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ELEXIA

Demonstration of a digitised energy system integration across sectors enhancing flexibility and resilience towards an efficient, sustainable, cost-optimised, affordable, secure, and stable energy supply.

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Definitions and Acronyms

CA	Consortium Agreement
EC	European Commission
EU	European Union
GA	Grant Agreement
PC	Project Coordinator
TC	Technical Coordinator
WP	Work Package
SA	Social Acceptance
BGO	The Municipality of Bergen
HTK	The Municipality of Høje-Taastrup
POS	Port of Sines

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Abstract / Executive Summary

This deliverable summarises the first results on stakeholder perspectives and social acceptance for an integrated and flexible energy system from interviews and focus groups in the three pilot communities Høje-Taastrup (Denmark), Dokken (Norway) and Port of Sines (Portugal). The purpose of the deliverable is to inform project partners about the different perspectives that arise when we engage stakeholders in discussions concerning sector integration. Through early engagement with stakeholders, we can gain valuable insight that will help tool developers refine the technology to meet the needs and expectations of future energy system users. Additionally, it will enhance our readiness to integrate and demonstrate the technology at the three pilot sites and give us better understanding of how project partners and external stakeholders wish to be communicated with throughout the progression of the project. Six pre-determined themes guided our questions in the interviews and focus groups, all of which might have an impact on social acceptance of the future energy system. First, we made the stakeholders reflect upon what the ideal future energy system looks like to them. Second, we discussed what kind of business models that are needed to make this ideal energy system work. Third, we made the stakeholders reflect on how they think different sustainability considerations should be weighted in questions related to infrastructure, energy planning and spatial planning. Fourth, we asked them to highlight what regulatory barriers and challenges they experience stand in the way of an integrated and flexible energy systems today. Fifth, we brought up the question of flexibility which constitutes a key concept in this project; both the kind of flexibility that can be achieved through interaction between different forms of energy and actors, and flexibility in the sense of developing digital solutions that utilize the flexibility in the system. Sixth, we rounded off the interviews by asking the various actors what they think about the chosen tripartite technology cooperation in the ELEXIA project, and to what extent they wish to be involved in development processes like this in the future. Please note that interview data and data analysis from Pilot Port of Sines are not included in this report due to delays in conducting stakeholder activities and data handover to the Task 1.1 team. In our findings, we discovered that various aspects of trust play a vital role in social acceptance, as it forms the foundation for user satisfaction and willingness to engage with the system. Furthermore, we learned that the concept of an integrated energy system involves not only horizontal integration across energy vectors, systems, and infrastructures, but also vertical integration across time. Additionally, we identified challenges stemming from regulatory and spatial limitations that hinder the seamless integration of shared spaces, and we recognized the necessity for changes in financing models to effectively address economic barriers. Lastly, we determined that collaboration is essential in the technology development process, enabling the pooling of collective resources and expertise to tackle issues that surpass the capabilities of any single ELEXIA partner.

Description of the Document

This document starts with an introduction to Task 1.1, followed by a brief presentation of the three pilots. In the subsequent chapters 3 to 5 we have defined key concepts, introduced the chosen social acceptance indicators, and explained our multi-layer methodology. The remaining of the document is organized around the two pilots Dokken and Høje-Taastrup. The interview guides and participants in focus groups and interviews can be found in chapter 6. The two “Reflections” chapters 7 and 8 provide preliminary observations and reflections on each of the pilots, based on the interview outlines in the appendices. Finally, a comparison across pilots is presented in chapter 9. A more comprehensive social acceptance analysis will be featured in a forthcoming publication. Note that the interview outlines included in the appendices represent the actual data and will serve as input to other partners in the ELEXIA project (Figure 1).

This report contains six appendices. Appendix 1 features an interview outline based on data gathered from the Danish pilot. Appendices 2 to 5 provide interview outlines based on data collected from the Norwegian pilot. Appendix 6 displays the results generated from the post-interview survey. Lastly, appendix 7 contains a "Community and Stakeholder Engagement Guide." In this guide, the social science researcher in charge of Task 1.1 supplies recommendations for continued stakeholder engagement throughout the duration of the project.

WP and Tasks Related with Deliverable 1.1

D1.1 is informed by the pilots, providing insights across all ELEXIA work packages. It will help tool developers (WP2) refining the technology to meet the needs and expectations of future energy system users. Additionally, it will enhance our readiness to integrate and demonstrate (WP3) the technology at the three pilot sites. D.1.1 will also support the T4.3/4 team to develop relevant questions and themes, allowing for continued integration of stakeholder views. Overall, this provides better understanding of how project partners and external stakeholders wish to be communicated (WP5) throughout the progression of the project.

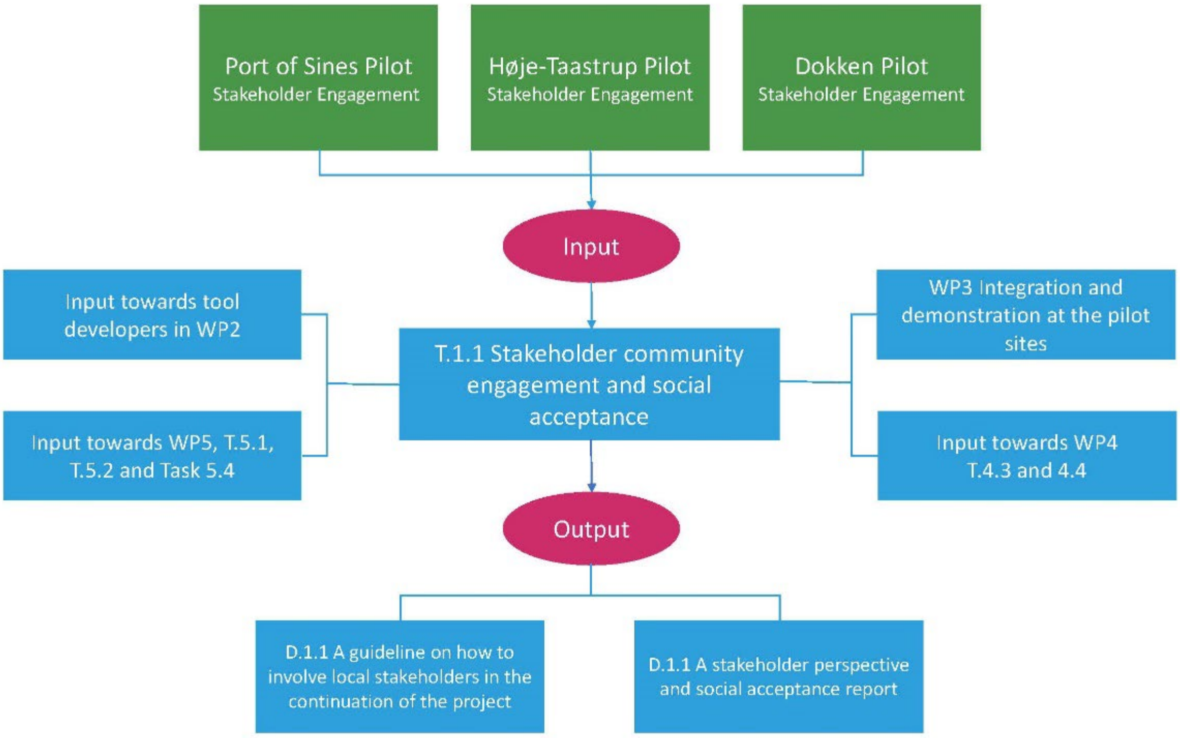

Figure 1: Task 1.1 interactions with other tasks and WPs in the ELEXIA project

Introduction

ELEXIA is a European Union project funded by the Commission's Horizon 2020 program under the topic of Energy Sector Integration (ESI): Integrating and combining energy systems to a cost-optimized and flexible energy system of the systems (HORIZON-CL5-2021-D3-02-05), coordinated by NORCE Norwegian Research Centre (NORCE), Norway.

The energy system is in transition. We can expect to see a move towards a digitalized and decentralized energy system in the future where energy system integration and sector coupling plays a significant role. Sector coupling creates flexibility for the power system that can be crucial for the transition to zero-emission societies. At the same time, it opens for new societal issues that must be understood and overcome to be accepted and deployed by the local communities. Lack of feedback early in the process can lead to tools being developed that do not meet the expectations and needs of future energy system users, thus preventing acceptance by different actors in the community.

The development of a digitized, flexible, and integrated energy system involves a range of new actors and stakeholders within several spheres of society. Power relationships between the new constellation of actors must be studied. Dilemmas, such as lack of inclusion that can result from a lack of diversity in the planning process, should be a priority for local authorities to assess when embarking on technology development projects. In the future energy system, end-users such as developers or even residents in a building block may also be producers of energy in that they have installed solar cells on roofs or walls in their building. This means that several actors can be labelled as both users of the future integrated energy system and producers of energy within the same system if business models and regulations facilitate this kind of energy production cooperation. Somehow, all these actors must find ways to cooperate, and coordinate their efforts towards effective, affordable, and decarbonized solutions. This requires efficient, transparent, democratic, and fair processes. It also requires incentives for investors and market actors, and an awareness of the needs and perspectives of all relevant stakeholders that can be affected by, or affect, the new system.

In ELEXIA, partners from the private sector, the public sector, and academia have come together to demonstrate a digitized energy system integration across sectors that will enhance flexibility and resilience towards an efficient, sustainable, cost-optimized, affordable, secure, and stable energy supply. The tripartite technology cooperation during the technology development phase, with a specific focus on end-users, has the potential to provide significant benefits in the development and demonstration of smart technological solutions that can impact the wider community.

D.1.1 reports the result of ELEXIA's Task 1.1 – Stakeholder community engagement and social acceptance. The purpose of the deliverable is to inform the other work packages in ELEXIA about the different stakeholders' preferences, needs, and concerns with regards to energy sector integration. Our approach has been to look at the interfaces between the tools and technologies that are being developed in the ELEXIA project and the different layers of society that might be affected by them in the future. The idea has been to develop a stakeholder engagement strategy that can capture important issues within social acceptance that might be a barrier for the implementation and deployment of the technology at the three pilots. This socio-technical approach to the technology development process implies that that project partners and other relevant stakeholders such as users and co-producers of the new energy system are involved and engaged from the early stages of the project. The social scientists in Task 1.1 believe that opening the technology development process to also include stakeholders beyond the consortium is a key strength of the ELEXIA project.

The Pilots

For the introduction of the pilots, we have asked each of the pilots to present themselves with their own words. Please note that interview data and data analysis from Pilot Port of Sines are not included in this report due to delays in conducting stakeholder activities and data handover to the Task 1.1 team.

Pilot Dokken

The Dokken area in Bergen is currently a harbor and logistics area that covers approximately 220 hectares. Bergen municipality is the largest landowner in the area. In the transition between 2018 and 2019, both the harbor area and the city council made decisions to move the freight port out of Bergen city center, and shortly thereafter, it was also decided to start the process of urban development and transformation of the port area stretching from Møhlenpriskaien in the south to Nøstetorget in the north-east.

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The city council had high ambitions and set clear political goals for the development already in 2019. The area is to be developed into a vibrant urban area for everyone, with energy and environmental solutions that provide sustainability and zero emissions of greenhouse gases.

In the early phase of the development project, work has focused on setting the development goals for the area. These goals include creating a diverse district that can be a model for sustainable urban living. It is desirable to challenge existing boundaries and find innovative solutions to current problems, without following the same mindset that created them. Furthermore, it is also important to have a flexible urban structure that can accommodate the unexpected and the unplanned.

Parallel to setting the development goals, the city council has also adopted an urban strategy that sets the direction of the future urban structure, transportation corridors and public space. In addition, the city council decided to establish a development company, Dokken Utvikling AS, who will be responsible for developing the area and delivering on the political ambitions.

Bergen Havn AS, the port authorities, is the responsible body for planning and reorganizing the harbor activities that cannot be combined with city life in the future situation.

The formal urban planning is currently in process, in addition to environmental and soil surveys, action plans for cleaning up soil pollution. Infrastructure planning is an important part of the early phase, where energy concepts and energy systems become central elements that need to be considered.

The Dokken area in Bergen is undergoing extensive development from being a traditional harbor and logistics area to becoming a modern and sustainable urban district. Significant efforts have been made in developing goals, area strategy, and the establishment of a development company. At the same time, work is underway to move harbor activities and develop an area regulation plan that considers environmental and energy aspects. The Dokken area thus becomes a forward-looking and sustainable urban district that can serve as a model for other areas. The collaboration with ELEXIA further emphasizes Dokken's commitment to energy and environmental solutions, aligning with the EU's vision for sustainable development. The ELEXIA project is expected to bring valuable insight into the development plans at Dokken, and hopefully contribute to relevant knowledge for future decisions of energy- and infrastructure investments.

Pilot Høje-Taastrup

The Municipality of Høje Taastrup has a total area of 78 km^2 and consists of three large towns with train stations and 14 original villages. The municipality lies approximately 20 km west of Copenhagen and has a population of around 50,000. Høje-Taastrup Municipality is one of the largest municipalities in Greater Copenhagen, with good motorway connections, besides the Intercity, regional, and S-train networks, and an extensive bus service. This is a large commuter municipality, with many commuters travelling to and from Høje-Taastrup daily. Around 25,000 people commute to Høje-Taastrup during the week, to their jobs in one of the many companies based here. The municipality has large companies within IT and service, logistics and transport, and regional retail trading. Danske Bank and Nordea are among the companies with large branches here, while PostNord, IKEA, DSV and DISA are also located in the municipality, besides knowledge-intensive companies and institutions such as the Danish Technological Institute and Rockwool. There are also many small and medium-sized craft and production companies. Høje-Taastrup Municipality stands for professional and effective municipal services. We wish to provide services to our residents that are based on openness, respect and understanding of other people's social and cultural backgrounds.

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Høje-Taastrup municipality participates in the EU ELEXIA project to promote energy efficiency and sustainable development through cooperation with external parties and knowledge institutions. This knowledge exchange and testing of innovative solutions aims to reduce the municipalities' emissions. With our participation, we hope that the project can contribute to our goal to become a net-zero municipality by 2050 at the latest.

Pilot Port of Sines

The Port of Sines, located in Southeast Europe, is strategically positioned at the crossroads of major international maritime routes. With 6.31 km^2 of land and 147.5 km^2 of maritime area, it serves as a significant hub port in the Ibero-Atlantic region. The port's direct hinterland covers the southern and midland parts of Portugal, while its extended hinterland extends to the Spanish Extremadura and Madrid.

The Port of Sines is an open deep-water seaport with excellent maritime access, without restrictions, leading the Portuguese port sector in the volume of cargo handled, and offering unique natural characteristics to receive any type of vessels. Due to its modern specialized terminals, the port is capable of handling different types of cargo.

Sines is the main port in the Ibero-atlantic front, whose geophysical characteristics have been determinant on its consolidation as a strategic national active. It is the country's leading energetic supplier (crude, refined products, and natural gas), as well as an important port as far as general and containerized cargo concerns, presenting a high growth potential, in order to become a reference port at an Iberian, European and worldwide level.

It is a modern port (1978), free of urban constraints, thus assuring long-term expansion capacity. Offering good land accessibility for present traffic, the port is also included within a road and rail development plan, allowing it to respond to the expected future growth of both the port and the region.

Energy System Goals

The port of Sines aims to enhance the overall port energy system, considering the diverse customers and terminals, and aligning with a clear strategy focused on digitization and complete decarbonization. The port not only focuses on analyzing the existing untapped flexibility and sector coupling in the energy system but also on future planning, driven by an ambitious goal of achieving decarbonization by 2050. This includes careful consideration of the port's expected tripled demand due to its planned expansion of operations.

