is currently unclear what is going to happen with the silos, these solutions were shelved for now. The research of the VU Amsterdam did a feasibility analysis for an energy sharing platform (ESP) for the area of Businesspark Wormerveer. Through a multi-criteria analysis and a participatory multi-criteria analysis, the research identified elements that need to be implemented or retained before an ESP can be realised (Luttenberg, 2021). These elements included batteries for energy storage, an energy management software platform, ownership of the solar panels, and a connection with the centralized electricity network. Difficulties for the realisation of an ESP were identified as well. These were insecure payback time, need for a back-office, different interests of stakeholders, expensive upfront investments in meters and solar panels, and insecurity surrounding legislation.

As a response to the research of Luttenberg (2021), Project DOEN-1 was born. SAENZ instructed aug·e, a Belgian software developer, to research what effect a smart energy sharing platform could have for the SAENZ members (aug·e, 2023). Around 70 businesses on Businesspark Wormerveer were interviewed and asked about their current energy needs and their plans for the future. After analysing their responses, the study of aug·e showed that 70% of the current energy use of the industrial park could be reduced through smart energy management (SAENZ, 2023d). This result was promising and thus SAENZ initiated the follow up project: Project DOEN-2. This project is focused on achieving a smart energy management system for Businesspark Wormerveer which is a kind of InCES. To realize this system, SAENZ has developed a nine-step plan together with DSO Liander and aug·e (SAENZ, 2023a) (Table 1). A key challenge in the plan is setting up the GTO, which is step 4 in Table 1. It is important that the technical aspect is in check, but it is also needed that businesses want to participate, and that the municipality approves of it. Thus, SAENZ has instructed this research to figure out the opportunities and the problems related to initiating this InCES. They aim to use this industrial park as an example and afterwards extrapolate the concept to other industrial parks in the area.

Table 1: The nine-step plan of SAENZ (2023a).

The 9-step plan	
1	Installation of digital meters at companies
2	Setting up an ICT platform for real data storage
3	In collaboration with Liander: mapping connections per “string” (sub-LEGs)
4	In collaboration with Liander: combined contract per “string” (GTO)
5	In collaboration with Liander: actual implementation of linking companies
6	Integrating charging infrastructure within the ICT platform
7	Connecting an energy company that facilitates mutual electricity supply
8	Implementation of storage capacity (can be used for imbalance regulation)
9	Operational phase

A target group has been selected beforehand by SAENZ. Characteristics of the target group are that they are members of SAENZ with an address on Businesspark Wormerveer. More specifically with an address that is connected to string 2 (Liander, 2023). A string is a medium voltage cable, and this is the dark purple cable in Figure 5 (Liander, 2023). The area within the orange circle in Figure 5 shows string 2 that runs on the eastern part of the industrial park. This means that a total of 50 SAENZ members are connected to the string (Figure 6). This group was already selected by SAENZ and Liander in Project DOEN-1 as focus group. Thus, for consistency this study also looks at them.

Figure 5: Location of string 2 (the purple cable within the orange circle) (adapted from Liander, 2023).

Figure 6: Location of SAENZ members in the area of string 2 (Broeder, 2024).

2.2 Research plan

As discussed in the introduction, three questions are used to support this research. The main research question is *How can business participation in an industrial community energy system be increased?* The two sub research questions are 1. *What drives or hinders businesses to increase participation in an industrial community energy system?* and 2. *What role do other stakeholders have in increasing participation in an industrial community energy system?* Two methods are used to answer these questions: interviews and surveys. The interview method is often used in exploratory research when it is unknown what a participant thinks about a situation (Jain, 2021). This is also the case for this research as the situation of a GTO and increased participation in an InCES is not yet existent. Thus, the participants have not shared their thoughts on this so far. The survey method is used to gather as many insights on this topic as possible. Different data collection tools can provide different insights to the same situation. Therefore, the data coming from each tool can be compared and tested for overlapping or new information (Jain, 2021). The participants to this study are divided into two types. Type 1 participants are business owners in the target group shown in Figure 6. Type 2 participants are other stakeholders that operate within the energy system. In section 2.2.3, the reasoning behind the selected stakeholders is elaborated on.

To answer sub question 1, the interview and the survey are used. In the interviews, three scenarios are presented to the type 1 participants. They will get an opportunity to react to these and what they like and dislike about the scenarios. These scenarios are described in detail in section 2.2.1. Next, these participants are asked to fill in the survey that gathers more information on what would motivate them to participate in an InCES. The content of the survey is discussed in section 2.2.2. To answer sub question 2, only the interview method is used. The type 2 participants will be presented the same scenarios as the type 1 participants. Next to this, they will get an opportunity to react to the comments that the type 1 participants had about them. This is explained further in section 2.2.3.

2.2.1 Three scenarios

To understand what would stop or motivate business owners to increase participation, scenarios are presented to them during the interviews. The starting point for these scenarios was the perspectives and categories of ICES as presented by Koirala et al. (2016) which can be found in Table 2. Koirala et al. (2016) discuss that integrated community energy systems (ICES) can be categorized according to activities, scale, grid connection, initiatives, location, and topology. There is some ambiguity as to what the topologies perspective refers to. In another paper of Koirala et al. from 2018, they discuss community energy storage as well and again use the term topology. In both papers, topology seems to refer to the way the energy infrastructure is arranged. Thus, the way the different energy resources are combined to supply an energy community with their energy needs. This will be the definition assumed in this research.

Table 2: Perspectives and categories of ICES as presented by Koirala et al. (2016).

Perspective	**Categorization**
Activities	Local generation, storage and demand response Collective purchasing Energy exchange and trading
Scale	Large/macro: city, region Medium/meso: neighborhood Small/micro: household / buildings
Grid connection	Grid connected Off-grid
Initiatives	Led by citizens Led by private enterprises Led by government
Location	Developed countries - urban Developed countries - rural Developing countries - urban Developing countries - rural
Topologies	State of the art integration of DERs Integration through common point of coupling Autonomous

Next, three scenarios were developed by choosing elements per perspective from Table 2 for each scenario. The results of this are shown in Table 3. The first scenario in Table 3 arranges the collective purchasing of energy for the community (industrial park). So even though this scenario has no technical attribute it still qualifies as an ICES. Scenario two requires smart energy management. This does not mean a radical change in the energy infrastructure but rather a change in the arranging of energy. It will require an online tool that can help design the best way of energy management. In order for this to work, digital meters have to be placed at the fuse box to get real time data in seconds of the energy consumption and production of the businesses. This is step 1 of the nine-step plan in

Table 1. The third scenario requires a completely new energy infrastructure, because the industrial park would go off-grid. This means that the electricity cables that are now in use, can no longer be utilized. Simply because the DSO who is in charge of these cables would not allow that. Other ways of transferring the energy from the production to the consumption location would be needed. Next to this, for scenario three to work, clear agreements with the municipality are needed.

Table 3: Overview of the three scenarios and their characteristics adapted from Koirala et al. (2016).

	Activities	*Scale*	*Grid connection*	*Initiatives*	*Location*	*Topologies*
Scenario 1 Baseline	Collective Purchasing	Medium	Grid connected	Private enterprise	Developed - Urban	Network operator manages energy distribution
Scenario 2 Project DOEN-2	Collective purchasing Local generation, storage and demand response	Medium	Grid connected	Private enterprise	Developed - Urban	Community manages energy distribution
Scenario 3 Micro-grid	Local generation, storage and demand response Energy exchange and trading	Medium	Off-grid	Private enterprise	Developed - Urban	State of the art integration of DERs

To then make the scenarios more accessible to the participants during the interviews, four elements were used to structure them. Each scenario has the following elements: Context, Terms, Results and Risks. The context describes what the scenario entails and what its boundaries are. Thus, it describes the situation the business owner would be dealing with. The terms relate to the requirements that you have to fulfil to participate in the scenario. The results reflect what you gain or lose from participating in this scenario. Finally, the risks show what could go wrong when the scenario is brought to realization. Each subsequent scenario is a level up from the one before. This means that the second scenario retains elements from the first scenario and includes new things. This also happens when moving from the second scenario to the third scenario.

Combining this structure with the background theory and the insights of SAENZ gave three different scenarios. The first one is Scenario 1: Baseline, which can be found in Table 4 below. It describes the current situation of collective purchasing that the majority of the members are already participating in. In order to participate in this scenario, business owners need to become members of SAENZ and provide authorization for SAENZ to handle their energy contract. The result is that the business owners pay and receive a favourable price for their energy. Next to this, it means that the business owners no longer have to dedicate time and resources to figuring out the best energy contract and they get to know their neighbours better through for example the general meetings. The risk proposed for this scenario is that connection to the electricity grid might no longer be possible or that businesses are not able to expand their connection. This scenario is the situation of the SAENZ members at the moment and thus is described as the baseline scenario.

Table 4: Characteristics of Scenario 1: Baseline.

Scenario 1: Baseline			
Context	**Terms**	**Result**	**Risks**
As a company, you are a member of SAENZ. They handle everything related to your energy needs. SAENZ is authorized to purchase energy on your behalf. Additionally, SAENZ assists you in applying for subsidies for energy-saving or sustainability measures such as electric vehicle charging stations and solar panels.	You need to be a member of SAENZ. You must provide authorization.	You can obtain and supply energy at a favourable price. You do not need to invest time in researching an energy contract or subsidy. You become better acquainted with your neighbours.	Without adjustments to this scenario, over time, businesses may no longer be able to connect to grid or expand their electricity connection.

Table 5: Characteristics of Scenario 2: DOEN-2.

Scenario 2: DOEN-2			
Context	**Terms**	**Result**	**Risks**
As a company, you are a member of SAENZ. They handle everything related to your energy needs. SAENZ is authorized to purchase energy on your behalf. Additionally, SAENZ assists you in applying for subsidies for energy-saving or sustainability measures such as electric vehicle charging stations and solar panels. To address network congestion issues, you join a Group Transport Agreement (GTO). Generated energy is distributed among the group members. Additional energy needs can be acquired through the network.	You need to be a member of SAENZ. You must provide authorization. Your capacity changes from individual to group capacity. Rules and legislation need to be adjusted. An online energy management system will be implemented to regulate the GTO.	You can obtain and supply energy at a favourable price. You do not need to invest time in researching an energy contract or subsidy. You become better acquainted with your neighbours. More businesses can connect to the grid. You no longer have to deal with grid congestion. As an industrial park, you partially disconnect from the grid. Within the group capacity, sharing energy becomes possible.	It is possible that expansion may not be feasible because the group capacity cannot be increased.

The second scenario is Scenario 2: Project DOEN-2 which is shown above in Table 5. As the name suggests, it is based on the follow-up project that SAENZ wants to roll out as discussed in section 2.1. This scenario adds the possibility of a GTO on top of the collective purchasing situation. To realize this scenario, extra terms such as changing individual capacity to group capacity and new regulations are needed. It also needs an energy management system to ensure correct handling of the GTO. As a result of this scenario, more businesses are able to connect to the grid. Next to this, the business owners move away from the network congestion problem and an opportunity is created in sharing energy amongst each other. A risk for this scenario is that businesses might not be able to expand their capacity as they might be capped by the group capacity. While the introduction of a GTO seems to be a promising solution to network congestion, there is no clear understanding yet how businesses respond to this idea and whether they would want to participate or not.

The third and final scenario is Scenario 3: Micro-grid, shown in Table 6 below. This scenario thinks more out of the box and suggests the businesses move away from everything they already know and participate in. The scenario proposes going off-grid and introduces a community battery. SAENZ becomes the organizer of this system. This requires a completely new energy infrastructure and new rules and legislations. On top of that this requires close participation of the municipality. The result is that energy needs are arranged by the businesses themselves and the DSO is put out of the picture. A risk for this scenario is that when not enough energy is generated, it will not be possible to draw extra energy from the grid and thus production processes have to be stopped temporarily. This scenario is a more radical change to the current situation than Scenario 2. This was done to test to what extent the business owners are willing to change.

Table 6: Characteristics of Scenario 3: Micro-grid.

Scenario 3: Micro-grid			
Context	**Terms**	**Result**	**Risks**
As a company, you are a member of SAENZ. They handle everything related to your energy needs. SAENZ is authorized to purchase energy on your behalf. Additionally, SAENZ assists you in applying for subsidies for energy-saving or sustainability measures such as electric vehicle charging stations and solar panels. As an industrial park, you're going completely off-grid. The connection to the central grid disappears. All generated energy is directly utilized in local production processes. Surplus energy is stored in a community battery. SAENZ assumes the role of organizer and facilitates the system.	You need to be a member of SAENZ. A completely new energy infrastructure needs to be installed. Rules and legislation need to be adjusted. Close participation of the municipality is needed.	You do not need to invest time in researching an energy contract or subsidy. You become better acquainted with your neighbours. You no longer have to deal with grid congestion. You manage all energy needs collectively with your neighbours through self-generated energy.	In the case not enough energy is generated, no additional energy can be drawn from the grid. This might result in the temporary shutting down of production processes.

2.2.2 Factors affecting willingness to participate

As an addition to the interviews with the three scenarios, the survey of Eslamizadeh et al. (2022) was used to gain more insight into the attitudes of the businesses towards the implementation of an InCES. Eslamizadeh et al. (2022) did a first attempt of describing CES for industrial parks. In their paper, they surveyed several business owners on Arak industrial park in Iran. That way they figured out what affects the willingness to invest in an industrial community energy system (InCES). The main findings from their research were that big businesses and higher educated business owners were more inclined to invest in an InCES. Next to this, they found that businesses were more willing to invest when they had more awareness of RE incentives. This research will apply the method of Eslamizadeh et al. (2022) to another context.

The survey consists of 32 questions in total and is divided into four sub parts. The first part asks for general information about the participants. The second part asks questions regarding the environmental attitudes of the participants. The third part focuses on the societal attitudes of the participants. The final part gathers information on the economic attitudes of the participants. Thus, the survey retains the same structure as the survey of Eslamizadeh et al. (2022).

In order for the survey to work for this context it was translated to Dutch, as the business owners are native Dutch speakers. Also, things such as location and currency were adjusted to reflect this case. There is another difference in the approach. Eslamizadeh et al. (2022) focus on investing in an InCES, however this research is focused on participating in general in which investing is one part. Since the study of Eslamizadeh et al. (2022) did cover more general factors that relate to participating in an InCES, it was deemed appropriate to use the survey for this study as well. In practice this meant that the questions related to investing, for example questions about bank loans, were omitted, or adjusted to reflect participation. Appendix B shows the survey of Elsamizadeh et al. (2022) and all questions that have been deleted or adjusted for this research are indicated here.

Several changes need further explanation. Some questions have been changed to a Dutch perspective. Question 2 about the education has been changed to Dutch education levels and Question 4 about the electricity consumption scheme was unclear and has been changed to two options about the electricity connection. Option 1 is *"Small consumer (3 x 25 ampere till 3 x 80 ampere)"*. Option 2 is *"Bulk consumer (similar to or larger than 3 x 80 ampere)"*. Question 8 about the monthly electricity bill does not have an option for receiving money back. In the Netherlands there have been high prices for returning generated energy through PV panels (SAENZ, 2023a). In practice this means that some businesses returned more energy than they used, resulting in actually receiving money from the energy company. This option has been added. Next to this, the currency in question 8 has been changed from Toman to Euros.

There was also some inconsistency within the questions throughout the survey. Most questions are statements where the respondent has to indicate their response through a Likert scale of 1 to 10. However, questions 23, 24 and 33 are questions rather than statements but still had a Likert scale as response gradient. These questions have been changed to statements. Finally, in the section about the environmental attitude there were only statements that reflected a positive environmental attitude. To extra check for the true environmental attitude of the respondent, a negative environmental statement was added. In the survey the respondents can choose a value from 1 to 10 where 1 means completely disagree and 10 means completely agree.

2.2.3 Comprehensive view

As this research focuses on an energy system that not only involves businesses but also other stakeholders, it is appropriate to gain insight on their vision as well. Koirala et al. (2016) have identified actors that have some interest in ICES. They recognize that it is not possible to rearrange your energy system without coming in contact with three regulated parties: the transmission systems operators (TSOs), the distribution systems operators (DSOs) and the government, policy makers and regulators.