The integration of energy sectors will be achieved through the following goals:

- Optimization of the existing flexibility from Port's loads, and centralized management of the port's electrical grid and related sectors;
- Planning the investment for the Port's future energy system, accounting for the expansion and correspondent increase in demand, while aiming to achieve an ambitious goal of fully decarbonizing the port, through the implementation of a various mix of Renewable Energy Sources – RES;
- Sector coupling and port digitalization - ELEXIA's EMS will interface with the port's Logistic Single Window (LSW/JUL), a management and information tool. The JUL combines port's maritime and land means of transport (road and rail), thus allowing all the players to interact. The integration between the JUL and EMS allows for load's prediction to become more relevant given the electrification process of road and rail vehicles and the introduction of OPS connections; and
- Port operators and citizens involvement - early engagement of stakeholders to gather feedback and contribute to the project's development and opportunities. Furthermore, port of Sines clients and terminal concessions will be involved in the internal energy grid management, providing load flexibility.

The ELEXIA project is part of APS's plans for the decarbonization of the Port of Sines. The overall objective of the project is the development of planning and management tools for electrical energy under different conditions to integrate and combine various energy vectors and sectors, creating flexible, resilient, and cost-optimized electrical energy systems. This aims to assist in the integration of renewable energies and achieve independence from systems based on fossil fuel combustion. The ELEXIA project will also demonstrate and create a digital platform integrating the planning and management tools for electrical energy.

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Concepts

From the early stages of the ELEXIA project, different views emerged on who the relevant stakeholders were. Some partners held the belief that stakeholders were limited to the ELEXIA project partners, while others had a broader understanding of the concept. Similarly, we experienced uncertainty regarding stakeholder engagement, including who should be included in these activities, as well as how their opinions and perspectives should feed into the technology development process. Our task in this project has been to manage stakeholder engagement and address social acceptance aspects related to the development of an integrated and flexible energy system. Thus, it is essential to begin this report by conceptualizing key terms related to the task.

Stakeholder

In the literature, there are numerous definitions of stakeholders. Bourne (2005) suggests that a stakeholder is an actor who has an interest or some aspect of rights or ownership in the project. On the other hand, Freeman (1984) argued as early as 1984 that there are additional parties involved, including customers, employees, suppliers, governments, competitors, consumer advocates, environmentalists, special interest groups, and the media. Freeman's understanding of stakeholders takes into consideration actors who may be affected in some way or another by the subject activity, such as the launch of new products or technologies, even if they are unaware of it.

In 2017, McGrath and Whitty used “The McGrath and Whitty definitional refining method” to derive a definition of stakeholders that applies across *all* fields of study, without restricting it to an organizational scope. Through this comprehensive method, they arrived at the following definition: "A stakeholder is an entity with a stake (interest) in the subject activity.” We have chosen to adhere to this undressed definition of stakeholders as an overarching conceptualization because it allows us to consider not only current stakeholders but also future end-users of the technology. This has been a focus for us from the beginning of the project.

In Task 1.1, our objective was to approach “stakeholder interest" in a broader sense than just shares and economic interest. We specifically aimed to incorporate social and environmental interests into our framework. Additionally, we wanted to adopt a forward-thinking perspective on stakeholders that aligns with the project's purpose of developing the *future* energy system. Consequently, we emphasized the need to identify not only current stakeholders but also future stakeholders who may affect or be affected by the subject activity in the future. By employing this approach, we believe that the ELEXIA project will be better equipped to identify dilemmas and barriers that could impede the development and implementation of a flexible and integrated energy system and finding ways to address them early in the technology development process.

Stakeholder Engagement

Stakeholder engagement refers to the process of involving stakeholders (in the broadest sense, individuals or groups who have an interest in, benefit from, or may be affected by a project or organization) in decision-making processes, eliciting stakeholders’ views on their relationship with, or other activities related to, a project or organization (Friedman, A. L., & Miles, S. 2006). Effective stakeholder engagement is essential for successful project outcomes, as it allows for the identification of stakeholder needs, perspectives and preferences, as well as the development of more equitable and sustainable solutions.

End-user

An end-user is the ultimate consumer of a finished product (Merriam-Webster, 2024). In the ELEXIA project, the end-users can be thought of as consumers of primary energy and users of the future flexible and integrated energy system. In the context of energy planning, policies, and initiatives, end-users are an important consideration as they can be targeted for energy efficiency measures, renewable energy adoption, and other sustainability actions, including reducing energy consumption, encouraging the use of energy-efficient appliances or equipment, and implementing programs that incentivize end-users to shift their energy use to off-peak periods. We used the category "Users" to map the various end-users at the three pilots and categorized them into the three subcategories: "Single users" (residents/occupants/pilots), "Public and private buildings as users" (real estate actors), and "Large-scale users" (large energy consumers) to account for their differences.

Social Acceptance

In the context of this project, we share two core beliefs: 1) We should not directly influence social acceptance regarding acceptance objects, but we can help identifying barriers and give support in finding solutions to overcome these barriers (Leucht et al. 2010, p. 5); 2) Social acceptance needs to be subjected to public scrutiny. It should not be considered merely as an obstacle to overcome and as a necessary condition to support innovation (Casiraghi et al. 2021). This understanding of social acceptance is supported by Wüstenhagen, Wolsink and Bürer when they point out that support for technologies needs analyses as much as opposition thereof (2007, p. 2686).

As a starting point for this report, we relate to Wolsink's (2018) conceptualization of social acceptance as "a bundle of processes of decision-making on issues concerning promotion of – or counteraction against – new phenomenon and new elements in the transformation of current energy systems". Würstenhagen et al. (2007) introduce a three-dimensional approach to social acceptance that provides greater clarity on the various layers of social acceptance, what triggers acceptance within the three dimensions, and which actors are most prominent within the different dimensions. See Figure 2.

Socio-political acceptance

Socio-political acceptance relates to acceptance of technologies and relevant policies among the public, key stakeholders, and political decision-makers. Policies in this context can make it easier to foster market and community acceptance, for example through purchasing arrangements.

In Wüstenhagen et. al.'s conceptualisation of social acceptance, social-political acceptance is at the top of the triangle with community and market acceptance at the base (2007, p. 2684), illustrating its role in market and community acceptance; in Wolsink's diagram from 2018, the same sentiment is reflected with social political acceptance as the base for market and community acceptance (p. 291). Socio-political acceptance is the most general of all three, and, while linked to, should not be confused with public acceptance; public acceptance is not a proxy for social acceptance (Wolsink, 2018, p. 287). Acceptance of technologies is not the same as acceptance for projects (Wolsink, 2018, p. 288); while consumers might like the general idea of renewable energy, it might look different when they have to alter their behaviours due to e.g., dynamic tariffs. Processes behind social political acceptance are related to concrete policies and geographic locations; from marker regulations, ownership legislation, to planning policies (Wüstenhagen et al., 2007). This aspect of social acceptance is also linked to socio-economic aspects, for examples introduction of regulations that require establishing new jobs in a region (Wüstenhagen et al., 2007). Social political acceptance links political decision making with social needs.

Community acceptance

Social political acceptance often meets debates related to community acceptance when it comes to policies around ownership. Here identification of individuals or a community to a place come into play, often at the point when technologies are implemented (Wüstenhagen et al., 2007, p. 2687). This can be in the shape of land, or alteration of landscapes, as is the case for example with windfarms (as discussed by Wüstenhagen et al., 2007), but also on a more granular level of offices and claim to space and its thermal qualities.

Community acceptance is overall the most individualized category of Wüstenhagen et. al.'s tripartite. One of the main aspects of community acceptance is trust, which in turn is closely linked to social political and market acceptance, in the sense of trust in governance and market actors (Wüstenhagen et al., 2007, p. 2685).

Community acceptance might involve acceptance of so-called "siting decisions" (Wüstenhagen et al., 2007, p. 2685). This is where the NIMBY ("not in my backyard") debate typically comes into play (Wüstenhagen et al., 2007, p. 2685) and decisions on where to install e.g., solar cells on roof tops or location of batteries. Community acceptance offers a different avenue for understanding the "NIMBY" phenomenon and overcome conceptualisations of social acceptance through "NIMBY" (Batel, 2020, p. 1). Factors that influence community acceptance can be distributive justice (e.g., how to distribute costs and profits between the various actors), procedural justice (e.g., fair decision-making processes that give all stakeholders opportunities to participate), and, as noted above, trust that comes in many different forms and facets. Residents and local authorities are typically stakeholders within this dimension. Hence community engagement is crucial, as Wolsink notes (Wolsink, 2018, p. 288); in the context of this project, we extend community engagement further to stakeholder engagement.

Community acceptance typically follows a U-curve: high acceptance at the beginning when, for example, excitement is high for new environmentally friendly solutions, goes low when it comes to concrete actions, such as siting decisions or in the case of ELEXIA making concrete behavioural changes around the new smart energy system, and rises again once the new technology is implemented and in use (Wüstenhagen et al., 2007, p. 2685). Here we would like to add that community acceptance is also closely linked to appropriateness of technologies and the benefits they bring, especially if new practices need to be learned (as might be the case with smart meters and dynamic tariffs).

While community acceptance is often an active process, it can be passive, depending on involvement of stakeholders (Wüstenhagen et al., 2007, p. 2685).

Market acceptance

Market acceptance can be understood as the processes how the market adopts new technologies (Wüstenhagen et al., 2007, p. 2685). Within this dimension, consumers, producers and investors are the most central stakeholders. Wüstenhagen et. al. notes a disconnect that can emerge between market acceptance and social political acceptance and community acceptance (Wüstenhagen et al., 2007, p. 2685). While consumers might have a high demand for e.g., renewable energy, this does not automatically translate into community acceptance (Wüstenhagen et al., 2007, p. 2685). Community acceptance, as noted above, is closely linked to trust in the investors. In turn, trust plays a key role for investors regarding governance and regulators, to ensure their commitment is secured.

Other aspects of market acceptance are linked to wider global economic developments, such as wars that influence energy prices, or import/export agreements between countries (Wüstenhagen et al., 2007, p. 2685). Market acceptance is often also linked to intermediaries, such as architects or installers advising clients about sensible technologies (Wüstenhagen et al., 2007, p. 2685). Market acceptance is always an active process (Wüstenhagen et al., 2007, p. 2685), and we would add, does not exist without social, political and market acceptance.

In summary, social acceptance is more than passive consent; it is a complex and dynamic process over time that moves between the three dimensions described above (Wolsink, 2018). Social Acceptance is an "active" form of acceptance where future users' willingness to install technologies in their buildings, homes, offices, terminals etc. is assessed. Within the framework of social acceptance, we discuss more than the mere "license to operate"; the aim is to investigate "supposed, observed, or [and] desired social processes" (Wolsink, 2018, p. 289).

Figure 2: The triangle of social acceptance of renewable energy innovation

Source: Würstenhagen et al., 2007, p. 2684

Social Acceptance Indicators

As mentioned in the previous chapter's concept description, social acceptance can be analysed along the three dimensions: socio-political, community, and market acceptance. Based on the conceptualization of social acceptance and these dimensions, five social acceptance indicators have been identified. These are *Knowledge*, *Trust*, *Satisfaction*, *Communication,* and *Technology cooperation*. The interview guides and post-interview survey were designed with these five aspects in mind. Furthermore, the social acceptance indicators developed in T1.1 are the initial social KPIs for the ELEXIA project, across all three pilots.

Knowledge

The *Knowledge* indicator measures the level of understanding and familiarity stakeholders have with the concept of a flexible and integrated energy system. It focuses on the extent to which stakeholders are aware of this innovation and comprehend its functioning.

According to the diffusion of innovation model by Rogers (2005), the decision-making process starts with individuals or organizations becoming aware of the innovation. Lack of awareness about the benefits of technology often leads to skepticism and criticism. Therefore, it is crucial to assess stakeholders' knowledge levels and their perception of the impact that an integrated energy system can have.

To measure this indicator, self-reported understanding of the innovation and its impact will be collected through survey questions administered during focus groups, interviews, and repeated later in the project period. The survey will include a set of statements and appropriate response scales for stakeholders to assess their understanding and opinions.

The expected outcomes include a decrease in the proportion of "don't know" responses over time, indicating increasing knowledge/awareness among stakeholders. Additionally, an increase in the proportion of stakeholders forming an opinion and being able to take a position on specific questions will demonstrate improved understanding of the innovation.

This indicator recognizes the significance of knowledge and awareness in technology adoption and social acceptance, as identified by Mallet (2007) and Rogers' diffusion of innovation model (Rogers, 2005). It acknowledges the influence of factors such as relative advantages, complexity, and triability in shaping stakeholders' acceptance and adoption of the technology.

The knowledge/awareness indicator recognizes that an increased level of knowledge or awareness does not necessarily lead to greater acceptance of a specific technology among stakeholders. This is supported by the notion that legitimate forms of opposition can arise from different reasoning than those related to the perceived advantages of the technology (Casiraghi et al. 2021, p. 110). Hence, it is essential to acknowledge the value of knowledge from different actors, including lay knowledge.

As highlighted by Casiraghi et al. (2021), technology acceptance is influenced by multiple factors, and stakeholders with a higher level of knowledge/awareness/education may have valid reasons for opposition to certain technologies. Therefore, a comprehensive assessment of stakeholder knowledge/awareness should not only focus on increasing understanding but also recognize the diversity of perspectives and reasons underlying technology acceptance or rejection.

Trust

The *Trust* indicator measures the level of trust that external stakeholders have in the project partners' (governance institutions/implementation institutions/research institutions) ability to achieve integrated energy sector innovation at the Pilot stage. Trust plays a crucial role in creating acceptance, particularly in dealing with risks, and is strongly linked to stakeholders' perceived competence and intentions (Würstenhagen, 2007).

The level of trust among stakeholders may vary depending on different factors, including trust in decision-making, trust in professional actors of the consortium, trust in the information and intentions of key actors, trust in aims, attitude, and competences of actors, trust in the authorities so sustain their financial support instrument, and trust in the real commitment to renewable energy policies. Moreover, Slovic (1993) and Würstenhagen (2007) highlight that trust is fragile and can be created slowly but destroyed rapidly.

The trust indicator in Task 1.1 will be measured through a survey administered at the end of focus groups and interviews. The participants will be asked whether they trust the project partners' capacity to create an integrated energy system that they would like to use in the future, aligned with the specific values and goals identified in the proposal stage. The outcomes of this indicator will provide insights into stakeholders' trust levels and how they might be influenced by changing values and priorities during the project period.

It is essential to emphasize the connection between the indicators trust and knowledge/awareness, where a balance between both factors is necessary to create acceptance. Moreover, changes in values and priorities during the project period can lead to obstacles for acceptance among stakeholders along all three dimensions of social acceptance.

Satisfaction

The *Satisfaction* indicator measures whether stakeholders are satisfied with the way the project objectives meet its societal, economic, technological, and environmental expectations.

In the literature, there are several examples where satisfaction has been used as an indicator to measure social acceptance in the field of energy technology, ranging from business model acceptance (Al-Debei, M. M., & Avison, D., 2010) to distributed solar photovoltaics (Chen, H., Liu, Y., & McLaughlin, M. (2018) to wind power implementation (Wolsink, M., & Pepermans, G. (2006).

In Task 1.1, we have used the Satisfaction indicator to assess stakeholders' satisfaction, beliefs, and concerns regarding the suitability and potential of an integrated and flexible energy system.

The satisfaction indicator will be measured through a survey administered at the end of focus groups and interviews. By capturing participants' responses towards different aspect of the integrated energy system, the data can help assess the level of social acceptance of a flexible and integrated energy system and identify areas that may require further attention or improvement.

Communication

The Communication indicator measures the effectiveness of communication strategies in creating acceptance of the ELEXIA innovation. Effective communication channels, such as mass media and interpersonal networks, are crucial for spreading awareness of an innovation and exposing it to potential users (Rogers, 2005). Lack of communication among companies, experts, and between the public and experts may also have a negative effect on social acceptance (Mallet, 2007).

The indicator considers the preferred communication channels and the level of collaboration among interpersonal networks and perceptions of ownership by potential adopters, as suggested by Walter (Walter 2000).

Effective communication is closely linked to technology cooperation, as demonstrated by various models such as one dominant actor, public-private partnerships, and end-user engagement. These models can be used to better understand how communication influences social acceptance. Thus, the indicator "Communication" examines the role of communication strategies in fostering acceptance and the ways in which technology cooperation can facilitate effective communication.

The communication indicator in the ELEXIA project will be measured through a survey administered at the end of focus groups and interviews. The participants will be asked questions related to the communication channels in the ELEXIA project and how they are beneficial for the exchange of information.

Technology Cooperation

The *Technology cooperation* indicator measures whether stakeholders are satisfied with the chosen form of technology cooperation in the ELEXIA project. The concept of technology cooperation refers to an ever-evolving interchange between two or more parties that play an active role in a dynamic manner (Mallet 2007). This indicator draws on the works of Mallet (2007), Wilkins (2022), Pietrobelli (2000), Lall (2004), Juma (2005), and Bunders (1999) to analyse different technology cooperation models' impact on social acceptance.

In the ELEXIA project, a public-private partnership model has been chosen, where each partner contributes unique skills and perspectives to the technology transfer/cooperation process. This model is instrumental in reducing coordination issues, enabling mutual exchange of ideas, and increasing stakeholder understanding of the project's goals. However, it may restrict active participation to only those deemed experts and partners.

According to Mallet (2007, p. 2791), technology cooperation plays a crucial role in technology adoption by promoting active acceptance through better communication and understanding. Such cooperation can take place between various entities, including companies, research institutions, government agencies, and organizations.

The goal of technology cooperation within the ELEXIA project is to achieve common goals and solve specific technological challenges that would be difficult to address individually. The Technology cooperation indicator for Task 1.1 will be measured by administering a survey at the end of focus groups and interviews. The participants will be asked questions related to ELEXIA's chosen tripartite collaboration model between academia, the public sector, and the private sector.

Methodology

In preparation for D.1.1, we conducted a landscape analysis to gain insights into the three pilot demonstrators. This was an early-stage exploration of the three pilot demonstrators where we aimed at getting to know the relevant stakeholders, the community to which they belong, and their needs and expectations when we disregard the purely technical aspects. More precisely, the landscape analysis provided an overview of the future users of the flexible and integrated energy system at the three pilots, the actors who will provide energy solutions to the system, and the actors who will govern the system.

As Science and Technology Studies (STS) scholars have shown (see for example Aramis by Latour), the development and implementation of technologies is always embedded in social relationships and networks, influencing the making (and unmaking) of said technologies. Our objective in the landscape was to identify and involve stakeholders early in the project to enable them to share their perspectives, and for technology developers to adjust the technology to their needs. In this respect, the landscape analysis of the three pilot communities will link the technical and the societal aspects of the project in a joint socio-technical approach which we believe is necessary for a successful implementation of the ELEXIA technology.

The landscape analysis was conducted in three stages: 1) Participation at working group meetings at the Norwegian pilot site, aiming to get familiarized with key stakeholders and comprehend their motivations for involvement in the ELEXIA project. By actively participating in these working groups, we gained a better understanding of key concepts such as "sector coupling" and an "integrated" and "flexible" energy system. 2) Stakeholder mapping in collaboration with pilot partners was conducted to ensure the identification of all relevant actors. 3) An advanced actor interaction assessment was done to identify all potential interfaces between relevant actors and the future energy system and identify any dilemmas that may arise in such interactions.

After completing the necessary preliminary preparations (landscape analysis), we commenced the planned stakeholder engagement activities at all three pilots, consisting of a combination of focus groups interviews and 1-to-1 interviews. To provide specific measures of social acceptance of an integrated and flexible energy system at the three pilot sites, we designed a survey based on five selected social acceptance indicators and distributed to all participants of the focus groups and interviews. Together, these five components comprise the selected methodology in Task 1.1.

Participation

As social scientists responsible for stakeholder engagement and social acceptance aspects in Task 1.1, it was vital for us to participate in the Pilot Dokken workgroups during the initial months of the pilot projects. This provided us with a unique opportunity to familiarize ourselves with key stakeholders and gain insight into the potential opportunities and challenges associated with developing an integrated and flexible energy system.

By being present at this early stage of the technology development process, we could ensure that social factors and community needs were considered in the design of use cases. We could also provide input on the potential social, economic, and environmental consequences of technological solutions.

Our presence in these workgroups allowed us to build relationships and dialogue with the pilot partners, enabling us give input to sustainable and inclusive solutions that consider the needs and values of society.

Since we did not have the opportunity to familiarize ourselves with key stakeholders in the other pilots, we always had a Task 1.1-member present at WP1 meetings, in addition to participating in selected task meetings to gain a better understanding of the systems being developed in the ELEXIA project.

Stakeholder Mapping

The mapping of stakeholders into groups and subgroups was done at the discretion of the respective pilots. Some stakeholders fit within more than one category and have different roles in the future energy system. In an Energy system integration project like ELEXIA, we can expect that users (consumers) of the energy system may also be providers of infrastructure. Therefore, the following suggestion for organizing the stakeholders was only indicative, and the Pilots were free to organize differently. See Appendix 1, Tables 1 to 4, for a detailed mapping of the stakeholders at the three pilots.

Pilot Dokken

The development of the Dokken area is still in the planning stage. The following tables show the stakeholders we have identified at the industrial port environment of the future Dokken.

Table 1: Users of the future energy system – Pilot Dokken

Individual users	Public and private buildings as users	Large-scale users
Residents/ occupants	**Agency for Construction and Real Estate (Etat for bygg og eiendom)**	**BIR**
	Development Agency (Etat for utbygging)	Plug (shore power provider)
	GC Rieber/Entra/OBOS/BOB/ **Sammen/UiB Eiendom/Bonova**	**Bybanen (Bergen light rail)**
	Statsbygg	**Eviny Termo (when they use their electric boiler for heating)**
		Mobility Hub

(Bold text indicates participation in focus groups or interviews)

In the category *Users of the future energy system*, we will prioritize the two subgroups “Public and private buildings as users” and “Large-scale users” in the stakeholder engagement activities. At the present time, it is too early to involve residents because it is unclear who will live in and occupy the future Dokken. Under the category “Public and private buildings as users,” we have included municipal offices such as the Agency for Construction and Real Estate (Etat for bygg og eiendom) and the Development Agency (Etat for utbygging) as these actors represent public buildings such as kindergartens, schools, sport facilities, community centres. In addition, we have identified several private property actors (real estate actors) who potentially can purchase a plot of land at the future Dokken. Lastly, we have included a government entity that has already made plans to settle at Dokken. Our assumption is that property actors have an excellent understanding of the operation and energy consumption of various buildings, ranging from residential complexes to commercial buildings to student housing. In the group of large-scale users, we have identified ELEXIA partners BIR and

Eviny Termo, Plug, Bybanen (with its light rail vehicles operating round the clock passing through Dokken), and a mobility hub of some sort.

Table 2: Providers of the future energy system – Pilot Dokken

Infrastructure provider	Energy provider	Energy management provider
Eviny Termo (heating and cooling grid)	**Eviny Termo (heating and cooling)**	Climify
BKK (electricity grid)	Electricity company (e.g., Fjordkraft)	Energy technology company (e.g., Volte)
BIR (waste management, waste collection system/grid)		
Plug (charging equipment)		
Bergen Vann (drainage)		

(Bold text indicates participation in focus groups or interviews)

In the provider category, we have identified Eviny Termo, BKK, BIR, PLUG, and Bergen Vann as infrastructure providers. Additionally, we have identified Eviny Termo as the provider of heating and cooling to the area, and a yet-to-be-identified electricity company. In the energy management provider group, we have identified ELEXIA partner, CLIMIFY, and a local energy technology company.

Table 3: Influencers of the future energy system – Pilot Dokken

Media	Knowledge institutions	Interest organizations
Bergens Tidende (local daily newspaper)	**Centre for Climate and Energy Transformation (CET)**	Friends of the earth, Norway (Naturvernforbundet)
Bergensavisen (local daily newspaper)	The Bjerknes Centre for Climate Research	
Communication advisors in public and/or private organizations		
NRK (TV broadcasting)		
TV2 (TV broadcasting)		

(Bold text indicates participation in focus groups or interviews)

In the Influencer category, we have identified various media, knowledge institutions, and interest organisations that can influence the general public's perceptions of the benefits/disadvantages of a flexible and integrated energy system at Dokken.

Table 4: Governance actors within the local, regional, and national level with decision-making power towards the future energy system – Pilot Dokken

Local authorities*	Departments in the local municipality	Regional and national authorities
The Municipality of Bergen (BGO)	**Municipal agencies (e.g., The climate agency, The city environment agency, Agency for Construction and Real Estate, and the Development agency.**	**Norway's Directorate of Water Resources and Energy (NVE)**[1]
		The Regulatory Authority for Energy (RME)[2]

(Bold text indicates participation in focus groups or interviews)

Under the category of governance, we have identified the municipality of Bergen as the local authority and majority owner of Dokken. Within the municipal departments that can influence the development plans at Dokken, we have identified various agencies, while in regional and national actors, we have identified NVE and RME responsible for managing energy resources in the country and processing applications and licenses for the construction of power plants, power lines, transformers, etc.

[1] *The Norwegian Water Resources and Energy Directorate (NVE), in its current form, was founded in 1921 and is subject to the Ministry of Energy (ED). NVE is responsible for managing the water and energy resources of the country and heads the national emergency preparedness for power supply. Additionally, it is NVE that processes applications for licenses for the construction of power plants, power lines, transformers, and other elements of the power supply, as well as regulates waterways. NVE works on changes that help reduce greenhouse gas emissions and adapt society to climate change. Source: Dette er NVE - NVE*

[2] *Until the implementation of the Third Energy Package in Norwegian law, the Regulatory Authority for Energy (RME) was a department within the Norwegian Water Resources and Energy Directorate (NVE), administratively under the Ministry of Energy (ED). On November 1, 2019, RME was designated by the ED as the regulatory authority pursuant to the Energy Act § 2-3 and the Natural Gas Act § 4 to perform the tasks as an independent regulatory authority. Following this, RME is organized as a separate unit within NVE. Source: Hvem er Reguleringsmyndigheten for energi? - NVE*

Pilot Høje-Taastrup

ELEXIA partner HTK has been responsible for identifying their pilot's stakeholders based on the overarching categories and subcategories provided to them by the Task 1.1 team.

Table 5: Users of the future energy system – Pilot Høje-Taastrup

Individual users	Public and private buildings as users	Large-scale users
Users of municipal buildings: **Townhall employees**, students, guests	Town hall	Datacentre
	Mølleholm Skolen	**Høje-Taastrup Fjernvarme**
	Borgerskolen	Transportcenteret
	Børne- og kulturhuset	Teknologisk Institut
	MindFuture	Nordic Harvest
	CEIS	Ikea
	Driftsbyen	Dansk Retursystem

(Bold text indicates participation in focus groups or interviews)

The Danish pilot differs greatly from the Norwegian pilot in that Høje-Taastrup is already a developed local district with a town hall, a culture center, schools, kindergartens, offices, data centers, and residents already living in houses and building blocks in the area. The Danish pilot has highlighted many of these local users in Table 5, together with large-scale users in the Høje-Taastrup area.

Table 6: Providers of the future energy system – Pilot Høje-Taastrup

Infrastructure provider	Energy provider	Energy management provider
VEKS	***VEKS (DH transmission and distribution)***	***VEKS***
Høje-Taastrup Fjernvarme	***Høje-Taastrup Fjernvarme (DH distribution)***	***Høje-Taastrup Fjernvarme***
Albertslund Fjernvarme	Albertslund Fjernvarme (DH distribution)	Albertslund Fjernvarme
Energinet		Center Danmark
Radius		Climify
Varmelast		Varmelast
		DTU
		ENFOR

(Bold text indicates participation in focus groups or interviews)

HTK has identified several infrastructure providers, energy providers, and energy management providers that operate in the Høje-Taastrup area. Among these are ELEXIA partners VEKS, Center Denmark, Climify, and DTU.

Table 7: Influencers of the future energy system – Pilot Høje-Taastrup

Media	Knowledge institutions	Interest organisations
The Municipality of Høje-Taastrup	Sjællandske nyheder	Dansk Fjernvarme
Board of directors VEKS	The Municipality of Høje-Taastrup - communication department	("Energi på Tværs")
	Dansk Fjernvarmes nyhedskanal - Fjernvarmen	Fælleskabet for dynamisk data (F2D2)
	Ingeniøren	Danmarks Naturfredningsforening
	Energiforum Danmark	MEC (Miljø- og Energicenteret)
	VEKS homepage, LinkedIn	
	Danish Board of District Heating (DBDH) - HOTCOOL	
	IEA DHC	
	Euroheat & Power	

(Bold text indicates participation in focus groups or interviews)

As requested by the Task 1.1 team, HTK has identified a range of media, knowledge institutions, and interest organizations that in some way have the influence to shape public perception about energy production and energy management in Høje-Taastrup.

Table 8: Governance actors within the local, regional, and national level with decision-making power towards the future energy system – Pilot Høje-Taastrup

Local authorities	Departments in the local municipality	Regional and national authorities
The Municipality of Høje-Taastrup	BMC (By- og miljøcenteret (The City and Environment Centre)	Region Hovedstaden
(Danish Energy Agency)	SPC (School and Educational Psychology Centre)	Energistyrelsen
Board of Directors, VEKS		Udvikling- og forenklingsstyrelsen

(Bold text indicates participation in focus groups or interviews)

Pilot Port of Sines

ELEXIA partner APS has been responsible for identifying their pilots' stakeholders based on the overarching categories and subcategories provided to them by the Task 1.1 team.

For the Port of Sines pilot, the focus was initially on identifying stakeholders that were already partners in the project. During the consortium meeting in October 2023, the researchers in task 1.1 sat down with representatives from the Portuguese pilot and encouraged them to think more broadly when mapping relevant stakeholders, as defined in the concept section above.

In the following tables, APS has identified both ELEXIA partners and external stakeholders that might have an interest or influence in the development of the Port, especially when it comes to the choice of energy management systems and technologies. This stakeholder mapping provides a useful overview of the roles that various stakeholders have and can be used as a tool for future engagement with stakeholders.

Table 9: Users of the future energy system – Pilot Port of Sines

Individual users	Public and private buildings as users	Professional and large-scale users
Pilots (e.g., APS employees working at the port)	ZALSINES (logistic platform)	LNG Terminal
	AMERICOLD (cold warehouse located on ZALSINES)	

Table 10: Providers of the future energy system – Pilot Dokken

Infrastructure provider	Energy provider	Energy management provider
APS (port authority)	E-REDES (Public distribution grid company)	Tecnalia

Table 11: Influencers of the future energy system – Pilot Port of Sines

Media	Knowledge institutions	Interest organizations
Rádio Campanário (Radio)	Sines Tecnopolo	Quercus (national environmental NGO)
		CPLS (public and private entities association with mission is to promote development of the Port with balance of interests)

Table 12: Governance actors within the local, regional, and national level with decision-making power towards the future energy system – Pilot Port of Sines

Local authorities	Departments in the local municipality	Regional and national authorities
APS (port authority)	Câmara de Sines (municipality)	aicep Global Parques (Sines Industrial and Logistics Zone)

Actor Interaction Assessment (preliminary conversations)

As part of fine tuning our research design and developing our interview guides, we engaged in preliminary conversations with the three pilots to bridge our theoretical framework with conditions "on the ground". Integrating context specific knowledge from the three pilots actively into our interview guide put us in a position where we can ask local stakeholders meaningful questions using a language that they are familiar with. These conversations were therefore important for securing criterion and measurement validity.

The preliminary conversations were executed in week 32/33, led by Siri Veland (former Task 1.1 leader) from NORCE. Each pilot had their individual meeting and was represented by local authorities and industry actor(s). The Norwegian pilot was represented by Laura Ve from the Municipality of Bergen and Line Bergfjord from BKK. The Danish pilot was represented by Marie-Louise Lemgart, Louise Nordtorp Veng, and Jens-Emil S. Nielsen from the Municipality of Høje-Taastrup, Henrik Madsen from DTU, and Lars Gullev from VEKS. The Portuguese pilot was represented by João Araújo, Jorge Quinhones de Sá and Eduardo Bandeira from APS, Carlos Madina Doñabeitia from Tecnalia, and António Matos Sousa from EDP (also WP1 leader).