Figure 7: Overview of all DSOs in the Netherlands adapted from Loreti et al. (2023).

In the Netherlands, TenneT is the TSO, and they are responsible for operating and securing the high voltage electricity grid (TenneT Holding B.V., 2024). While the TSO is mentioned as an actor by Koirala et al. (2016), it will not be considered in this research since it is not yet of added value to include their view on this. The DSO namely has to report to the TSO and the impacts of the InCES in the scenarios will be dealt with by the DSO.

The DSOs are responsible for the regional distribution of the electricity from the high voltage electricity grid to the end consumers. In the Netherlands, there are six electricity DSOs as Figure 7 shows (Loreti et al., 2023). Stedin, Enexis and Liander are the biggest ones. The case study of this research is located within the domain of Liander. Thus, for this research an employee of Liander who is also a member of the LAN was selected to represent the DSO. The relevance of including the DSO in this research is that they have a lot of influence on the electricity network and the contracts associated with that.

The case study is located in the municipality of Zaanstad. Therefore, an alderman of this municipality was selected to represent the local government. The local government will have a role in providing permits for renewable energy technologies. The relevance of the local government is also found in their role in public funding. Milchram et al. (2020) namely argued that government subsidies are key in incentivizing innovative projects.

These two stakeholders were shown the same scenarios as the business owners. Thus, Table 4, Table 5 and Table 6. Next to this, they were shown the comments that the business owners had made about them which is shown in Table 7 below. The local government representative got to see the comments of the business owners on the local government and the DSO employee got to see the business owner comments on the DSO.

Table 7: Comments presented to the type 2 participants.

Comments of business owners
On the local government
"I find it very strange that we have to collaborate so intensively and solve this problem, while I actually consider it someone else's problem. The national government and the network managers. I see this as a serious problem, a typical case of mismanagement." "We've been paying taxes for years to ensure that everything is in order. I find that a serious matter. But it is what it is, so let's put our heads together and address the problem." "In my opinion, this was a bad vision of the national government, and now the hot potato is being passed on. In my eyes, you're coming up with emergency solutions now." "If you have to invest in making your business more sustainable, for example, in the cars and machines we use, then you already have to invest quite a bit. It's okay, that's a part of sustainability. But if you also have to invest in these kinds of things, then I think you're putting a lot on SMEs and coming up with emergency solutions."
On the DSO
"I find it very strange that we have to collaborate so intensively and solve this problem, while I actually consider it someone else's problem. The national government and the network managers. I see this as a serious problem, a typical case of mismanagement." "I understand that we at SAENZ are brainstorming to solve the problems, but I actually think that Liander should be providing the solutions. I don't think entrepreneurs should invest in a million-dollar battery, for example. SAENZ should not take on that role. I do believe that we as entrepreneurs can make agreements on how we use our energy and use it more intelligently." "Liander remains the one who has to ensure that there is ultimately enough power. Liander does not have to play a role in distributing the power among us but must ensure that the grid is in place and that there is enough power." "I think this alone is not sufficient, and you will still have a capacity shortage. It may relieve the pressure a bit for TenneT and Liander, but they will still have to get to work."

2.3 Data collection

Thus, there are two kinds of participants to the research. Participant type 1 includes the businesses that are members of SAENZ. Participant type 2 includes the local government representative and the DSO representative.

All participants had one interview with the researcher where the scenarios of 2.2.1 are discussed. Each scenario is presented to the participants, and in a structured manner the likes and dislikes towards a scenario are questioned. The questions that guide these interviews can be found in Table 8 below. These questions vary somewhat between type 1 and type 2 participants to better align with their perspective on the matter. As discussed in section 2.2.3, type 2 participants also had to comment on the remarks in Table 7.

Table 8: Questions guiding type 1 and type 2 participants during the interviews.

Questions for type 1 participants
- What do you like about this scenario?
- What do you dislike about this scenario?
- According to you, what are the risks of this scenario?
- Would you participate in this scenario? o Why yes/no?
- Do you have other remarks regarding this scenario?
Questions for type 2 participants
- What do you like about this scenario?
- What do you dislike about this scenario?
- Do you see risks for the municipality/DSO?
- Do you have other remarks regarding this scenario?
- What is your opinion on the comments of the businesses?

The "Risks" column of the scenarios is empty during the interviews as to not influence the participants and to stimulate that they form their own opinion about this. However, in the development of the scenarios the column was not left empty. This is to have the possibility to help the respondents if they cannot identify a risk themselves. The suggested time for the interview is 30 minutes. Afterwards the researcher makes a summary of the interview which is then sent back to the respondent. They have to give consent before their remarks are included in the research.

Type 1 participants get an extra task to fill out the adapted survey of Eslamizadeh et al. (2022) which is discussed in section 2.2.2. If the participant wishes, the survey can be filled in right after the interview. Another possibility is that the survey is sent to the participant via email after the interview. That way the participant can decide themselves what time is best. This opportunity is given as most business owners are busy people that have limited time. To facilitate the filling in of the survey, google forms is used. This helps with gathering all of the responses in one place, also it makes it easier to send the survey to the respondents. The suggested time for the survey is 15 minutes.

3. Results

3.1 Responses

In total fourteen business owners were interviewed and filled out the survey. This means that 28% of all SAENZ members on string 2 have participated. The industries in which the businesses operate differ a lot and it goes from public transport advertising to metalworking and from woodworking to the food industry. Seven of the fourteen businesses owners that filled in the survey had a high education level, five of them had a lower education level and two of them completed high school. For the electricity consumption scheme, nine businesses were bulk consumers and five were small consumers. Six businesses had a private ownership type, and eight businesses had a private (family-owned) ownership type. Most of the businesses had 1-50 employees. There were three exceptions where businesses had 50 -100, 100 – 150 or more than 200 employees. Eight out of fourteen businesses had a monthly energy use in the category 0-10 MWh. Three businesses used 10-50 MWh per month. There were two other businesses that used 100-400 MWh or more than 400 MWh per month. Three business owners receive money on their average monthly energy bill. Two business have to pay €0 - €1000 and three pay €1000 - €2500 every month. There are two businesses that pay €2500 - €4000 each month and two that pay €4000 - €5500. Finally, there are two business owners that have an average monthly energy bill of more than €5500. Eleven out of the fourteen businesses have 1 working shift per day. The remaining three had either 2, 3 or 5 working shifts. All of the businesses that participated in the research are also part of the collective energy contract.

3.2 Barriers and benefits

The next section gives a brief description of the findings from the interviews with the business owners. The detailed but anonymized reports of the interviews can be received upon request.

Scenario 1, which describes the baseline situation of SAENZ, was positively commented on by the respondents. Benefits of this scenario are the combining of strength and knowledge, working together, and finding the right partners for projects. They also commented on the financial benefits that are associated with buying energy collectively, and they like the way risks are reduced in some way by being part of an energy cooperative. Finally, the businesses like that this scenario removes a burden which this quote by respondent 10 shows well: *"You do not have to spend time on it. SAENZ arranges everything."* The respondents had no negative comments on the scenario, but they did see some risks. The main one being the quality of the employees of SAENZ, which is reflected by the following quote of respondent 1: *"The biggest risk for SAENZ is the quality of its directors. It depends on how motivated they are and how much energy they put into it. Now there are very driven and talented people."* This risk does not only apply to the board and employees of SAENZ, but also to the working group that is responsible for choosing the collective energy contract. Another risk observed was that as a business you might lose all knowledge on energy purchasing.

The next scenario proposed project DOEN-2. All respondents had positive remarks. They saw this as the solution to the network congestion problem, and again liked the element of working together. Some even went to say that they see this as the ideal scenario for the future. The smarter way of using energy was appreciated too which is expressed by this comment of respondent 2: *"The smart use of energy appeals to me, that we can consume and use the energy ourselves and also make it available to members of SAENZ."* However, four of the fourteen respondents had some doubts. They highlighted that rearranging the energy and only focusing on electricity, will not solve the problems on their own. They suggest that hydrogen and wind energy should also be looked at as solutions and that the energy infrastructure would need adjustment regardless. Two of these commented that it is not the responsibility of SAENZ and the small medium enterprises (SME) to pick this up and argue that this is a problem that the DSO should solve. The respondents saw risks as well as this quote of respondent 9 shows: *"I have what I have, and if I decide to let go of what I have what does that mean for me? What if I actually need it in the future? Will I get it back? Because by then someone else has already used it."* This was not the only respondent recognizing this risk. Six others were also worried about the fact that they would not get the amount of capacity when they would need it. In line with this, four business owners mentioned that they feared they would lose the flexibility and possibility to grow their business when they are limited by a group capacity. Another risk mentioned was the situation where one party would leave the group contract. Nonetheless, when asked, twelve of the respondents would join this scenario. Two respondents recognized that this scenario would become the new reality and that businesses will have to get used to that. Five respondents would join the scenario but did set the conditions that the costs would be kept low, the terms were well thought through and juridically valid. Respondent 3 mentioned that to join this scenario, it *"must be properly technically organized and automated."*

The respondents were more divided on scenario 3 about the micro-grid as half of them would join, but half of them would not. Again, the respondents liked the part about working together to solve the energy problem and the smarter energy management. Two of the respondents also liked that this would reduce their ecological footprint as this quote of respondent 1 shows: *"This way of achieving sustainable energy and not leaving a footprint for future generations appeals to me very much."* However, others did not like this scenario at all. They mentioned that it is not achievable and worried about the financial and technical aspects. Two of them mentioned that the current system is sufficient enough. This comment of respondent 4 shows this stance well: *"This goes too far for me. There is a good system and the Lianders of this* *time are doing reasonably well and that will only get better in the coming years. I don't see the need to disconnect completely."* The risks mentioned in this scenario were related to losing the connection with the grid and having no back-up if energy runs out. Besides there were concerns on how it would be possible to generate enough energy to supply all of the businesses. Others mention that this kind of scenario is more appropriate for new construction projects as respondent 8 said: *"You already see this happening on new industrial parks, but doing this on an existing site seems impossible to me."*

3.3 Survey results

Most of the respondents filled in the survey right after their interview. Five respondents wished to fill in at a later point in time and were sent the link to the google forms. As mentioned in section 2.2.2, the first version of the survey did not have an option for businesses to state that they got money back from the energy operator. This was changed afterward for the three businesses that had this but were not able to choose this option when filling out the survey. Afterwards this option was added to the survey. The remainder of this section will briefly discuss the results of the survey per attitude. As discussed in section 2.2.2 Factors affecting willingness to participate, giving a rating of 1 means that the respondent completely disagrees with the statement and a rating of 10 means they completely agree with the statement.

Results: Environmental attitude

There were five questions in the environmental attitude section of the survey. To the first question whether fossil-based energies should be replaced by renewable energies, the majority of the respondents filled in a number of 7 or higher. The next question asks whether the respondents are willing to pay more to use renewable energy in their household. Thirteen out of fourteen respondents would do this and rated it a 7 or higher. When asked the same but then for their businesses instead of household, eleven businesses rated this question a 7 or higher. All of the businesses think it is important to participate in societal and environmentally friendly projects. They all rated it a 6 or higher and three even rated this question a 10. The final question in this section asked the respondents if they had no concern for the climate at all. The majority rated this question with a 3 or lower which means they disagreed with this. The survey results show that most of the respondents are environmentally aware and are concerned for the climate.

Results: Societal attitude

The societal attitude section of the survey had eleven questions. The section starts with a question about not starting partnerships due to not trusting other businesses with their on-time payments. Almost all of the respondents disagreed with this question. They all gave a rating of 3 or lower, expect for one who rated it a 9. The next question investigated whether the respondents would be okay with sharing their electricity consumption information with other businesses. Most of the respondents did not mind and rated this question a 5 or lower. Two respondents were an exception and rated this question a 6 and 10. The financial and operational transparency in partnership projects were deemed important by more than half of the respondents as they rated this an 8 or higher. The respondents were divided on the topic on whether the national government could be trusted. Some respondents rated this question a 3 and others a 10. When the respondents were asked whether they would be interested joining a project if a prominent company does, there was a slight tendency to rate the question higher. However, there were some respondents who would not be affected by this. The majority of respondents valued a democratic system in partnerships since most of them rated this a 6 or higher. Next to this, all respondents apart from one are interested in partnering with other businesses in strategic issues as thirteen of them rated this question 5 or lower. To the question whether shares needed to be legally credible and tradable, twelve out of fourteen respondents gave an 8 or higher. Five of them even gave a rating of 10. The respondents recognize the complexity of partnerships but believe they can be overcome by strict institutions. They all rated this question with a 5 or higher and thirteen of the fourteen respondents even rated it a 7 or higher. Thirteen respondents are willing to work together as they all rated this question a 7 or higher. To the questions whether the respondents feel connected to the other businesses on their industrial park, thirteen agree to feel that way. Some more than others as the ratings vary from 6 to 10.

The survey results for this section show that most respondents trust other businesses and feel a connection with them, but they do feel a need for financial and organizational transparency, democracy, and strict institutions before they step into a partnership.

Results: Economic attitude

The last section of the survey looked into the economic attitude of the respondents. They are divided on the topic whether they would participate in an InCES to gain economic profits as the ratings are spread out from 1 to 8. The idea of becoming gradually more independent through an InCES appeals to the majority of the respondents. The business owners do not feel like they are entitled to cheap electricity as all of them, apart from two who rate it a 5 and 10, rate this question a 3 or lower. Three-quarters of the respondents see it as a necessary condition to easily opt out of the InCES, as they rate this question a 5 or higher. Most respondents are aware of incentives dedicated to renewable energy (RE) generation as eleven out of fourteen respondents rate this a 1 or 2.

All of the respondents, except for one, would participate in an InCES if one would be initiated on their industrial park. There are eight respondents who even rate this question a 9 or 10. The results of this section show that the majority of the respondents would join the InCES, but not all for the same reason. The more independent position appeals to most of them and they like the idea of an easy way out.

3.4 Reflection on interview and survey

The interviews and surveys were two tools to figure out the opinion of business owners on InCES in various forms. Scenario 1 was received well by all the participants. The businesses were also likely to adopt scenario 2 where the introduction of a GTO was proposed. This is viewed as a small change compared to scenario 1 which they have already accepted. This is also confirmed by the survey results were almost all of the respondents would participate in an InCES. For half of the participants, scenario 3 was a step too far. The survey results showed what the business owners think of InCES in more general terms. The interviews help to dive deeper into this and gain a better understanding of what a rating in the survey could mean.

The majority of the respondents showed in the survey that they highly value transparency regarding the operational and financial processes of a project. What this exactly embodies becomes clear from the interviews. Here respondents 2, 4 and 14 mentioned that they would need some guarantee that they can expand their business and thus receive the possible additional higher electricity connection when they would need it. Similarly, respondents 2, 4 and 7 commented that they would not want to push the limits of the electricity connection and keep some safe space. Respondents 3, 7 and 8 mentioned that they would need the certainty of technical and automatic processes. Thus, that the InCES would not be based on verbal agreements only. The financial processes are commented on by respondents 12 and 14 whom refer to investing in the flexible assets together. Respondent 14 added that a sort of investing model could be interesting to convince businesses that do not have problems of their own, to still invest in a solution.

The question about mistrusting government induced incentives was rated relatively high (rating 5 to 10) by eleven out of fourteen respondents. Respondents 1 and 12 mentioned why they mistrust the national government in their interviews. Respondent 1 referred to the changing of policies and that they made choices for investing in solar energy based on a subsidy that would change the subsequent year. Respondent 12 was frustrated about the lack of progressive insight the Dutch government had regarding the topic of network congestion and the energy transition.

3.5 Other actors' perspective

There were two interviews with type 2 participants. These participants were the alderman of the municipality of Zaanstad and the Liander employee. They were shown the same scenarios as the business owners. For scenario 1, they both liked the element of getting advantages through a cooperative and they encourage that businesses organize themselves like this. The alderman added that it is an accessible way to get involved with energy and for the municipality it is a real plus to have one point of contact (SAENZ) and immediately reach more than a hundred businesses (members of SAENZ). The alderman also said the following: *"SAENZ already has knowledge, and that also makes the conversation easier."* The Liander employee added a note that as a DSO they have no influence at all on this kind of organization of businesses because it is outside of the regulated market in which they operate.