The actor-interaction matrix that structured our conversations is shown in Table 13. We proposed that two key dimensions can help us describe how potential actors may interact with the future integrated energy system. First, the degree of ownership (occupant, host, or owner) and second, the flow of energy (consumers, prosumers, producers, and facilitators). When placing these in a matrix, twelve possible interactions emerged. For each "cell" in the matrix, our aim was to provide a description of the relationship and possible dilemmas that might occur in the particular interface, as well as to identify relevant questions to be asked during the interviews. We made it clear that some of these twelve interactions might be non-existent in their pilot, something that proved to be the case.

Table 13: Actors' interactions with the future energy system

Relationship to the system		Flow of energy (in, out, enabling)			
Ownership		Consumer	Prosumer	Producer	Facilitator
	Occupant	Consumer-occupant	Prosumer-occupant	Producer-occupant	Facilitator-occupant
	Host	Consumer-host	Prosumer-host	Producer-host	Facilitator-host
	Owner	Consumer-owner	Prosumer-owner	Producer-owner	Facilitator-owner

Our preliminary conversations with stakeholders were organized around an actor-interaction matrix that allowed a systematic walkthrough of possible interfaces between relevant actors and the future energy system, and dilemmas that may arise in these interfaces. We collected potential dilemmas together with local pilot partners, aiming to bring the identified dilemmas into our focus groups and interviews. Conversations with the three pilots were carried out in digital meetings. Framing the conversation as a collective exercise, the leading researcher walked through the actor-interaction matrix with the local pilots while simultaneously taking notes on screen for everyone to see. This approach gave the conversation a clear purpose and endpoint, and also helped us clarify potential misunderstandings up front.

While engaging the local pilots actively in the research design process have benefits with regards to the validity of the research, one potential drawback is that the local pilots guide our interview questions towards or away from subjects that are not necessarily beneficial for the research. As social scientist, we have theoretical, methodological, and substantive knowledge that guides our decisions on research design and interview questions, yet we depend on local and domain specific expertise to design research that produce relevant knowledge. It is certainly possible for the local pilots to steer the research in certain directions, for instance if they want to avoid questions on touchy or controversial topics.

We took several precautions to avoid such pitfalls. First, while one researcher was responsible for carrying out conversations, she was backed up by other researchers from the research group. They observed the conversation and could ask follow-up questions on topics that were not addressed. Second, we could draw on hypothetical and real examples of dilemmas from the other pilots to ease discussions on controversial subject matters. For instance, in our conversations with the Portuguese pilot, where the public are not relevant to the same extent as in the Norwegian and Danish pilot, we could draw on examples from the two other pilots to discuss future potential dilemmas with regards to interaction between the public and the energy system. Third, and most importantly, research processes that involve stakeholder engagement depend on mutual trust between researchers and stakeholders. As such, we emphasize that the preliminary conversations with the three pilots followed from more than a year of planning that involved researcher-stakeholder interactions.

Focus Groups and Interviews

Focus groups and 1-to-1 interviews were chosen as the main methods to help the project gain new knowledge of and insight into the different stakeholders' perspectives, preferences, and concerns with regard to a future integrated energy system at the three pilots.

The strength of focus groups is the ability to initiate knowledge exchange through listening to the different stakeholders' experiences and needs as. A drawback of focus groups can be hierarchical power relations that might make some participants uncomfortable to share their thoughts and experiences.

Morgan and Bottorff (2010) argue that there is no right way to do focus groups. Instead, there are many different options, and for each research project investigators need to select a way of using focus groups that matches the goals of the project. In the stakeholder engagement strategy that we shared with selected pilot partners (HTK, APS and BGO), we recommended arranging the focus groups with a healthy balance between homogeneity and variety. Variation in order to represent a breadth of experiences and perspectives in relation to the problems to be discussed, and homogeneity so that the interaction in the group would produce constructive associations, not tension and competition. Building on this reasoning, the social scientists in Task 1.1 suggested inviting Users and Influencers to focus groups, while Providers and the Governance actors could be invited to individual in-depth interviews, see Table 14.

The strengths of 1-to-1 interviews is the ability to gather opinions and perspectives that are not necessarily "polished" and influenced by other stakeholders in the room. The issue of uneven power relationships between stakeholders can therefore be ignored in a 1-to-1 interview setting but should be considered in the analysis. By combining focus groups and interviews, the aim was to build on the strengths of each method and counteract limitations that arise if each of these methods when used in isolation.

Table 14: Organization of focus groups and interviews

Method	Stakeholder categories	Stakeholder subcategories
Focus Group 1	Users	Single users (residents, occupants)
Focus Group 2	Users	Public and private buildings as users
Focus Group 3	Users	Professional/Large scale users
Focus Group 4	Influencers	Media, knowledge organizations and interest organizations assembles in one focus group.
Interviews*	Providers	Infrastructure providers
Interviews*	Providers	Energy providers
Interviews*	Providers	Energy management providers
Interviews*	Governance	Local authorities
Interviews*	Governance	Departments in the local municipality
Interviews*	Governance	Regional and national authorities

Designing interview guides

Our interview guide is organized around six themes: The ideal future energy system, business models, sustainability, regulation, flexibility, and (tripartite) technology cooperation. The six chosen themes were developed to capture the three social acceptance dimensions and to cover all the relevant actors identified in the stakeholder mapping. Moreover, we aimed to develop topics that were relevant and comparable across pilots situated in different geographical, economic, and regulatory contexts. Within each theme, we adjusted questions slightly so that they were relevant to different stakeholders in different pilots.

We developed the content of different themes with specific dimensions of social acceptance in mind, yet we were also aware that the same theme could be interpreted differently depending on the role of the stakeholder. For instance, for the business model theme, we developed questions aiming to address market acceptance, yet we were also aware that some actors could potentially give answers that emphasizes different dimensions of social acceptance.

The process leading up to the six themes departed from our preliminary conversations with stakeholders at the three pilots (ref. actor interaction assessment), as well as our own knowledge about the three pilots. At this point in time, and because of our geographical and cultural proximity to the Dokken pilot, we were most familiar with the Dokken pilot. Our approach was therefore to first develop interview guides for Dokken, with contribution from Laura Ve (BGO), and then send drafts of our Dokken interview guides to the two other pilots for input.

An important consideration when we designed the interview guide was to develop a common ground for asking questions that help us anchor the stakeholders' views in their expectations about the future energy system. Therefore, our interview guide started out with a general theme focusing on the ideal future energy system. By anchoring our analysis in stakeholders' views about the future energy system, we gained an analytical advantage in that we could identify any differences that exists between stakeholders in terms of their expectations towards smart energy systems. These differences in expectation, in turn, could have an impact on stakeholders' opinions on matters such as the regulation of energy systems.

Conducting Focus Groups and Interviews at the Pilot Sites

Pilot Dokken

At the Norwegian pilot, most of the interviews and focus groups were conducted between weeks 45 to 47 at the Town Hall (BGO), with some interviews delayed until week 49. The Municipality of Bergen (BGO) was responsible for conducting the interviews, based on interview guides prepared by the Task 1.1 team, and adapted to the individual pilot in collaboration with the moderator. Laura Ve (BGO) moderated the interviews while Marie L. Ljones (NOR) took notes and recordings.

Prior to the focus groups and interviews, Laura Ve contacted the interview participants via email, scheduling dates for focus groups and interviews. Additionally, the Task 1.1 team prepared an invitation letter, providing information about the ELEXIA project, the purpose of the interviews, and the handling of interview data in accordance with privacy and GDPR regulations.

Although not all stakeholders identified in the stakeholder mapping were invited, the Municipality conducted interviews with several relevant actors. Ahead of time, Laura Ve provided the participants with themes and related questions for discussion to help them prepare.

The focus groups and 1-to-1 interviews were a mix of physical, team, and hybrid meetings, accommodating participant availability and location. While Table 14 served as a guiding principle, adjustments were made based on scheduling conflicts and the inability to gather all focus group participants on the same days. Some focus groups were split, and additional 1-to-1 interviews were conducted where necessary.

Throughout interviews and focus groups, a PPT presentation based on the interview guides was used. Laura Ve started all interviews with a presentation of Dokken and the Municipality's development plans for the area. She then moved on to discuss the ELEXIA project and BGO's reason for engaging in the project. The themes and contexts were largely the same throughout the various interview guides, but the questions were adapted to the specific stakeholder group (ref. stakeholder mapping) and relevant cases at the pilot.

Pilot Høje-Taastrup

For Task 1.1, Høje-Taastrup Kommune (HTK) customized the interview guides especially for the Danish pilot. This customization was done to better reflect the relationships between the stakeholders. Prior to conducting the focus groups and interviews, Louise Veng, on behalf of the Municipality, sent out emails to the actors identified for participation to confirm their invitations and schedule the sessions. The invitations outlined details about the ELEXIA project, and the purpose of the participants' involvement. Louise Veng was also responsible for conducting the interviews, serving as moderator.

While it was not feasible to invite all stakeholders identified in the interview guides, HTK successfully conducted interviews with numerous pertinent stakeholders.

All interviews were initially planned as focus groups. However, due to scheduling constraints and challenges in assembling participants simultaneously, HTK decided to divide certain focus groups and instead conduct 1-to-1 interviews. All interviews were conducted in person at the Høje-Taastrup town hall in September 2023.

Pilot Port of Sines

To acquiring essential data for Task 1.1, APS tailored the interview guides to the Portuguese pilot, categorizing them into distinct Stakeholder groups and their respective sub-groups.

Subsequently, an internal meeting, involving representatives from the engineering and communication departments, was convened by APS to ensure the accurate identification and invitation of appropriate individuals or entities for each group.

While we found that face-to-face discussions might enable better mutual understanding of the task at hand, in individual conversations with the Danish and Portuguese pilot during the consortium meeting, challenges were identified, such as time constrains. Therefore, a decision was reached to conduct the interviews via email for the Portuguese pilot.

For the Users group, interview invitations were dispatched to an APS Pilot and the Lead Engineer at REN Atlântico, the LNG Terminal.

In the case of the providers group, APS contacted two different EDP's business units, E-REDES and EDPC. Also interview invitations were dispatched to Tecnalia as Energy Managemente Providers.

Addressing the Influencers group, APS engaged its communication department to liaise with the president of CPLS (Sines Port and Logistics Community), with the interview subsequently dispatched.

Navigating the Governance group, APS rationalized that focusing solely on the Local Authority sub-group was enough, considering APS's comprehensive decision-making authority over the Port of Sines and its ownership of the internal electrical grid. The Head/Director of the Energy Transition and Maintenance Unit at APS was deemed a fitting candidate for the interview.

While the overarching objective was to secure responses for the interviews within each identified group, ensuring a comprehensive and insightful dataset for the fulfillment of Task 1.1., some originally intended stakeholders were left out.

In this trimming of stakeholders, the infrastructure provider was left out. APS also decided to leave out Aicep Global Parques who is situated outside the jurisdiction area of the port. Aicep Global Parques is the company that manages the ZILS park. This industrial park includes the Portuguese Refinery (Galp), the Petrochemical factory (Repsol) and other small companies and does not own the electrical grid. Furthermore, according to APS, APS is not connected to their grid.

Given time constrains, interviews in Portugal were delayed and not conducted in time for this report. The interview data will nevertheless feed into the project though partner meetings, and subsequent publications.

Survey

In addition to the focus groups and 1-to-1 interviews, we developed an online survey designed to measure (and follow up on) our predefined five social acceptance indicators (KPIs), discussed in the previous chapter “Social Acceptance Indicators”. Online surveys offer valuable opportunities to study either broadly representative samples or focus on specific groups (Stantcheva 2023). In our case, the survey was sent to all internal and external stakeholders participating in focus groups or 1-to-1 interviews. The survey was circulated between November 2023 and January 2024, and a total of 34 respondents completed it. As shown in Appendix 6, most respondents were associated with the Norwegian pilot. Out of the 34 respondents, 12 internal project partners, while 22 represent external stakeholders. Later in the project period, we plan to administer the survey to the same participants one more time to perform a “before-after” analysis of their perspectives and opinions to determine any changes over the duration of the project.

For insights from the survey, see Appendix 6.

Interview Guides and Participants

Participants in Stakeholder Interviews and Focus Groups in Bergen (Pilot Dokken)

All those interviewed represent their respective companies but will not be held financially and legally accountable for their statements in these interviews.

Eviny Termo is a subsidiary of Eviny AS and provides district heating from BIR's waste incineration plant in Rådalen, Bergen. Eviny Termo is owned by Eviny AS (51%) and the waste management company BIR AS (49%). Eviny Termo has several roles in the ELEXIA project. In the stakeholder mapping we have identified Eviny Termo as an infrastructure provider, energy provider and large-scale user (when they use the electric boiler for heating). The meeting took place physically at the City Hall.

BKK (Bergenshalvøens Kommunale Kraftselskap) is an energy and infrastructure company based in Bergen, Norway. The company is involved in the production, distribution, and sale of electricity, district heating, and broadband services. BKK is one of the largest power producers in Norway and plays an active role in renewable energy, particularly hydropower. They are also engaged in various projects and initiatives to develop integrated and sustainable energy systems. BKK var invited in their role as infrastructure provider to the new Dokken area. The meeting took place physically at the City Hall.

BIR (Bergen Interkommunale Renovasjon) is a waste management company serving the municipality of Bergen. BIR is responsible for the collection, sorting, recycling, and disposal of household and commercial waste in the Bergen region. They also provide services related to composting, hazardous waste management, and environmental education. BIR provides waste management infrastructure to the Dokken area but was interviewed in their role as large-scale users. The meeting took place physically at the City Hall.

Sammen is a Student Welfare Organization (student housing provider) that builds and rents housing to students in Bergen. Sammen participated in a focus group interview together with Obos and Bara. The meeting took place physically at the City Hall.

Bara is a real estate operator that constructs and leases commercial properties in Bergen. The company emphasizes energy-efficient solutions, utilizes smart technology for sustainable operations, places great importance on biodiversity, and facilitates sharing solutions for efficient resource utilization. They participated in a focus group interview alongside Obos and Sammen. The interview took place physically at the City Hall.

Obos is the largest residential property developer in the Nordics, with over half a million members. Obos operates in various business areas, and in the focus group interview, Obos Region Bergen participated in their role as a property developer that constructs and sells homes. They participated in the focus group interview alongside Sammen and Bara. The interview took place physically at the City Hall.

UiB Eiendom is the real estate department of the University of Bergen (UiB) and is responsible for the management, operation, and maintenance of the entire building stock of UiB. The department is also responsible for planning and implementing new construction projects, as well as the operation of buildings, outdoor areas, and postal and transportation services. UiB Eiendom participated in a digital 1-to-1 interview.

Entra is a property developer that focuses on developing offices, commercial buildings, and urban areas in several Norwegian cities. They aim to create the most future-oriented office environments in the country. Entra is headquartered in Trondheim and participated in a digital 1-to-1 interview.

GC Rieber Eiendom is a leading actor in property development, operation, and management in central Bergen. They primarily develop properties for rental purposes. GC Rieber is passionate about area development, innovation, and sustainability. GC Rieber participated in a focus group alongside Bonava. The meeting took place physically at the City Hall.

Bonava is a property developer primarily focused on developing properties for sale. Their vision is to create good neighborhoods and living environments. The company is entering a new phase with a new organization and will, in this context, change its name to Nåbo. Bonava participated in a focus group with GC Rieber. The meeting took place physically at the City Hall.

Statsbygg is a state-owned construction company that leads and finances large and complex building projects in Norway. Statsbygg is responsible for constructing the Institute of Marine Research (Havforskningsinstituttet), which will be a "first mover" to the new Dokken area. They participated in a digital interview alongside Norconsult.

Norconsult is Statsbygg's consultant in the project at Dokken with expertise in building management. One of their ambitions is to increase the use of the buildings (no of occupants) and reduce costs linked to the operation and maintenance of buildings. They participated in a digital interview alongside Statsbygg.