The second scenario was received well by both, and they see it as the solution to network congestion. The alderman included that this scenario would help businesses to continue their sustainability steps. The Liander employee was most positive and said: *"Everything that businesses can arrange and exchange with each other, we no longer have to transport back and forth."* Another remark was that the businesses tend to take a more flexible position and are willing to adapt their business processes to the energy supply they get. This scenario would also give the businesses a new type of ownership they have never had before, and this was seen as a positive result. Finally, the employee highlighted the opportunities that were created by investing together. The alderman saw a difficulty in making this scenario interesting for everyone and doubted about the organization of a system like this. The Liander employee saw two risks in this scenario. The first one was the possibility to discriminate as *"everyone has equal opportunities and has rights to be connected to that network."* This is something that might come into question when working with group contracts as then SAENZ can decide who joins. The other risk was liability. It is now unclear who would be responsible when something like a transformer breaks. There is no clear idea if this would be SAENZ, the members of SAENZ or the DSO. The alderman adds that solving this problem is not a municipality task which is reflected by this quote: *"Strictly speaking from an electricity supply perspective, you could say this is not a municipal task. That is a responsibility of others."* The alderman is worried that the national legislation is not in place yet when SAENZ would be ready to roll out the contracts. The Liander employee ends by saying that SAENZ has the opportunity to purchase and use flexible assets which allows them to manage the energy system and work out a group contract in their favour. This is something the DSO cannot do.

The third scenario was not received well by both. The Liander employee felt strongly about this and said: *"I think in terms of the sociality, the costs and the possibilities it offers SAENZ, this is not optimal."* This scenario would also result in not being able to participate on the energy market which is something SAENZ currently does do. The alderman agrees with this view and thinks it would be scary for a business owner to participate in this. Next to this, losing the security of energy supply is a risk that the alderman would not want to take.

As a response to the comments of the business owners, the alderman stated that looking at it very black-and-white, the municipality has no role in this problem and thus does not feel a need to invest in these kinds of projects. However, the alderman does recognize the need for businesses to become more sustainable whether it be through intrinsic motivation or through imposition by the national government and that these kinds of projects are a way of doing that. The alderman comments that the DSO should have acted earlier on this problem, but that it also happened very fast all of a sudden and praises the attitude and cooperation of the DSO to solve this issue. Finally, the alderman commented that the way the national government has organized the national electricity network did not work as well as thought in the beginning, referring to both limiting investments of the DSO but also the separating of energy supply and network.

The Liander employee understands the frustrations of the business owners and their reasoning that it is the problem of the DSO. However, he says that the solution should not only be focused on building more cables but that it should be bigger than that. The employee recognizes the following: *"We are really working on a system change."* That statement relates to the need of working together to make better use of the current electricity network, but also to the fact that it cannot be solved by the DSO on its own and that all actors within this energy transition need to change their attitude towards the way they use energy.

4. Discussion

For this research the choice was made to use a case study. By doing this it was easy to find respondents for the interviews and surveys. Next to this, it helped to easily gather information about the situation as SAENZ was already trying to increase participation for an InCES. This research shows that the sense of connection the businesses feel between each other and the benefit they see in the energy cooperative, allows them to see past some hurdles associated with participation in an InCES. This indicates that community feel is an important starting point for initiating an InCES and that a cooperative is a good tool to achieve that. The same was found by Wierling et al. (2018) and thus confirmed by this research. It should be noted that this case is somewhat unique in its structure. Currently there are only four business energy cooperatives in the Netherlands. However, there are 3800 industrial parks. If some form of a business association or group would be initiated on each industrial park, this could benefit the development of InCES for these industrial parks and in turn help reach the renewable energy goals of the businesses and the Dutch government. There is a critical note to the formation of business groups. It could be that members block other businesses from participating in a cooperative when this new member is for example a competitor or there is a general disliking towards this business. This kind of discrimination could be prevented by incorporating something about this in the rules of the cooperative.

A contrasting finding from this research is that the spokesperson of the local government believes that they have a small role in the development of an InCES. However, the findings from other research show that the public funding of the local government is necessary for these experimental projects to succeed and in turn grow from small-scale to market wide projects (Milchram et al., 2020). This was also commented on by the business owners as they said that not all of the responsibility for investing in sustainability should be placed upon the SMEs. Thus, for the InCES to work in this case study, efforts have to be made to connect the municipality.

It was chosen to semi-structure the interviews by using scenarios and guiding questions. To not make these scenarios too overwhelming, they were kept concise and to the point. However, this raises the question whether this truly allowed the participants to understand the impacts the scenario could cause. This is for example reflected in the responses for scenario 3. Half of the business owners namely commented that they liked this idea, but the DSO employee strongly commented that this is not a desired scenario for anyone, not for the DSO but also not for SAENZ and Dutch society. The proposed risk for scenario 1 was not completely accurate in hindsight. It was not really a risk for businesses that already have a grid connection. It is more of a risk for new businesses that want to get a new connection. Besides, this was a risk that is present for the whole of the Netherlands and not limited to SAENZ. Next to this, choices were made in section 2.2.1 in regard to what each scenario would discuss. It could have been interesting to explore other kinds of scenarios as well. As two business owners mentioned in their interviews, the use of wind and/or hydrogen energy could have been included within the InCES scenarios. However, for simplicity only solar energy was included in this research. Choosing this kind of interviewing structure slightly limited the participants in their responses and different scenarios could have sparked different opinions on InCES. Nonetheless, working with scenarios helps to quickly get all of the participants on the same page and ensures that everyone has some basic understanding of the situation. Besides, it allows better comparison between the interview responses.

The use of the survey was a valuable addition to the research. It helped to gather some more information on the general opinion of the businesses towards an InCES. Some questions in the survey had double elements. This means that it would ask two things in one question, thus it would then not be clear if the rating was focused on the first part of the question or the second part. This is for example the case for the following question: *We have no problem in our electricity provision and if we participate in an InCES it would only be for economic profitability by selling RE.* In this case it was unclear if the respondent would rate it according to whether they have a problem with their electricity provision or whether they responded to the part about economic profitability. This happened as well with questions 10 and 28. Next to this, it can be argued whether the survey was appropriate for this context as the intended purpose was for an industrial cluster in Iran and this context is an industrial park in the Netherlands. Apart from cultural differences between the two contexts, there is also the notion that Iran is an oil-rich country. This could have influenced the view on renewable energy (and thus an InCES) already before even starting the survey. However, it is not possible to test this as the survey results of Eslamizadeh et al. (2022) were incorporated into hypotheses and correlations and there is no insight into how each question was ranked by the respondents. When comparing the insights from the survey results in both contexts, there are some similarities and some differences. From the survey results of Eslamizadeh et al. (2022) it became evident that bigger businesses and higher educated business owners, are more willing to invest in an InCES. This is the same for the survey results of this research. However, the notion that businesses are more willing to participate when they are more aware of RE incentives does not hold true for the results of this research. For completeness, it should be noted that this difference could also be caused by the much smaller sample size of this research compared to the sample size of Eslamizadeh et al. (2022).

Keeping social goals in mind is key in making new energy systems successful as Hoppe & de Vries (2018) mentioned in their paper. This was also found in this research. The DSO representative mentioned that introducing a GTO would be providing the business owners with ownership over their own energy distribution. Next to this, the majority of the business owners liked the idea of becoming autonomous or being able to arrange their energy needs themselves. This would mean not only technological changes to the current energy system, but also behavioural changes. To make sure that this is properly organized, the responsibility could be laid in the hands of the energy cooperative which was viewed as a reliable but independent partner by all participants. As Li et al. (2022) showed, there are difficulties in determining the cost allocation for an ICES for households. The same holds true for cost allocation for an InCES on an industrial park. Key is that in both contexts the division of costs should be done fairly. The respondents commented that they do not see value in investing in a solution for a problem they do not have. Thus, in order for a system like this to work and to also get businesses on board that do not have problems, a clear investment model should be thought out.