Bybanen (The Bergen Light Rail) is a collective, rail-based transportation system in Bergen, owned by The Vestland County (through Bybanen AS) and Tide Buss og Bane on behalf of Skyss. A new route is currently being planned, starting from Kaigaten and running through Teatergaten to Dokken. Bybanen has been invited to participate in an interview, regarding its role as a large-scale energy user when passing through (and stopping at) Dokken. The meeting took place physically at the City Hall.

CET (Centre for is a research center affiliated with the University of Bergen, with the aim of conducting research to generate actionable knowledge that can be used in policy and practice to achieve comprehensive, rapid, and equitable societal transformation in order to mitigate climate change. The meeting took place physically at the City Hall.

NVE (Norwegian Water Resources and Energy Directorate) is a government agency responsible for administering Norway's water and energy resources. Its tasks include supervising the energy and water supply, regulating the market, and promoting the use of renewable energy sources. They participated in a digital interview.

The Municipality of Bergen (BGO) was represented in the focus group through several of its agencies. The meeting took place physically at the City Hall.

Participants in Stakeholder Interviews and Focus Groups at Høje-Taastrup

All those interviewed represent their respective companies but will not be held financially and legally accountable for their statements in these interviews.

VEKS, Vestegnens Kraftvarmeselskab I/S, was established in 1984 to harness surplus heat generated both from combined heat and power (CHP) plants and from waste incineration as well as larger industrial facilities. VEKS' transmission system enables significantly reduced fuel consumption when utilizing surplus heat. VEKS' supply area is interconnected with its sister company CTR in Copenhagen and with Vestforbrænding. The combined facility constitutes one of Europe's largest district heating transmission systems. Today, VEKS encompasses three business areas: Transmission, Production, and Distribution of district heating and some production of electricity.

- Transmission: VEKS Transmission supplies heat to 19 local district heating companies in the Vestegn region. The local district heating companies handle further distribution to residential, commercial, and institutional customers. The delivered heat corresponds to the consumption of 170,000 households. VEKS participates with a one-third ownership stake as a stakeholder in the Capital Geothermal Company (HGS) along with CTR and HOFOR. HGS, on a concession basis, undertakes exploration of the possibilities for extracting geothermal heat through a geothermal demonstration plant in Amager.
- Production: Køge CHP plant (100% sustainable biomass) produces electricity for the grid, steam for Junckers Industrier A/S, and sells (internally) district heating to VEKS Transmission. VEKS Gas Engine, Solrød, established in December 2015, produces electricity for the grid and district heating for VEKS Transmission, based on biogas supplied by Solrød Biogas A/S.
- Distribution: Køge District Heating handles the distribution of district heating to residential consumers, commercial customers, and institutions in the city of Køge. The heat is internally purchased from VEKS Transmission. Tranegilde District Heating manages the distribution of district heating to customers in the Tranegilde business area in the municipalities of Ishøj and Greve. The heat is internally purchased from VEKS Transmission.

HTF Høje Taastrup District Heating a.m.b.a. is part of the Greater Copenhagen integrated district heating system. The supply area of Høje Taastrup District Heating includes Høje-Taastrup Municipality and, since 2023, also Greve Municipality. Høje Taastrup District Heating a.m.b.a. was established on January 1, 1992, through a merger between the consumer-owned Taastrup Heat Works a.m.b.a. and the municipal heat supply in Høje-Taastrup. The establishment took the form of a limited liability cooperative. Consequently, the company is owned by the heat customers. On January 1, 2011, Høje Taastrup District Heating a.m.b.a. also merged with Hedehusene District Heating Plant a.m.b.a. The company's top management is a board of representatives consisting of 35 members who approve the company's budget and accounts. The board of representatives holds 2 ordinary meetings per year. The daily management is handled by a board of 9 members.

The Technical University of Denmark (DTU) is a leading academic institution dedicated to advancing knowledge and solving complex challenges in engineering, science, and technology. Established in 1829, DTU has a rich history of innovation and is recognized globally for its cutting-edge research, high-quality education, and strong partnerships with industry and academia. With a diverse community of students, faculty, and researchers from around the world, DTU fosters an environment of collaboration and creativity. Its state-of-the-art facilities, laboratories, and research centers enable groundbreaking discoveries and technological advancements in fields ranging from sustainable energy and biotechnology to information technology and materials science. DTU's commitment to excellence extends beyond the classroom and laboratory, as it actively engages with industry, government, and society to address pressing global challenges and drive positive change. Through its research-driven approach and emphasis on practical application, DTU equips students with the skills, knowledge, and mindset needed to tackle the complex problems of today and tomorrow.

The Centre for Properties and Internal Services (CEIS) handles tasks related to property management and service in municipal buildings. At CEIS, the core mission is the focal point of our work. We have a clear and shared core mission across the centre, which we collectively strive to achieve with our diverse range of expertise. The core mission of the centre is as follows: CEIS succeeds when users of the municipal facilities experience that, through dialogue, we collectively provide excellent service and create the best possible physical environment for them. CEIS is a shared service centre, and our target audience comprises users of the municipal properties - both employees and citizens. We create value for users by providing the best possible physical environment and delivering excellent service. We aim to be a well-functioning and professional service organization. Our approach to tasks is constructive and service-oriented, with a focus on visibility and close dialogue with users.

Driftsbyen is Høje-Taastrup Municipality's service company within parks, roads, waste, and technology. We foster inclusivity, maintain an informal atmosphere, and prioritize well-being and culture. The Department employs 68 skilled and dedicated individuals divided into 7 teams, whose core task is to manage and maintain the municipality's green areas, including schools and institutions. The teams operate partially autonomously, organizing daily operations and supporting each other when additional input or manpower is needed. We prioritize a strong sense of community and ensure everyone feels valued and enjoys coming to work. We place significant emphasis on development and continuously optimize operations to stay ahead of trends and remain informed with the latest knowledge. We take pride in delivering high-quality work and garnering respect from our collaborators, colleagues within the organization, and at the political level.

MindFuture. The Hub was initially started in 2015 by Danske Bank Growth to create valuable and impactful services for the rapidly growing Nordic start-up ecosystem, focusing on tailored recruitment and fundraising services. They teamed up with Rainmaking to build and operate the service and together they successfully matched 1 million talents with job opportunities and grew the user base to more than 10,000 start-ups and 300,000 candidates. In 2022, Mesh Community acquired The Hub. They already owned and operated the second largest recruiting platform for start-up-ready talent in the Nordics, Startupmatcher, and the two services were merged to create the undisputed market leader for start-up recruitment in the Nordics. With new owners and a strengthened position, The Hub’s focus going forward is to create a complete Nordic recruitment marketplace with a free basic layer for companies that are just starting out, and advanced paid services for growth start-ups and scale-ups. Empowered by a deep desire to create new and better ways for people to find meaningful work, we invite you to join our journey to become the world’s best start-up job board.

Townhall. The new Town Hall in Høje-Taastrup aims to kickstart the development of the new district "Høje-Taastrup C." – a urban development project that transforms Høje-Taastrup by establishing a new city centre, which will become the municipality's green and vibrant district. The new town hall is positioned as a tower and a visible landmark amid the green corridor in Høje-Taastrup C's new city park between City 2 and the future new city. The town hall is located at the pivotal point of the park, serving as a connecting element between the existing buildings, the new park, and City 2, thus becoming the focal point of the new district. The town hall is constructed with 9 floors. The two lower floors house citizen-oriented functions such as the job centre, registration, and a large part of the meeting centre. A grand staircase leads from the central atrium up to the 1st floor, where the canteen and meeting centre are located. The next 6 floors contain flexibly designed work areas. On the 9th and top floor, the council chamber, meeting and training rooms, and a viewing lounge are situated. Access to the publicly accessible rooftop landscape and terrace is provided from this floor.

The Municipality of Høje Taastrup. Høje-Taastrup Municipality has a total area of 78 km^2 and consists of three large towns with train stations and 14 original villages. The municipality lies approximately 20 km west of Copenhagen and has a population of around 50,000. Høje-Taastrup Municipality is one of the largest municipalities in Greater Copenhagen, with good motorway connections, besides the Intercity, regional, and S-train networks, and an extensive bus service. This is a large commuter municipality, with many commuters travelling to and from Høje-Taastrup daily. Around 25,000 people commute to Høje-Taastrup during the week, to their jobs in one of the many companies based here. The municipality has large companies within IT and service, logistics and transport, and regional retail trading. Danske Bank and Nordea are among the companies with large branches here, while PostNord, IKEA, DSV and DISA are also located in the municipality, besides knowledge-intensive companies and institutions such as the Danish Technological Institute and Rockwool. There are also many small and medium-sized craft and production companies. Høje-Taastrup Municipality stands for professional and effective municipal services. We wish to provide services to our residents that are based on openness, respect and understanding of other people's social and cultural backgrounds.

Interview Guides at Pilot Dokken

Table 15: Interview guides at Pilot Dokken

Interview Guides – Pilot Dokken							
Themes	Users		Providers	Influencers	Governance		
	Public and private buildings as users Real estate actors	**Large-scale users** BIR, Bybanen, Eviny Termo	**Infrastructure provider and Energy providers** BKK, Eviny Termo, (BIR)	**Knowledge organizations** CET - Centre for climate and energy transition	**Local and regional government authorities** Municipality agencies	**Local politicians**	**National authorities** NVE
Theme 1: The energy system of the future	Q: What does an ideal smart (flexible and integrated) energy system look like for you as builders or building owners in the real estate industry?	Q: What does an ideal smart (flexible and integrated) energy system look like in your industry?	Q: What does an ideal smart (flexible and integrated) energy system look like in your industry?	Q: What do you think an ideal smart (flexible and integrated) energy system could look like? Q: How do you think communication surrounding transition projects, in this case, a smart energy system, affects acceptance in society? What role do you play in this regard?	Q: What do you think an ideal smart (flexible and integrated) energy system could look like? Q: What role do you think the municipality can take for us to build an ideal energy system at Dokken?	Q: What do you think an ideal energy system could look like at the area level? Q: What role do you think the municipality can play in ensuring that we build an ideal energy system at Dokken?	Q: How do you envision an ideal smart (flexible and integrated) energy system?
Theme 2: New business models in the future energy marked	Q: What is important for you as a builder/building owner to be part of this business model?	Q: What is important to you as a professional/large scale user that is part of this business model?	Q: When creating new business models that the various actors on Dokken will join, what needs to be done to secure the interests of you as an	Q: Based on zero-emissions and new business models in the energy market, what do you think is essential for various stakeholders, such	Q: What needs, benefits and drawbacks, opportunities, and barriers do you believe will impact the process of	Q: What needs, advantages and disadvantages, opportunities and barriers do you think will affect the process of	Q: What needs, benefits, drawbacks, opportunities, and barriers do you believe will impact the process of developing new or

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	Q: What are your needs? What factors do you think determine the acceptance of a smart (flexible and integrated) energy system in your industry?	Q: What are the needs of your systems and business? Q: What needs, advantages and disadvantages, opportunities and barriers do you think will affect the process of developing new business models?	infrastructure owner/energy provider? Q: What needs, advantages and disadvantages, opportunities and barriers do you think will affect the process of developing new/necessary business models?	as experts, technologists, residents, and decision-makers? Q: What do you think will influence the public discourse and policy development on this topic?	developing new or necessary business models? Q: What role do you believe government institutions at the national, regional, and local levels play in this context, and what role do you think your organization can and should play in this effort?	developing new/necessary business models in the energy market? Q: What role do you think state, regional and local institutions have in this picture, and what role do you think Bergen municipality can and should take in this work?	necessary business models? Q: What role do you believe government institutions play in this context, and what role do you think NVE should take in this effort?
Theme 3: A sustainable energy system	Q: What opportunities and limitations will this give you as a builder/building owner? Q: How can other sustainability considerations influence the choice of energy concepts in new buildings?	Q: In the energy system of the future, it will also be possible for new actors to enter the market on the production side, for example by capturing/producing surplus energy that is sold into the market. What opportunities and limitations will this give the business you represent? Q: How do sustainability considerations affect choices related to design and energy solutions in your business?	Q: What opportunities and limitations will this give the business you represent as a future actor at Dokken? Q: How do sustainability considerations affect choices related to design and energy solutions in your business?	Q: Has the climate crisis become less important in the context of energy transition? Q: If so, what are the consequences of this?	Q: How does your agency prioritize sustainability goals in questions related to infrastructure, energy planning, and spatial planning? Q: How do you believe the Municipality of Bergen can use its supervisory role to influence sustainable development within the energy sector?	Q: How do you think Bergen municipality can use its management role to influence sustainable development within the energy sector? Q: How do you think the sustainability goals should be weighed in questions related to infrastructure, energy planning and spatial planning?	Q: How does NVE prioritize the Sustainable Development Goals in their work, and how do you believe NVE should use its management role to influence sustainable development in the energy sector? Q: In what ways do you think environmental and climate considerations should govern energy projects like Dokken? Additionally, what considerations do

							you believe can outweigh climate considerations in these types of projects? Q: What do you believe are the (regulatory) barriers/obstacles for so-called prosumers or other actors to deliver surplus energy to the market?
Theme 4: Regulation	Q: What barriers and challenges do you experience stand in the way of a smart energy system today? Q: What kind of political action is needed for you as a building owner/builder to want to become part of a flexible and integrated energy system?	Q: What barriers and challenges do you experience stand in the way of a smart energy system today? Q: What political action is needed for your business to become part of a flexible and integrated energy system?	Q: What barriers and challenges hinder the delivery of smart energy systems for the business you work in? Q: What measures (political or otherwise) are needed for your business to become a part of a flexible and integrated energy system?	Q: What barriers and challenges do you think are hindering the necessary change in the energy market to address the climate and energy crisis? Q: What political measures do you think are needed to establish smart energy systems in transformation areas like Dokken?	Q: What barriers and challenges hinder the development of flexible and integrated energy systems in transformation areas like Dokken? Q: What do you believe are the barriers/obstacles for so-called prosumers or other actors to deliver surplus energy to the market? Q: What kind of political measures do you think are needed to achieve the transition to a flexible	Q: What barriers and challenges do you think could stand in the way of a comprehensive energy concept in transformation areas such as Dokken? Q: What do you think are the barriers/impediments to so-called prosumers or other players being able to deliver surplus energy to the market? Q: What type of political action do you think is needed to bring about the	Q: What barriers and challenges stand in the way of the development of smart (flexible and integrated) energy systems in transformation areas like Dokken? Q: What changes in rules and regulations can be expected to facilitate energy exchange among prosumers? Q: What type of political measures do you believe will be necessary to achieve the transition to a flexible and

					and integrated energy system?	transition to a flexible and integrated energy system?	integrated energy system?
Theme 5: Flexibility	*Part 1: Flexibility in terms of interaction between different forms of energy and actors* Q: Imagine that you as a builder/building owner will become an active part of an integrated and flexible energy system where you both produce and consume energy according to your needs and ability. What will this entail in terms of advantages and disadvantages for you as a builder? Q: How do you assess your own/the company's ability and motivation to produce and release surplus energy, and possibly contribute solutions that can provide flexibility to	*Part 1: Flexibility in terms of interaction between different forms of energy and actors* Q: Imagine that your business will become an active part of an integrated and flexible energy system where you both produce and consume energy according to your needs and ability. What will this entail in terms of advantages and disadvantages for your business? Q: What limitations do you have as a flexible energy actor or energy consumer? *Part 2: Flexibility in the sense of developing digital solutions that exploit*	*Part 1: Flexibility in terms of interaction between different forms of energy and actors* Q: Imagine that your business will become an active part of an integrated and flexible energy system where you both produce and consume energy according to your needs and ability. What will this entail in terms of advantages and disadvantages for your business? Q: What limitations or barriers do you see as an infrastructure owner/energy provider? *Part 2: Flexibility in the sense of developing digital solutions that exploit the flexibility of the energy system*	Q: What role do you believe flexibility will play in future energy systems? Q: Who stands to gain or lose in the development of new flexibility markets? Q: Do you foresee any obvious dilemmas concerning requirements, regulations, and potentially top-down development of flexible energy systems?	Q: Will new collaboration models or technological developments have an impact on the role and exercise of authority of the Municipality of Bergen? If so, how? Q: Do you think that new collaboration models across energy carriers, infrastructure, and systems are a realistic future scenario?	Q: Will new collaboration models or technological developments have an impact on the role and exercise of authority of the Municipality of Bergen? If so, how? Q: Do you think that new collaboration models across energy carriers, infrastructure, and systems are a realistic future scenario?	Q: Will new collaboration models or digital systems have an impact on NVE's role and exercise of authority? If so, how? Q: Do you believe that new collaboration models across energy carriers, infrastructure, and systems are a realistic future scenario? Q: Are changes in regulations, new guidelines, or regulations expected to force changes in the energy market and new collaboration solutions to avoid unnecessary energy waste, heat dumping, or lost optimization

	the system (locally at Dokken/central parts of the city center, etc.)? Q: What limitations do you have as a flexible energy player or energy consumer? *Part 2: Flexibility in the sense of developing digital solutions that exploit the flexibility of the energy system* Q: What positive/negative effect can this have for the building owner and for the users in "your" buildings? Q: What considerations do you think it is important to take into account in the development of these digital solutions in order for building owners and users to get the	*the flexibility of the energy system* Q: What considerations do you think it is important to consider in the development of these digital solutions in order for building owners and users to get the most out of such solutions?	Q: Will this type of system have an impact on the business you represent? If so, how? Q: What opportunities do you see in using these types of tools/systems? Q: What considerations do you think are important in the development of these digital solutions to ensure that your business gets the most out of such solutions? Q: What do you think are the biggest challenges/barriers for the systems not working optimally, not delivering the desired results, or not being adopted?				solutions at the area level?

	most out of such solutions?						
Theme 6: The technology development process	Q: What advantages and disadvantages do you see in a tripartite collaboration between academia, the public and private sectors for the development of new energy systems? Q: To what extent and in what way do you as a builder/building owner want to be involved in development processes like this?	Q: What advantages and disadvantages do you see in a tripartite collaboration between academia, the public and private sectors for the development of new energy systems? Q: To what extent and in what way does your business want to be involved in development processes like this?	Q: What advantages and disadvantages do you see in a tripartite collaboration between academia, the public and private sectors for the development of new energy systems? Q: To what extent and in what way does your business want to be involved in development processes like this?	Q: What advantages and disadvantages do you see in a tripartite collaboration between academia, the public and private sectors for the development of new energy systems? Q: To what extent and in what way does your business want to be involved in development processes like this?	Q: What advantages and disadvantages do you see in a tripartite collaboration between academia, the public sector, and the private sector for the development of new energy systems? Q: To what extent is it important that The municipality of Bergen is involved in development processes like this?	Q: What advantages and disadvantages do you see in a tripartite collaboration between academia, the public and private sector for the development of new energy systems? Q: To what extent is it important that The municipality of Bergen is involved in development processes like this?	Q: What advantages and disadvantages do you see in a tripartite collaboration between academia, the public and private sector for the development of new energy systems? Q: To what extent and in what way does your organization wish to be involved in development processes like this?
Theme 7: Open question	Q: Anything you would like to add, comment on, etc.?	Q: Anything you would like to add, comment on, etc.?	Q: Anything you would like to add, comment on, etc.?	Q: Anything you would like to add, comment on, etc.?	Q: Anything you would like to add, comment on, etc.?	Q: Anything you would like to add, comment on, etc.?	Q: Anything you would like to add, comment on, etc.?

Interview Guides at Pilot Høje-Taastrup

Table 16: Interview guides at Pilot Høje-Taastrup

Interview Guides – Høje-Taastrup				
Themes	**Provider – VEKS**	**Provider – DTU and HTF**	**Users – Administration**	**Users – Townhall**
Theme 1: The energy system of the future	Q: How do you see an ideal, flexible, and integrated district heating system based on your field?	Q: How do you see an ideal, flexible, and integrated district heating system based on your field?	Q: From your point of view, what does an ideal district heating system look like?	Q: From your point of view, what is a good indoor climate? (How do you feel about not being able to turn up and down or open a window?)
Theme 2: New business models in the future energy marked	Q: What interests do you have as providers (suppliers) in a flexible district heating system? Q: What needs, opportunities and barriers do you think will affect the process of developing new/necessary business models in relation to hourly energy prices and CO_2 emissions?	Q: What interests do you have as providers (suppliers) in a flexible district heating system? Q: What needs, opportunities and barriers do you think will affect the process of developing new/necessary business models in relation to hourly energy prices and CO_2 emissions?	Q: As part of the project, we will investigate introducing hourly prices for district heating, in the same style as the variable electricity prices. How do you think it will affect your consumption?	Q: As part of the project, we will investigate introducing hourly prices for district heating, this could perhaps mean that it would be cold (19 degrees) in the morning when you arrive and only get warmer during the day. What do you think about that?
Theme 3: A sustainable energy system	Not part of the interview guide at HTK. *VEKS Has reduced the CO_2-emission/MWh with more than 83% since 1990 – target is a reduction with approx. 98% before 2030.	Not part of the interview guide at HTK	Q: What opportunities and limitations will a green heating sector give you as building managers? Q: How can other sustainability initiatives influence the choice of technical systems in your buildings?	Q: A green transformation of the heating sector, where oil and gas are taken out of the supply, can lead to short periods without heat during the day. How do you relate to that?
Theme 4: Regulation	Q: What barriers/challenges stand in the way of delivering a smarter district heating system? Q: What kind of political action is necessary for your company to become part of a flexible and integrated district heating system?	Q: What barriers/challenges stand in the way of delivering a smarter district heating system? Q: What kind of political action is necessary for your company to become part of a flexible and integrated district heating system?	Q: What barriers and challenges do you experience standing in the way of smart district heating systems today? Q: Which political measures do you think will be able to contribute to a more flexible district heating system?	Not part of the interview guide at HTK
Theme 5: Flexibility	Q: What are the advantages and disadvantages of operating within a flexible district heating system?	Q: What are the advantages and disadvantages of operating within a flexible district heating system?	Q: How flexible would you rate your buildings to be in terms of heat consumption?	Q: What do you think is most important? Comfort or green heat? (Comfort before CO_2 emissions)

	Q: How do you assess your own company's ability and motivation to discharge excess energy/flexibility to the district heating system? Q: What do you consider most important? Indoor climate or the flexibility of the district heating system?	Q: How do you assess your own company's ability and motivation to discharge excess energy/flexibility to the district heating system? Q: What do you consider most important? Indoor climate or the flexibility of the district heating system?	Q: What do you think is most important? Indoor climate or the flexibility of the district heating system? Q: Imagine yourself digital solutions where both buildings and users can communicate with the district heating system. What value would it have for you as building managers and the users of your buildings? Q: What considerations do you think are most important to take into account when we develop these digital solutions so that building owners and users get the most out of such solutions? Q: Is there anything you would like to add that you haven't had a chance to talk about yet? Maybe some thoughts or ideas you got during the conversation?	Q: Imagine a heating solution here at the town hall, where both building and users can communicate with the heating system. What value would it have for you as users of the building? Positive/negative
Theme 6: The technology development process	Q: What advantages and disadvantages do you see in a collaboration between academia, the public and private sectors on the development of new energy systems?	Q: What advantages and disadvantages do you see in a collaboration between academia, the public and private sectors on the development of new energy systems?	Q: What advantages and disadvantages do you see in a tripartite collaboration between the academic world, the public and private sectors on the development of smart district heating systems?	Not part of the interview guide at HTK
Theme 7: Open question	Q: Is there anything you would like to add that you haven't had a chance to talk about yet? Maybe some thoughts or ideas you got during the conversation?	Q: Is there anything you would like to add that you haven't had a chance to talk about yet? Maybe some thoughts or ideas you got during the conversation?	Q: Is there anything you would like to add that you haven't had a chance to talk about yet? Maybe some thoughts or ideas you got during the conversation?	Q: Is there anything you would like to add that you haven't had a chance to talk about yet? Maybe some thoughts or ideas you got during the conversation?

Reflections on Interview Data from Pilot Dokken

Socio-Political Acceptance

In this section we combined all reflections that fall within this social acceptance dimension from the interviews conducted in Bergen for Pilot Dokken. A description of the sociopolitical dimension of social acceptance can be found in the theory chapter.

Regulations for better or worse

In recent years, the energy sector in Norway has undergone a significant liberalization process, with increased competition in the market and a gradual transition to renewable energy. However, there are several signs that current regulations in the energy sector are becoming outdated and overly mature.

Through our interviews, we learned that the current regulatory framework imposes restrictions when it comes to *system boundaries for energy sharing*. Today, it is difficult to share electrical energy between buildings, even if they are developed and owned by the same company. Both the *BREEAM certification scheme* and the *Energy labeling of buildings* are designed to assess the performance of individual buildings, which makes it problematic to utilize synergies between buildings.

Our participants are clear that new revisions of the energy labeling of buildings are needed. One participant proposed a revision that focuses on the building's energy efficiency in terms of consumption and costs. It is more important to consider how much energy the building purchases rather than how much it uses. For example, if you install a heat pump in one building and supply heat to another building, these buildings may receive different energy ratings because one building consumes more energy than the other. Similarly, developers may be penalized if they choose to pursue BREEAM certification. The BREEAM certification is awarded to buildings that meet certain standards of environmental sustainability and are designed to reduce their impact on the environment. Despite good intentions, it is more cost-effective to install solar panels on your own roof than to purchase electricity from a neighbor's solar power system when seeking a higher building energy rating. With the current regulations, developers may be reluctant to participate in a project like the one planned for Dokken, where one of the intentions is to share energy between buildings. The governance official at NVE explains this rigidity by the fact that using the power grid incurs a cost. You are using a portion of the power grid's capacity, and then others must pay for it.

Despite these regulation issues around system boundaries, there appear to be some positive changes on the horizon. There are currently several proposals under consideration. The government is considering changes to the energy labelling scheme, with one of the goals being to promote district heating and provide better incentives for its use. NVE has also currently submitted a proposal for weighing factors, also known as primary energy factors, which are included in the calculation to determine the energy performance of a building. Climate gas emissions are one of the factors involved. Another proposal suggests that up to 5 kW of energy can be shared across different properties. Over time, this may open the possibility for even further sharing of solar power between buildings, and even for the entire area which would benefit the plans at Dokken. A third proposal under consideration is to promote the use of district heating and provide better incentives for its adoption. A regulatory barrier for district heating today is the new *pricing model*, introduced on January 1, 2019, deciding that the price of district heating should follow the electricity price. When the electricity prices in Europe skyrocketed the last couple of years, this also affected the price of district heating, thereby making it less attractive for developers.

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It is often challenging for bureaucrats and governance officials to keep up with the fast pace of technological advancements and the shifting needs of the market, making it difficult to have everything in place for early adopters. Therefore, we emphasize the importance of ensuring that regulations in the energy sector are in line with national, regional, and local climate goals. We also believe that the new proposals currently under consideration will facilitate progress in the sector and encourage stakeholders to adopt more sustainable practices.

Meeting of systems

In the realm of energy and infrastructure, the concept of "meeting the systems" refers to the process of integrating various energy systems and infrastructural elements to create a more efficient and sustainable network. This integration is about linking together various components, each with their unique characteristics and functions. It involves tackling challenges head-on and making the most of the potential synergies that arise.

At Dokken, traditional energy systems, such as electricity grids and district heating, will be joined by water and sanitation systems, and renewable energy sources, such as solar and wind power. This convergence allows for the harnessing of multiple energy sources, optimizing their use and potentially reducing the need for fossil fuels. However, meeting the systems also brings challenges beyond the technical aspects. Through our interviews we learned that meeting the systems also includes addressing legal and regulatory barriers, developing standards for interoperability, and establishing mechanisms for fair and equitable distribution of energy resources and benefits.

In addition to the energy systems and grids discussed earlier, there are also other systems that could be a part of the future integrated energy system at Dokken, such as the light rail system known as "Bybanen". With frequent train passages throughout the day, we were initially concerned about how much electricity Bybanen would require from the grid. However, during our talk with the Bybanen participant, an exciting possibility came up that could bring flexibility into the integrated energy system at Dokken. In the future, we might be able to capture the energy produced by Bybanen when it is not using power from the grid. This could happen during braking or when the train is going downhill. We could store this energy in special stations called rectifier stations. The energy stored in the rectifier stations could initially be used to power Bybanen, while any surplus energy could be sold back to the grid.

This is an exciting possibility that could make the ELEXIA energy system at Dokken even more more efficient and sustainable. It demonstrates how different systems can come together and create opportunities for novel solutions and advancements in sustainable infrastructure. Collaboration between different sectors such as energy and transportation, could become increasingly important to create integrated and interconnected systems that support the sustainable development goals set by the Municipality of Bergen. We encourage all the pilots to think broadly when it comes to system integration and explore the possibilities that could potentially be within reach also within other systems.

Long term thinking

One of the recurring topics in our focus groups and interviews was the importance of long-term thinking. The Dokken development project, with a target completion date of 2050, underscores the necessity of adopting a forward-thinking approach to infrastructure, urban planning, and energy system planning.

When examining the financial aspects of this endeavor, the division between CapEx and OpEx plays a crucial role. It is not enough to simply build the infrastructure and energy system; careful consideration must be given to the long-term costs and operations. Constructing the system involves significant capital expenditure (CapEx), but its ongoing maintenance and operation - the operational expenditure (OpEx) - are equally vital.

As the development of Dokken progresses, it will be essential to integrate CapEx and OpEx considerations to ensure the sustainability and functionality of the integrated energy system. This integration will require collaboration between investors, stakeholders, and policymakers to strike a balance between initial investments and the long-term costs of maintenance and operation.

Moreover, the long-term perspective for Dokken must extend beyond the financial and technical aspects. It should encompass societal and environmental factors, prioritizing equity, accessibility, and sustainability. This entails addressing questions of who bears the costs and who benefits from the integrated energy system, another recurring topic in the focus groups and interviews. It also involves ensuring the participation of diverse stakeholders, considering their needs, and fostering a sense of ownership and responsibility among both current and future users.

Having a focus on end-users has been a priority for the Task 1.1 team since the beginning of the project. However, we acknowledge that it is still early to involve future residents and users in the development of the integrated energy system at Dokken. Nevertheless, in the near future, we recommend including them as central stakeholders in the integrated energy system at Dokken. By integrating the perspectives and needs of future residents and users, a more inclusive and equitable energy system can be established that considers the interests of all stakeholders. This approach can foster ownership and participation among all stakeholders, thereby contributing to the development of a socially sustainable and engaging energy system that benefits both current and future users.

Flexible pricing

Another topic that reoccurred in our focus groups and interviews was net fee models. Net fee models can create barriers to an integrated and flexible energy system at Dokken by discouraging the adoption and implementation of sustainable energy solutions. The net fee models tend to rely on a fixed fee for grid connection and usage, which can discourage the promotion of distributed energy generation and storage.

For instance, with a net fee model, users are charged for electricity they draw from the grid. However, they receive no compensation when they generate excess electricity and feed it into the grid. This structure is a disincentive for the adoption of renewable energy sources such as rooftop solar panels since customers must still pay a fixed connection fee and other charges even if they are generating and using electricity more sustainably.

Furthermore, the net fee model can limit the potential for integrating and managing energy flows across different sectors and sources, such as heat pumps which could be relevant for Dokken. It can incentivize energy consumption during certain periods, thus limiting the flexibility of the grid and preventing the adoption of more efficient energy systems.

Dynamic pricing came up a solution to this barrier. This pricing model continuously adjusts prices based on real-time changes in supply and demand. It utilizes advanced technologies and data analytics to set prices that reflect the current market conditions and grid load.

A common goal

The interview with local authorities began with an interesting discussion of the premise we assumed in question 1; that society's energy demand is increasing and that there is a steadily growing demand for renewable/emission-free energy production in the future. This premise does not align with the Bergen municipality's zero-emission vision by 2050 at Dokken.