Future research could adjust the scenarios and also look into energy from hydrogen and wind to investigate how the businesses would respond to that. Next to this, the businesses in this research were already part of a cooperative. This causes to not have a complete understanding of what businesses need to participate in an InCES. This research shows what businesses who have already accepted a form of InCES need to increase participation in said InCES. Future research could look into what businesses need to join a cooperative or business group in the first place and what would motivate them to participate in an InCES. This would provide a more thorough view on the topic of participation of businesses in an InCES.

5. Conclusion

The starting point for this research was to find out how industrial parks in the Netherlands can become more sustainable in order to help achieve the sustainable goals of the Dutch government. The research had a focus on the concept of InCES. The research was supported by a case study: business energy cooperative SAENZ in Zaanstad, the Netherlands.

The first sub question to answer is: *What drives or hinders businesses to increase participation in an industrial community energy system?* The business owners comment that the organizational structure of a cooperative helps them in making sustainable energy decisions. Besides, they obtain higher subsidies and cheaper electricity. They also like working together and the opportunity of investing in flexible assets together is interesting to most of them. Other drivers for increasing participation are trust and connection between businesses and the feeling of ownership and independence. Barriers in increasing participation are related to the need for complete information. The business owners want to have a clear understanding of what the risks and benefits are before stepping into a partnership. They also need financial and organizational transparency, democracy, and strict institutions. When these are not in place, the business owners would be more hesitant to join. Other factors that would influence their decision is the possibility to easily opt out and guarantees that they can use the amount of capacity they are currently using, or at least get this capacity back at a later time. This also relates to the business owners worrying about the flexibility within their business operation. They would want to be able to expand when they wish and not be limited.

The second sub question is *What role do other stakeholders have in increasing participation in an industrial community energy system?* The role of other stakeholders is prominent. The local government spokesperson likes that the business owners organize themselves in this way. According to the alderman the role of the local government in organizing projects like these is limited. The spokesperson believes that the local government does not have to invest in these projects. However, this is contrasted by the literature and the opinions of the business owners. The local government could help lower the barriers to increase participation in the InCES by relieving some investment pressure from the SMEs. The DSO recognizes that they have a big role in the story. They would have the tools to give businesses more ownership over their capacity and could support the infrastructure. The DSO could help increase participation in an InCES by providing transparency to the risks of joining a GTO. Besides, they have the means to guarantee the businesses that they can be flexible within a GTO and still expand in economic or in sustainable terms.

The main question of this research is *How can business participation in an industrial community energy system be increased?* From this research it became evident that business owners need to be provided with complete and transparent information on projects. This should be information on how much capacity they keep, and how they could expand when needed. This should also include information on investment structures and how members can opt in or out of the InCES. Next to this, the risks for the DSO, such as liability issues and discrimination, should be balanced out well with the risks of the business owners, such as reducing the size of their capacity and taking on new responsibilities such as ownership. The local government should support the development of these kind of InCES by investing in them and reducing the barriers associated with these innovative projects. In taking these steps, it is important to have a cooperative or a designated group of businesses that is pulling the cart and taking the initiative to coordinate such a project. One way of aligning these opposing views is by making a focus group with SAENZ, selected members from SAENZ, spokespersons of the DSO and spokespersons of the local government. This could help in taking steps forward in designing an InCES with a GTO. The sustainable achievement of realizing an InCES in this form could have a huge impact on the sustainable goals of the Dutch government. This way the networks become less congested, leading the way to a sustainable future for Dutch businesses.

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7. References

aug·e. (2023). *Home*. https://www.aug-e.io/

Bauwens, T., Schraven, D., Drewing, E., Radtke, J., Holstenkamp, L., Gotchev, B., & Yildiz, Ö. (2022). Conceptualizing community in energy systems: A systematic review of 183 definitions. *Renewable and Sustainable Energy Reviews*, *156*, 111999. https://doi.org/10.1016/J.RSER.2021.111999

Bedrijfsunits.nl. (2023). *Bedrijfsunits Wormerveer*. https://bedrijfsunits.nl/locatie/wormerveer/

Boon, F. P. (2012). *Local is Beautiful The emergence and development of local renewable energy organisations Local is Beautiful*.

Braat, M., Tsafarakis, O., Lampropoulos, I., Besseling, J., & van Sark, W. G. J. H. M. (2021). Cost-effective increase of photovoltaic electricity feed-in on congested transmission lines: A case study of the Netherlands. *Energies*, *14*(10). https://doi.org/10.3390/en14102868

Broeder, L. M. (2024). *Leden SAENZ*. https://www.google.com/maps/d/viewer?hl=nl&mid=1Y8iShpX1GsDTPDIyjjMTlaji7DzEG4A&ll=52.50629777390112%2C4.787976539917516&z=16

C3S. (2023, September 8). *Summer 2023: the hottest on record*. https://climate.copernicus.eu/summer-2023-hottest-record

CBS. (2022). *Hernieuwbare energie in Nederland 2021*. https://longreads.cbs.nl/hernieuwbare-energie-in-nederland-2021/algemene-overzichten/

CBS. (2024). *Regionale Kerncijfers Nederland*. https://opendata.cbs.nl/#/CBS/nl/dataset/70072ned/table?searchKeywords=

Chen, J. (2022, July 12). *Industrial Areas: Overview, Significance, Special Considerations* . https://www.investopedia.com/terms/i/industrial-park.asp

CLO (Compendium voor de Leefomgeving). (2022, August 30). *Energieverbruik per sector, 1990-2021*. https://www.clo.nl/indicatoren/nl005224-energieverbruik-per-sector-1990-2021

deA. (2024). *Home*. Duurzame Energiecoöperatie Apeldoorn. https://www.de-a.nl/

Deb, S., Goswami, A. K., Harsh, P., Sahoo, J. P., Chetri, R. L., Roy, R., & Shekhawat, A. S. (2020). Charging Coordination of Plug-In Electric Vehicle for Congestion Management in

Distribution System Integrated with Renewable Energy Sources. *IEEE Transactions on Industry Applications*, *56*(5), 5452–5462. https://doi.org/10.1109/TIA.2020.3010897

Duchin, F., & Levine, S. H. (2014). Industrial Ecology. *Encyclopedia of Ecology*, 352–358. https://doi.org/10.1016/B978-0-12-409548-9.09407-0

Energy Storage NL. (2023). *Nationaal Actieplan Energieopslag 223*.

Eslamizadeh, S., Ghorbani, A., Araghi, Y., & Weijnen, M. (2022). Collaborative Renewable Energy Generation among Industries: The Role of Social Identity, Awareness and Institutional Design. *Sustainability (Switzerland)*, *14*(12). https://doi.org/10.3390/su14127007

European Commission. (2023, March 30). *Renewable energy directive*. https://energy.ec.europa.eu/topics/renewable-energy/renewable-energy-directive-targets-and-rules/renewable-energy-directive_en

Geerts, D. (2021). *Haalbaarheidsanalyse energieopslag in de silo's van het voormalige Meneba complex in Wormerveer*.

Gemeente Zaanstad. (2024). *Subsidieregelingen Lokale Duurzame Energieopwekking Bedrijventerreinen 2024*. https://www.zaanstad.nl/mozard/!suite86.scherm0325?mVrg=27596

Gerlach, L., Bocklisch, T., & Verweij, M. (2023). Selfish batteries vs. benevolent optimizers: An exploratory review of agent-based energy management with distributed storage in microgrids. *Renewable and Sustainable Energy Reviews*, *177*, 113211. https://doi.org/10.1016/J.RSER.2023.113211

Ghaemi, S., Li, X., & Mulder, M. (2023). Economic feasibility of green hydrogen in providing flexibility to medium-voltage distribution grids in the presence of local-heat systems. *Applied Energy*, *331*. https://doi.org/10.1016/j.apenergy.2022.120408

Hier. (2022). *Lokale Energie Monitor 2022*. https://www.hier.nu/lokale-energie-monitor-2022

Hoppe, T., Butenko, A., & Heldeweg, M. (2018). Innovation in the European Energy Sector and Regulatory Responses to It: Guest Editorial Note. *Sustainability*, *10*(2), 416. https://doi.org/10.3390/su10020416

Hoppe, T., & de Vries, G. (2018). Social Innovation and the Energy Transition. *Sustainability*, *11*(1), 141. https://doi.org/10.3390/su11010141

IPCC. (2023). *Synthesis report of the IPCC Sixth Assessment Report (AR6) - Summary for Policymakers*.