Currently, there might be two opposing visions for energy consumption in the new Dokken area. One vision is to have an area that uses minimal energy, while the other involves producing as much energy as possible to meet the growing energy demand. These visions require different plans, regulations, and definitions of land and area usage, all of which may impact the local government's involvement and support for implementing and promoting smart energy solutions.

Furthermore, the participation of different actors with varying interests and power relations in the consortium raises questions about power dynamics and the potential for certain interests to dominate at the expense of others. This highlights the importance of discussing and addressing these divergent premises within the consortium and clarifying what we want to achieve on Dokken.

Reaching a consensus on a common goal is not a straightforward matter, and within Task 1.1, we have discussed whether we believe it is possible at all. While a shared goal may seem like a far-fetched idea, there is still an argument to be made for the importance of this narrative as something to strive for.

Facilitator

The need for a facilitator or energy coordinator kept arising in the focus groups and interviews. The facilitator would be responsible for securing energy supply, managing peak loads, keeping prices at a minimum level, and ensuring the sustainability of the system. This is a concern that both large-scale users and real estate actors share. They are particularly interested in the idea of having a single entity that customers and users can interact with for their energy needs.

In our stakeholder mapping, we have not identified an "energy facilitator," and it is also not our responsibility. However, during interviews and focus groups, participants emphasized the need for a facilitator or platform to integrate all energy sources into the system. Our participant in the "Energy provider" group was clear that this is a role they can take on. They have already allocated 20 MW of district cooling to Dokken in their infrastructure and see the facilitator role as an opportunity for them to ensure a sustainable system.

What is interesting is that grid/utility companies in some large Norwegian cities have also started to take on similar roles. Several participants point to one of these companies as the right actor for the coordinator role, but there are also suggestions to establish a "Dokken energy company".

Responsibility

The Municipality of Bergen (BGO) is the majority owner of Dokken and presents itself as both the problem owner and opportunity owner of the future plans for Dokken. The municipality holds responsibility for all aspects of urban development, planning, and program work in the area. However, there are still some unresolved, or perhaps unaddressed, questions regarding the newly established development company on Dokken, approved by the City Council on June 22, 2022. The purpose of establishing the company was to oversee the development of municipally owned properties on Dokken. This raises questions about the division of responsibilities between the municipality and the development company, what role the company is envisioned to play in relation to the ELEXIA project, and finally, whether the development company will provide directives for the energy system plans at Dokken.

Regulations regarding urban planning

Regulations regarding urban planning can limit the integration of innovative energy solutions into building facades and surrounding areas at Dokken. For example, urban and architectural restrictions on buildings can prevent the use of solar panel façade designs, which is essential to the innovative approach of the ELEXIA project. This also speaks to green space regulations and the challenges of determining how much green space can be sacrificed for certain renewable technologies. As an example, ELEXIA partner BIR has made significant investments in the blue-green regulatory plan. This is a recommended approach for cities and local communities that aim to promote sustainable development. Their goal is to cover roofs and balconies with plants and integrate their own self-irrigation systems into the building structure. This indicates that there is a potential for conflicts to arise between competing sustainability considerations when the construction of Dokken begins. If energy production is implemented on all rooftops, it has the potential to compromise the green roofs, which are a crucial aspect for the Municipality.

Despite these challenges, it is critical that we find ways to balance technology, cost, well-being, health, and the environment in the urban space as we transition towards a net-zero future. This requires active collaboration between architects, developers, government officials, and other stakeholders to find innovative solutions and overcome the barriers presented by regulations.

Community Acceptance

In this section we combined all reflections that fall within this community acceptance dimension from the interviews conducted in Bergen for Pilot Dokken. A description of the community dimension of social acceptance can be found in the theory chapter.

Space and energy

One of the key aspects of space and energy is "energy landscapes", referring to areas of energy production such as wind farms or hydropower dams, and the associated infrastructure that makes up the energy landscape.

During the discussion on "Regulations for better or worse," we addressed the issue of system boundaries for energy sharing from a regulatory standpoint. However, energy sharing has also been identified as a spatial problem in the focus groups and interviews.

Energy storage facilities like batteries need space, raising the question of who is responsible for this space when a transition to net-zero takes effect. The allocation of space for energy-related technology also raises questions of responsibility and risk. An example of such technology includes batteries that come with risk, while sensors come with ethical responsibilities.

The connection between space and energy is complex on both economic and governance levels. Ultimately, addressing the spatial dimension of energy geography requires a collaborative approach, integrating energy *and* spatial planning to ensure a sustainable, equitable, and efficient transition towards net-zero emissions.

In this context, "Energy geography" is an exciting concept used in geography and environmental research that helps us understand how energy systems shape and are influenced by geographical locations. It examines the spatial distribution and interactions of energy systems. Moreover, it explores the social, economic, and environmental implications of energy production, distribution, and consumption.

Sensors

The mention of sensors and monitors throughout the interviews raises questions about the impact of these technologies on human behavior and social dynamics. It prompts us to critically examine who has access to such devices, as affordability becomes a key issue. This consideration intersects with discussions on privilege and the unequal distribution of resources, as some individuals or communities may have limited access to tools like "air things".

Additionally, the use of sensors and fine-grained data poses concerns regarding privacy and the potential for surveillance. As the monitoring of everyday activities becomes increasingly detailed, it challenges notions of personal space and autonomy within the home.

On the flip side, the use of sensors and fine-grained data also creates new opportunities to explore relationships between humans and non-human entities through data collection and analysis. Understanding these relationships can provide new insights into the ways in which we interact with our environment and, in turn, help us to develop more sustainable practices.

Dynamic comfort

One challenge among real estate actors is finding a balance between optimizing technical aspects of indoor temperature and considering the preferences and feedback of end-users. The common goal is to create an environment that accommodates most users while still maintaining energy efficiency. Most of the actors we speak with have some form of flexible "user-in-the-loop" solutions in their buildings where users can adjust and provide feedback on the perceived indoor climate, such as temperature within a predefined range. One actor has even designed an advanced autonomous system for energy management and monitoring based on two years of data collection. They have also connected their system to national temperature forecasting, enabling it to prepare for significant temperature changes on the horizon.

However, there is considerable variation in the perception of what a comfortable indoor climate means for different people and in different types of buildings and room setups. Individual personal experiences and preferences will always result in some tenant complaints unless users are given full control over their indoor climate, which would be suboptimal in terms of energy efficiency. This suggests that even with technological advancements and "user-in-the-loop" systems, subjective experiences can still influence individual perceptions.

We were intrigued by the concept of autonomous buildings, where the entire building operates on a demand-driven system, adapting its functions based on the occupants' presence or absence, and on the national temperature forecasting. This autonomous operation significantly reduced energy consumption and created a more stable indoor climate. The feedback from users in this building is almost non-existent compared to other buildings, indicating a high level of satisfaction.

Diversity

Urban planning cannot be separated from energy system planning! We agree with the participant who made this statement and believe that "diversity" and who gets to live on Dokken is directly linked to Theme 3, "A sustainable energy system", in the interview guides. The gender dimension is part of the ELEXIA proposal, and we want to reiterate what is stated there:

> It is well documented that energy practices are significantly gendered – both in relation to energy consumption and in energy industry practices. Perspectives on gender and other forms of diversity must be integrated throughout the process to avoid what Strengers calls designing for 'Resource Man'. This means not only ensuring gender balance among participants of stakeholder and public engagement processes, but attention to gender issues within discussions and analysis. ELEXIA will pay attention to gender representation, and to gendered priorities through the engagement activities, and ensure that these are considered throughout the technology design activities. The different gender politics found in the three case studies will help to highlight how the gender dimension must be integrated throughout the project and provide the basis for considering gender dimensions in the broader scaling-up implementation strategy. ELEXIA will go beyond a narrow concern with representation of men/women to consider intersectionality that may impinge on various aspects of energy system integration, since different existing energy systems may have different gendered or diversity implications. 'The Gender Dimension' will remain on the agenda for all project meetings and in project reports to ensure that focus remains on these questions.

Beyond gender, we believe that there are other divides that should be part of the ELEXIA discussion as we move towards testing and implementing the new energy solutions at Dokken, including the socioeconomic divide, cultural divide, generation gap, and the digital divide.

Within the socioeconomic divide, we must consider students who will live in the new student housing managed by Sammen at Dokken, compared to more affluent individuals who can afford advanced technologies like sensors and smart solutions to reduce energy consumption. Within the cultural divide, there may be differences in language, religion, cultural practices, and traditions that will affect energy consumption and behavior at Dokken. Within the generation gap, there will be differences between age groups and their needs, lifestyles, and perspectives on energy consumption. Within the digital divide, we will encounter discrepancies in access to and use of digital technologies and the internet, as well as differences in the ability to use technology, which will impact the participation and opportunities of different groups at Dokken.

Based on these reflections, our claim as social scientists is that diversity must be considered within the scope of ELEXIA.

Market Acceptance

In this section we combined all reflections that fall within this market acceptance dimension from the interviews conducted in Bergen for Pilot Dokken. A description of the market dimension of social acceptance can be found in the theory chapter.

Peaks and troughs

Peaks and troughs are inherent in energy systems, and managing them is a critical challenge, especially for large-scale energy users. Peak demands refer to those times when the electricity demand is at its highest within a specific period, regardless of whether that is a few minutes, hours, or several months each year.

For large-scale energy users, peak demand poses significant challenges. These actors often face significant energy demands during specific periods. For example, Eviny Termo has a 25-megawatt electric boiler on Dokken used for heating, whose one-hour operation costs them 600,000 kroner. BIR's waste management terminal at Dokken has a predictable energy demand (high loads of energy for one hour in 15-minute bursts throughout in the day), but the process of emptying is highly energy-intensive and must be completed within a specific timeframe. Bybanen is also expected to pass through Dokken regularly throughout the day once the route is established. Additionally, there may be ships seeking shore power in the future.

Meeting the power requirements during these times can put significant pressure on the energy infrastructure. The cost of meeting peak demand is high since bringing additional capacity online for a few minutes or hours each day is a costly exercise.

Furthermore, peak demand puts considerable strain on the system and can lead to power outages, load shedding, and other disruptions if not managed effectively. Without the right infrastructure and strategies in place, peak demands can cause a ripple effect throughout the energy system, affecting various aspects of our daily lives.

A model of coordination and collaboration can be seen in the Brattørkaia project in Trondheim, where Pirbadet, a large bathing facility, operates a wave machine during specific periods. This wave machine's operation requires a significant energy supply in short time intervals, leading the area to switch off the heat cables on a bridge over the railroad nearby during Pirbadet's operational periods. The coordination in this project showcases the potential for collaboration in managing fluctuations in energy demand. Peaks and troughs are inherent in energy systems, and managing them is a critical challenge, especially for large-scale energy users. Peak demands refer to those times when the electricity demand is at its highest within a specific period, regardless of whether that is a few minutes, hours, or several months each year.

In conclusion, Peaks and troughs are one of the most significant challenges facing the integrated energy system. Managing peak demands will be a critical issue for the entire energy system at Dokken and its users. During periods of high energy consumption, the question of who gets priority becomes increasingly important. In such times, there may be a trade-off between the needs of different groups, and those who are prioritized will benefit, while those who aren't may suffer. The reference to end-users highlights their vulnerability as they typically have little control over the energy distribution system and may experience the consequences of power shortages. This serves as a reminder that prioritization decisions must be made with care and consideration for the well-being of *all* users.

Business models of the "future energy system"

Several suggestions came up for the ideal business model for the Dokken area, reflecting individual needs. Some actors focused on the company's individual needs, while others considered the larger picture.

One proposal was to avoid developing Dokken-specific solutions that do not correspond to the overall energy market. Another referred to collective solutions, such as those seen in Denmark. Several participants emphasized the need for technically focused business models that prevent some actors from choosing simple solutions that do not align with the overarching plans and visions for Dokken.

Participants from the Municipality of Bergen emphasized social sustainability when discussing future business models for Dokken. They do not want business models that allow privileged actors to exploit smart technologies and regulations for their own gain, leaving the community unable to share the benefits of becoming a low-energy or surplus community. On the other hand, they also do not want a community where all Dokken residents become small capitalists.

Property developers focused on ensuring price predictability, clarity around investment costs, opportunities for energy sharing, and incentive schemes for building more environmentally friendly solutions. They also noted that business models must align with their company's needs, the regulatory framework to which they must adhere, and how they are financed. Many property developers also emphasized the needs of their residents, occupants or those who will buy homes in the future, showing a strong commitment to the end-user.

We want to emphasize the importance of balancing technical requirements and social sustainability when designing future business models for Dokken. If we only create business models that focus on either technical requirements or social sustainability, there can be some negative consequences. If we solely focus on technical requirements, it can result in inefficient or unreliable solutions that are not adapted to and accepted by society. There may also be reluctance to collaborate with the energy system, or increased economic inequality if prices become too high for the population, resulting in the economically disadvantaged being left out of the benefits of sustainable solutions. On the other hand, if we only focus on social sustainability without considering technical requirements, it can result in inefficient or unreliable solutions, higher operating costs, and generally lower user acceptance.

To ensure a sustainable and successful implementation of the zero-emission vision for Dokken, we emphasize the importance of considering both technical requirements and social sustainability in the design of business models.

Especially under this topic, there is much more to gain from the interview outlines in the appendices, particularly under Theme 2. Here, one can read about concrete proposals for new business models (e.g., cooperative models) that have been tested in the Bergen area that may be interesting to consider for Pilot Dokken.

Flexibility, Simplicity, Predictability, and Redundancy

For real estate actors, flexibility often revolves around the ability to switch between price and energy sources. Net companies emphasize the importance of considering both f*lexibility to deliver* and *flexibility to receive* energy. Energy provider actors highlight the need for flexibility in low-energy consumption areas, and they note that there are more flexibility options and opportunities in the thermal side compared to electricity. Additionally, flexibility in regulations, which currently may feel locked and rigid, is another aspect of flexibility. The national authority emphasizes the need for more discussions on *flexibility in energy use* instead of *flexibility of energy production.* All these facets of flexibility should be considered to achieve social acceptance of an integrated and flexible energy system. Otherwise, we may end up satisfying only the market dimension, the socio-political dimension, or the community dimension of social acceptance. It may be challenging to address flexibility on the user side with such a strong focus on technology in the ELEXIA project, but there are significant possibilities within this realm that we think ELEXIA should consider.

The desire for simplicity resurfaced repeatedly, particularly among the real estate actor group. Simplification of the energy system and user interfaces can promote seamless interaction between different actors while reducing complexities that may hinder optimal performance. By prioritizing simplicity, stakeholders can achieve more effective and efficient energy solutions that promote social acceptance of the integrated energy system across all layers of the community.

Predictability is another "need" that has received a lot of attention in our focus groups and interviews. Thus, it appears to be yet another important factor in achieving social acceptance in the Dokken community. Predictability can include predictability in energy flow, prices, system management, financing, and energy forecasting, to name a few examples from our interview outlines. The cry for predictability is evident among all stakeholder groups and believe it can create a stable and reliable environment for all stakeholders. Predictability will also facilitate long-term planning and improve decision-making processes, thereby connecting market acceptance with community acceptance, where procedural justice is an important aspect.

Redundancy, in essence, pertains to having multiple energy sources available for economic and practical reasons. Redundancy necessitates good energy management systems and accurate calculations to mitigate the risk of shortages, particularly during periods of high demand. Ultimately, redundancy is essentially synonymous with ensuring energy security. Redundancy can also be linked to earlier reflections on "Energy geography" and the relationship between systems, buildings and people, because, in practice, it concerns where energy is produced, where (and how) it is transported to users, and where it is stored. In our focus groups and interviews, some property owners were particularly concerned with storage options.

Favorable loans

The International Energy Agency (IEA) recognizes the construction industry as a significant source of carbon emissions. According to the IEA, buildings account for approximately 40% of the world's total energy consumption and around 30% of global greenhouse gas emissions. This includes both direct emissions associated with the use of energy in buildings and indirect emissions associated with the production and transport of building materials.