IPO. (2022, July 6). *IBIS Bedrijventerreinen - Metadata*. https://data.overheid.nl/dataset/ibis-bedrijventerreinen#panel-description

Jain, N. (2021). Survey Versus Interviews: Comparing Data Collection Tools for Exploratory Research. *The Qualitative Report*. https://doi.org/10.46743/2160-3715/2021.4492

Knox, S., Hannon, M., Stewart, F., & Ford, R. (2022). The (in)justices of smart local energy systems: A systematic review, integrated framework, and future research agenda. *Energy Research & Social Science*, *83*, 102333. https://doi.org/10.1016/J.ERSS.2021.102333

Koirala, B. P., Koliou, E., Friege, J., Hakvoort, R. A., & Herder, P. M. (2016). Energetic communities for community energy: A review of key issues and trends shaping integrated community energy systems. *Renewable and Sustainable Energy Reviews*, *56*, 722–744. https://doi.org/10.1016/j.rser.2015.11.080

Koirala, B. P., van Oost, E., & van der Windt, H. (2018). Community energy storage: A responsible innovation towards a sustainable energy system? *Applied Energy*, *231*, 570–585. https://doi.org/10.1016/J.APENERGY.2018.09.163

Künneke, R., & Fens, T. (2007). Ownership unbundling in electricity distribution: The case of The Netherlands. *Energy Policy*, *35*(3), 1920–1930. https://doi.org/10.1016/J.ENPOL.2006.05.008

Li, N., Hakvoort, R. A., & Lukszo, Z. (2022). Cost allocation in integrated community energy systems — Performance assessment. *Applied Energy*, *307*, 118155. https://doi.org/10.1016/J.APENERGY.2021.118155

Liander. (2023). *ArcGIS Liander Open Data*. https://www.arcgis.com/home/webmap/viewer.html?useExisting=1&layers=11b7bcf1b78b4462b91db0dff234cf78

Loreti, F., Pasquier, P., Mauduit-Le Clercq, C., Dubois-Pelerin, E., & Schiavo, M. (2023). *Dutch Electricity And Gas Transmission And Distribution Framework: Supportive Key Takeaways*. www.spglobal.com/ratingsdirect

Lowe, E. A., & Evans, L. K. (1995). Industrial ecology and industrial ecosystems. *Journal of Cleaner Production*, *3*(1–2), 47–53. https://doi.org/10.1016/0959-6526(95)00045-G

Luttenberg, H. T. (2021). *Een Energy Sharing Platform op bedrijventerrein Noorderveld-Molletjesveer*.

Maqbool, A. S., van der Waal, E., & van der Windt, H. (2023). 'Luctor et emergo', how a community energy initiative survived the changing policy and technology landscape of the Dutch energy system? *Energy Policy*, *177*, 113528. https://doi.org/10.1016/J.ENPOL.2023.113528

MAZ. (2022). *Energielabel woningen en gebouwen*. https://www.rijksoverheid.nl/onderwerpen/energielabel-woningen-en-gebouwen

Meinshausen, M., Lewis, J., McGlade, C., Gütschow, J., Nicholls, Z., Burdon, R., Cozzi, L., & Hackmann, B. (2022). Realization of Paris Agreement pledges may limit warming just below 2 °C. *Nature*, *604*(7905), 304–309. https://doi.org/10.1038/s41586-022-04553-z

MEZK. (2022). *Iedereen doet wat - Energie*. https://www.iedereendoetwat.nl/energie

Milchram, C., Künneke, R., Doorn, N., van de Kaa, G., & Hillerbrand, R. (2020). Designing for justice in electricity systems: A comparison of smart grid experiments in the Netherlands. *Energy Policy*, *147*, 111720. https://doi.org/10.1016/J.ENPOL.2020.111720

Netbeheer Nederland. (2023). *Position paper Groeps-TO v1.0 - augustus 2023*.

Netbeheer Nederland, ACM, Rijk, IPO, Provincie Limburg, Provincie Noord-Brabant, VNG, NP RES, VNO-NCW, VEMW, CES-cluster Rotterdam-Moerdijk, CES-cluster Chemelot, CES-clust 6, Energie Nederland, & NVDE. (2022). *Landelijk Actieprogramma Netcongestie*.

Omgevingsdienst IJmond. (2024). *Vereniging GreenBIZ IJmond*. https://www.odijmond.nl/projecten/greenbiz-ijmond/

O'Neill, D. W., Fanning, A. L., Lamb, W. F., & Steinberger, J. K. (2018). A good life for all within planetary boundaries. *Nature Sustainability*, *1*(2), 88–95. https://doi.org/10.1038/s41893-018-0021-4

PBL Planbureau voor de Leefomgeving. (2023). *Klimaat- en Energieverkenning 2023 Deel 1: ramingen van broeikasgasemissies op hoofdlijnen*. www.pbl.nl/kev

Petovarga. (2021). *Power renewabale energy electricity scheme with solar buildings - Illustratie*. https://www.istockphoto.com/nl/vector/power-renewabale-energy-electricity-scheme-with-solar-buildings-gm1356188862-430426005

Port of Amsterdam. (2024). *Energie Coöperatie Amsterdamse Haven (ECAH) opgericht*. https://www.portofamsterdam.com/nl/nieuws/energie-cooperatie-amsterdamse-haven-ecah-opgericht

RVO. (2017). *Hernieuwbare Energietransitie (HER+)*. https://www.rvo.nl/subsidies-financiering/her

RVO. (2023, October 10). *Flinke groei opwek zonne-energie door kleinere zonne-energieprojecten*.

Saavedra, Y. M. B., Iritani, D. R., Pavan, A. L. R., & Ometto, A. R. (2018). Theoretical contribution of industrial ecology to circular economy. *Journal of Cleaner Production*, *170*, 1514–1522. https://doi.org/10.1016/J.JCLEPRO.2017.09.260

SAENZ. (2023a). *Algemene Ledenvergadering SAENZ*.

SAENZ. (2023b). *Op naar een nieuwe energietoekomst?*

SAENZ. (2023c). *Over SAENZ*. https://www.saenz.nu/

SAENZ. (2023d). *Presentatie Project "Doen."* https://www.saenz.nu/1551-2/

SAENZ. (2024a). *Hoe word ik lid van SAENZ?* https://www.saenz.nu/lid-worden/hoe-word-ik-lid-van-saenz/

SAENZ. (2024b). *SAENZ Contributiemodel*. https://saenz.nu/lid-worden__trashed/contributie/

SAENZ. (2024c). *SAENZ Ledenlijst*. https://www.saenz.nu/onze-leden/ledenlijst/

Schuiling, M., Strijker, B., Loehr, D., & Schutte, R. (2021). Handboek aanpak collectieve verduurzaming bedrijventerreinen. In *Energie Collectief Utrechtse Bedrijven*. https://www.ecub.nl/

Stedin. (2023). *Pilot GCO Stedin - Tholen*.

TenneT Holding B.V. (2024). *Market roles*. https://netztransparenz.tennet.eu/electricity-market/about-the-electricity-market/market-roles/

ValleiEnergie. (2024). *Homepage*. https://valleienergie.nl/

van Blijswijk, M. J., & de Vries, L. J. (2012). Evaluating congestion management in the Dutch electricity transmission grid. *Energy Policy*, *51*, 916–926. https://doi.org/10.1016/j.enpol.2012.09.051

van der Waal, E., van der Windt, H., & van Oost, E. (2018). How Local Energy Initiatives Develop Technological Innovations: Growing an Actor Network. *Sustainability*, *10*(12), 4577. https://doi.org/10.3390/su10124577

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

Wolsink, M. (2020). Distributed energy systems as common goods: Socio-political acceptance of renewables in intelligent microgrids. *Renewable and Sustainable Energy Reviews*, *127*, 109841. https://doi.org/10.1016/J.RSER.2020.109841

Yu, Y., Reihs, D., Wagh, S., Shekhar, A., Stahleder, D., Mouli, G. R. C., Lehfuss, F., & Bauer, P. (2022). Data-Driven Study of Low Voltage Distribution Grid Behaviour with Increasing Electric Vehicle Penetration. *IEEE Access*, *10*, 6053–6070. https://doi.org/10.1109/ACCESS.2021.3140162

8. Appendices

Appendix A: Literature study

All search results were limited to the document type 'Article.'

Grid congestion in the Netherlands			
Date	**Keywords**	**Number of Hits**	**Papers to review**
05-10-2023	grid AND congestion	1781	Too much
05-10-2023	electricity AND grid AND congestion	462	Too much
05-10-2023	grid AND congestion AND dutch OR Netherlands OR holland	12 (six included)	Braat, M., Tsafarakis, O., Lampropoulos, I., Besseling, J., & van Sark, W. G. J. H. M. (2021). Cost-effective increase of photovoltaic electricity feed-in on congested transmission lines: A case study of the Netherlands. Energies, 14(10). https://doi.org/10.3390/en14102868 Ghaemi, S., Li, X., & Mulder, M. (2023). Economic feasibility of green hydrogen in providing flexibility to medium-voltage distribution grids in the presence of local-heat systems. Applied Energy, 331. https://doi.org/10.1016/j.apenergy.2022.120408 Nizami, M. S. H., Haque, A. N. M. M., Nguyen, P. H., & Hossain, M. J. (2019). On the application of Home Energy Management Systems for power grid support. Energy, 188. Https://doi.org/10.1016/j.energy.2019.116104 Nortier, N., Paardekooper, M., Lucas, C., Blankert, A., van der Neut, A., Luxembourg, S., Mewe, A., & van Sark, W. (2023). Spatially resolved generation profiles for building, land, and water-bound PV: a case study of four Dutch energy transition scenarios. Advances in Geosciences, 58, 199–216. https://doi.org/10.5194/adgeo-58-199-2023 van Blijswijk, M. J., & de Vries, L. J. (2012). Evaluating congestion management in the Dutch electricity transmission grid. Energy Policy, 51, 916–926. https://doi.org/10.1016/j.enpol.2012.09.051 Yu, Y., Reihs, D., Wagh, S., Shekhar, A., Stahleder, D., Mouli, G. R. C., Lehfuss, F., & Bauer, P. (2022). Data-Driven Study of Low Voltage Distribution Grid Behaviour with Increasing Electric Vehicle Penetration. IEEE Access, 10, 6053–6070. https://doi.org/10.1109/ACCESS.2021.3140162
05-10-2023	electricity AND grid AND congestion AND dutch OR Netherlands OR holland	7 (no new papers included)	

Grid congestion management in the Netherlands			
Date	**Keywords**	**Number of Hits**	**Papers to review**
09-10-2023	grid AND congestion AND management	642	Too much
09-10-2023	grid AND congestion AND management AND dutch OR Netherlands OR holland	6 (no new papers included)	

Grid congestion on industrial parks			
Date	**Keywords**	**Number of Hits**	**Papers to review**
10-10-2023	grid AND congestion AND industrial AND park	3 (one included)	Deb, S., Goswami, A. K., Harsh, P., Sahoo, J. P., Chetri, R. L., Roy, R., & Shekhawat, A. S. (2020). Charging Coordination of Plug-In Electric Vehicle for Congestion Management in Distribution System Integrated with Renewable Energy Sources. *IEEE Transactions on Industry Applications*, *56*(5), 5452–5462. https://doi.org/10.1109/TIA.2020.3010897
10-10-2023	grid AND congestion AND industrial AND cluster	0	
10-10-2023	grid AND congestion AND eco AND industrial AND park	0	
10-10-2023	grid AND congestion AND business AND park	0	

Appendix B: Survey

Questions marked with red have been deleted in the Dutch survey. Questions marked with blue have been adjusted from the investing perspective to the participating perspective or adjusted in another way. The justification can be found in section 2.2.2.

(i) Name of the company:
(ii) First and last name of the respondent:
(iii) Address:
(iv) Phone number:
(v) Email address:

1. What is your company's field of activity?
2. Please choose your latest educational degree
    - High school
    - MBO
    - HBO
    - WO
3. In which industrial cluster in Arak is your company located?
    - Ghotb industrial zone
    - Kheir Abad industrial zone
    - Haji Abad industrial zone
    - No.1 industrial zone
    - Urban territory
4. Which of below options best describe your company's electricity consumption scheme?
    - Small consumer (3 x 25 ampere till 3 x 80 ampere)
    - Bulk consumer (similar to or larger than 3 x 80 ampere)
5. What type of ownership does your company have?
    - State-owned
    - Private
    - Private (family business)
    - Public
    - Hybrid
6. How many people are working in your company?
    - 1–50 people
    - 50–100 people
    - 100–150 people
    - 150–200 people
    - More than 200 people
7. How much is the average monthly electricity consumption of your company?
    - 0–10 MWh
    - 10–50 MWh
    - 50–100 MWh
    - 100–400 MWh
    - >400 MWh
8. How much is your monthly electricity bill? (in Euros)
    - Receives money back
    - € 0 - € 1000
    - € 1000 – € 2500
    - € 2500 – € 4000
    - € 4000 – € 5500
    - More than € 5500
9. How many working shifts do you have?
    - 1 daily shift

- 2 daily shifts
- 1 daily and 1 night shift
- Three shifts
- Five shifts

Questions regarding the "environmental attitudes": (please rate below phrases between 1 to 10)

10. Personally, I am concerned about the environment, and I believe fossil-based energies should be replaced by renewables
11. Personally, due to environmental concerns, I am willing to pay more for RE in my household
12. Due to environmental concerns, we are willing to use RE in our company but only if it is economically feasible (the economic feasibility is more prior)
13. It is important for us to participate in societal and environmentally friendly projects even if they are not economically feasible
14. We are not concerned for the climate at all and are more focused on running our company.

Questions regarding the "societal attitudes": (please rate below phrases between 1 to 10)

15. We are not interested in partnering with other companies since we cannot trust them in issues such as their on-time payments
16. We don't like other companies to have access to our electricity consumption information
17. We would participate in partnerships projects if only all the financial and operational performances are transparent to all the members
18. We cannot trust introduced incentives from the government since we doubt if these promises can be kept by different governments over time
19. We would be interested in participating in a project if prominent companies join that project
20. We believe that in partnerships all the members should have the right to vote, and decisions should be made in general meetings in a democratic way
21. We are not interested to partner with other companies in strategic issues such as electricity and water
22. In partnerships, we want our shares to be legally credible and tradable
23. We are aware of the partnerships' complexity, but we believe that we can overcome them by setting strict institutions
24. I am interested to work together with other companies in my industrial zone.
25. I feel connected with the other companies in my industrial zone.

Questions regarding the "economic attitudes": (please rate below phrases between 1 to 10)

26. We have no problem in our electricity provision and if we participate in an InCES it would only be for economic profitability by selling RE
27. Similar to other energy carriers, we assume that the increase in the price of electricity is probable, and we are willing to participate in InCES to become gradually independent
28. We entitle the industrial sector to cheap electricity, and we are not willing to participate in InCESs to prevent the probable expensive electricity threat
29. To participate in an energy sharing system, it is important that we can easily opt out.
30. We are not aware of the incentives dedicated to RE generation at all
31. In case you are interested to invest in an InCES by getting loans from banks, which of the following would be more interesting to you?
    - Loan with short payback period + low interest rate + properties as guarantee
    - Loan with long payback period (5–7 years) + Normal interest rate + No property as guarantee
    - Loan with normal interest and payback period + no properties as guarantee
    - Not interested in getting loans from banks
32. How much (of your annual revenue) are you willing to invest in a collective renewable electricity production project?
    - less than 5% of annual revenue
    - 5% to 10% of annual revenue
    - more than 10% of annual revenue

- Not willing to invest revenue

33. In case your company invests in collective renewable electricity production, how long would be your preferred investment's payback period?
    - Less than 3 years
    - Between 3–5 years
    - Between 5–10 years
    - Between 10–15 years
    - >15 years
34. If an energy sharing system is initiated in my industrial zone, I am willing to participate.