In our conversations with real estate actors, many suggestions for measures that can reduce the construction industry's carbon footprint were brought up. «Favorable loans for good energy rating" can be effective in supporting green development initiatives as they provide incentives for actors to engage in sustainable practices. The proposal for "Green loans for green energy" addresses the issue of financing sustainable energy solutions and could foster acceptance among the public as they would receive green energy. The concept "Energy as a service" was brought up in several focus groups and could also be a promising concept with the potential to mitigate the challenges of coordinating energy supply. Similar to the fiber network model, it would create a more flexible and consumer-centric energy system where users can choose their energy suppliers once the necessary infrastructure is in place. This would promote competition, innovation, and customer empowerment, leading to a more efficient and sustainable energy market.

Moreover, there are several other energy-efficient measures that can be implemented in the construction industry, such as using sustainable materials, improving insulation, installing low-emission energy systems, and implementing renewable energy.

Throughout our conversations, we observed a strong willingness from real estate actors to engage in energy-efficient measures, with most already placing it as a high priority on their agenda. Their motivation can be explained by the prospects for cost-saving over time through reduced energy bills and maintenance costs. Additionally, rising public awareness and demand for more sustainable buildings also contribute to their eagerness to adopt energy-efficient practices.

The insights provided by the interviewed real estate actors at Pilot Dokken offer valuable lessons, and we encourage referring to Appendix 2 for further details.

Solar Power versus District Heating

In focus groups and interviews, we often notice an underlying tension between solar power and district heating. In "Regulations for better or worse," we saw that the issue of energy sharing is more problematic for solar power than for district heating, whereas, in "Flexible pricing," we observed that existing net fee models create problems for district heating.

For solar power, the two main barriers seem to be the capacity of the power grid and lack of profitability. The ability to receive and transport energy, especially for prosumers and surplus energy suppliers, is a fundamental obstacle. Additionally, solar power initiatives require a power grid that can handle the additional influx of power.

In the context of district heating, two significant barriers emerge throughout our focus groups and interviews. The capacity of the district heating grid and the temperature requirements pose challenges. The limited capacity of existing pipes in the district heating system affects the integration of surplus heat sources. Additionally, the high-temperature requirements of district heating systems make it difficult to incorporate surplus heat sources that operate at lower temperatures. Transitioning towards lower temperatures in district heating systems might be part of the future solution at Dokken, and it could facilitate the utilization of surplus heat sources.

When it comes to benefits, solar power contributes to increased renewable energy production and reduced greenhouse gas emissions. Solar energy can also be produced in a decentralized manner to balance the load on centralized power grids, reducing the risk of outages and increasing energy security. In addition, solar energy can potentially reduce the costs for residents, who could produce their own electricity through solar panels and sell the excess energy back to the grid. However, achieving these benefits requires overcoming regulatory barriers for energy sharing.

District heating can also be produced using renewable sources, thus reducing greenhouse gas emissions. In addition, it can be a cost-effective solution for providing heating, especially in larger buildings and urban areas. The new net fee model has, however, almost evened out the price difference between district heating and other heating solutions such as heat pumps, hence creating a need for incentivization schemes to promote district heating. Furthermore, in the context of “energy and space”, district heating has the advantage of not requiring as much space as solar power, which needs space for both solar panels and batteries for energy storage.

In sum, both solar power and district heating can contribute to increased renewable energy production and reduced greenhouse gas emissions in Dokken.

In-the-loop

Data sharing in an integrated and flexible energy system can bring both opportunities and barriers. On one hand, sharing data between energy producers, net companies, and consumers can facilitate the optimization of energy production, distribution, and consumption. This can lead to increased efficiency, reduced emissions, and lower costs for consumers. However, data sharing can also raise concerns regarding privacy, ownership, and control. Who has access to the data, and how is it being used? These are important questions that need to be addressed to ensure that data sharing is not problematic for the users.

Furthermore, in the context of "loop systems," someone needs to be in the loop. Therefore, it is essential to carefully consider the benefits and challenges of implementing in-the-loop systems and who will have access to the data provided by them. By participating in Pilot Dokken's working groups (Pilot partners) in the early stages of the project period, we know that the challenges of data sharing were already being discussed at the initial meetings. Overall, careful management of data sharing and feedback is crucial to ensure that the integration of an energy system is efficient, reliable, and sustainable for all stakeholders involved.

Reflections on Interview Data from Pilot Høje-Taastrup

Socio-Political Acceptance

Socio-political acceptance relates to acceptance of technologies and relevant policies. In this section we combined all reflections that fall within this social acceptance dimension from the interviews conducted in Høje-Taastrup.

Flexible pricing

The discussion of flexible pricing in the interviews leads us to question who can genuinely navigate flexible tariffs, in terms of time and education. We need to consider the privilege associated with adjusting to such models. In one interview, it was suggested that those looking to save money can charge their cars after midnight. However, this statement overlooks the challenges faced by certain groups who might not have the privilege of flexibility, for example the taxi driver working a second job at night or shift workers.

Flexibility is often seen as a personal choice, but in reality, flexibility is influenced by societal structures. The question arises: who exactly are the "they" mentioned in the interviews? Embracing flexibility requires supportive systems, financial resources for, for example, automation (e.g. to facilitate the suggest night-time charging of EVs), and the literacy to handle complex systems. Therefore, flexibility turns out to be connected to privilege and intertwined with issues of inequality.

Understanding privilege in the context of flexible pricing sheds light on broader societal implications of wealth disparities.

Control and flexibility

Control and flexibility go hand in hand; having more control allows us more flexibility. This connection holds true both within the system and for users. It implies that flexibility isn't just a convenience but also a source of power, and once again, it's closely tied to privilege. When we asked users in interviews if having more control over their environment would be a positive thing, their responses were uncertain, expressing concerns about potential conflicts.

Suggestions in interviews seem to lean towards remote or digital control. However, we should recognise that even simpler actions, like being able to open a window, offer a form of flexibility that holds emotional and environmental meaning. The physical control of our comfort is a crucial aspect of flexibility, showcasing the diverse and personal nature of the concept “flexibility”.

Policy

Policy often becomes a hurdle, lacking the flexibility needed in that integrated systems and the dynamic field of energy need. We noted in the interviews that existing policies can be rigid and struggle to adapt to changing needs. An example of this can be seen in sector coupling, where the connection between different sectors faces limitations due to inflexible policy frameworks.

We find that the domains of district heating and energy storage are particularly affected by this lack of flexibility. Existing policies often struggle to keep up with the evolving needs and innovations in these areas. Additionally, tax legislation related to surplus heating adds another layer of complexity. Conversations with stakeholders in Høje-Taastrup reveal that these policies may not adequately address the nuances of surplus heating, hindering the potential for sustainable and efficient energy practices.

When unravelling these issues, it becomes clear that we need a more adaptive and nuanced approach to policymaking. This would allow for greater flexibility to accommodate the intricacies of sector coupling, district heating, energy storage, and tax legislation, considering the broader social and environmental contexts that impact us all. Here, suggestions made under “Market Acceptance” below, especially with relation to capacity payments, might be an interesting extension to this discussion.

Meeting of systems

Integrated systems and sector coupling usher in a scenario where various systems converge; the political system intersects with the heating system, and in these intersections, people come together. The challenge lies in integrating different existing elements, both material (such as actual infrastructures) and immaterial, each with its inherent flaws.

It would be simplistic to suggest keeping politicians out, as they constitute a system themselves, intersecting with the heating and energy systems. We find that people are often more a part of the solution than the problem when systems encounter failures or leave gaps behind. This perspective aligns with the insights from scholars like Vernooji et. al (2022), who delve into notions of responsibility, repair, and care, especially evident in healthcare systems.

Throughout the interviews, a notion of “meeting of systems” was palpable; here we suggest that a productive area of investigation, and a point to note in the technology development, are the areas between systems, or meeting points of systems.

A common goal

“A common goal” emerged as a recurrent theme in the interviews, emphasised by participants using varying expressions; the significance of a shared objective becomes evident. However, a crucial question arises: is the notion of a common goal merely a fantasy? This line of inquiry draws attention to the concept of "shared fantasies" (Simpson 2020), prompting us to critically examine the feasibility and reality of aligning diverse individuals or entities towards a collective purpose. The exploration of shared fantasies, as illuminated by Simpson's article on notions of home, enriches our understanding of the complexities and challenges inherent in striving for a unified objective, such as a flexible and integrated energy system.

Mobility of responsibility

Participants highlight a noteworthy aspect: the fluidity of responsibility, especially concerning the shifting dynamics of responsibilities, such as waste management. The notion of an integrated system prompts us to broaden our perspective, considering not only geographical dimensions horizontally but also vertical aspects encompassing historical contexts and future aspirations.

Important for technology development is here to consider who is responsible for what, when and where. Interesting here is also the notion of capital costs and an operational cost, discussed under “Market Acceptance” below.

Community Acceptance

Social political acceptance often meets debates related to community acceptance. Community acceptance speaks to identification of individuals or a community to a place, often at the point when technologies are implemented; this can be as fine-grained as office spaces. Below, we collected observations that reflect discussions pertaining to community acceptance.

Inequality; data and diversity

A prevalent narrative emerged in the interviews, but not foreign to most of us: the perception that women are always cold, and that someone is perpetually dissatisfied. However, questioning whether it must consistently be women who are associated with being cold raises a crucial point – if women are perpetually perceived as cold, it implies that the standard is not established by women. This underscores the significance of recognizing the bias inherent in data input, as standards are shaped by the data available. It emphasizes the necessity for diverse input in the initial phases of setting standards or operationalizing flexibility.

Translating this understanding to ELEXIA prompts us to scrutinise the data lake. It necessitates a consideration of what data is input, what remains uncaptured, and why. The decision-making processes governing the content of the data lake and the functioning of breakers become pivotal. It becomes evident that inequality is embedded in the data itself, reflecting the biases ingrained in the systems.

Examining who sets the standards highlights complexities. Participants note instances where people feel cold despite the temperature being at the “conventional” 20 degrees Celsius. The idea emerges that "people must comply with the environmental conditions set by authorities." Who dictates these conditions and the underlying power dynamics inherent in these decisions? The narrative emphasises an opportunity for transparency, diversity, and inclusivity in shaping standards, ensuring a more equitable representation in the foundational elements that govern projects like ELEXIA.

Dynamic comfort

In the interviews, a compelling question emerged from one participant: the scenario where individuals choose to work from home due to the town hall being too cold. The implication is e.g., 500 people heat their homes to 22 degrees Celsius while the town hall, despite being at 19/20 degrees Celsius, remains empty. This prompts the consideration: when does it become economically justifiable to raise the temperature in the building? This question is situated at intersection of economic considerations and the dynamic nature of workplace preferences.

Further complexity is added when we consider activities in spaces; libraries are typically heated a bit more, for example to 24 degrees, justified by the assumption that people sitting still in these spaces require higher temperatures. This emphasises the critical connection between the activities taking place in a given space and the corresponding temperature adjustments required.

The concept of dynamic comfort settings encapsulates the essence of this. It underscores the need for adaptable and responsive temperature adjustments aligned with the activities and preferences of the occupants. This multifaceted perspective prompts us to move beyond static temperature norms and embrace a dynamic approach that considers the diverse activities occurring within different spaces. However, we would like to add a note of caution here, as this points to human-in-the-loop systems; here the human-in-the-loop needs to be considered carefully, pointing back to the discussion of privilege and flexibility at the beginning of this chapter; developers and technology providers must critically ask, who is/can be in the loop? Who can use, for example apps, to provide feedback, in terms of accessibility of the apps as well as time and interest to provide feedback.

Sensor (data)

From the interviews, sensors emerged with a dual role; they are data providers while simultaneously consuming energy. The question emerged: how much energy do sensors use, and to what extent should this energy consumption be factored into our considerations? This aspect emphasises the importance of not only harnessing data but also understanding the energy costs associated with data collection and processing.

While sensors enable control, a symbiotic relationship emerges with issues of power, privacy, ethical concerns, and legal frameworks. Contemplating who controls the sensors, such as automatic heating adjustments or occupancy monitoring in offices, introduces a realm of questions. This includes potential privacy concerns; who has access to this data, and what safeguards are in place to prevent unauthorized access or hacking? How is the data used, and who ultimately owns this data? Energy data is never anonymous or uncomplicated as it allows to reverse-engineer manufacturing processes to when some made boiled the kettle in their home.

For instance, in the context of social housing, sensors measuring humidity levels could inadvertently disclose occupants' presence or absence. This information could have implications, such as a state agency using it for legal purposes, raising new legal and ethical considerations; today and in a future which might have different political and legal frameworks in place. The intersection of sensor technology, control, and privacy necessitates a careful examination of potential consequences.

Wellbeing and productivity

Participants drew a notable connection between temperature and efficiency, echoing a historical argument akin to that made by British colonisers during the British Raj and in other contexts related to urban planning; here factors like better sleep, improved hygiene, enhanced ventilation, and access to shade contribute to cultivating more productive workers or subjects of the colonial state.

This underscores the enduring relevance of the intersection between environmental conditions and human efficiency. The narrative extends to encompass considerations of wellbeing and productivity, emphasising the intrinsic relationship between the two. This parallel between historical perspectives and contemporary discussions emphasises the enduring significance of understanding and optimising environmental conditions for individuals and their productivity; highlighting the connection between decarbonisation and decolonisation, as discussed by anthropologist of energy and infrastructure (for example Dominic Boyer's 2024 book *No More Fossils* or Laurie Parsons's 2023 *Carbon Colonialism*).

Retaining heat, retaining people

In interviews, a positive indoor climate emerged as a crucial factor in retaining employees, particularly in the context of start-ups. The correlation is evident: maintaining a comfortable indoor environment is not just about temperature control; it is about retaining people and, by extension, valuable employees. This sentiment aligns with insights from Dokken interviews, where predictability also surfaces as a key element contributing to client (tenants, potential home buyers) satisfaction and retention.

The notion that retaining heat equates to retaining people underscores the broader significance of environmental factors in the workplace. A conducive indoor climate becomes a tangible aspect of employee well-being and job satisfaction. In the competitive landscape, especially within the dynamic sphere of start-ups, the recognition of the role of the indoor environment becomes a strategic consideration for organisations aiming to foster a loyal and productive workforce. This ties in with observation in above section on dynamic comfort as well as notions of wellbeing and productivity in this section.

Simplicity and flexibility; and breakdown

Throughout the interviews we saw a call for simplifying the system in tandem with a demand for flexibility. We might initially perceive this as a contradictory demand. The underlying idea is that while the system itself may require advanced capabilities, the interfaces connecting the various layers of actors should be kept simple. Here, a nuanced understanding of the "user" is necessary; in a sense, as discussed above, we need to ask who *is* a user, and who *can* be a user, and how does the energy systems (and its designers) imagine a user?

This nuanced perspective highlights the importance of striking a balance between system complexity and user accessibility.

While the call for simplification pertains mostly to the user interfaces, ensuring that different actors can interact seamlessly with the system without being overwhelmed by its intricacies, participants in interviews also mentioned the difficulty when individuals leave an organisation who developed the system, or were familiar with its running. In this sense, the "user", is/are also the maintenance team/s.

Here, the consideration of break downs, repair and care for the system(s) should be considered in the design phase, alongside its seamless functioning. Science and Technology Studies (STS) scholars, for example Sarah Pink or Jeanna Grant in a recent article on *Repair in Translation* (2020) in Cambodia, have discussed the importance and social meaning of breakdown and maintenance of technologies extensively in their scholarship.

The human body as part of an integrated energy system

The recurring mention of clothing by the user groups in the townhall raises the question: should clothing be considered part of an integrated energy systems, and what implications would arise if we do? This inquiry prompts us to broaden our perspective on the components that contribute to the energy dynamics within a given space.

By considering clothing as a potential component of the energy system, we acknowledge its role in shaping individual comfort (and control) and thermal needs. This perspective expands our understanding beyond traditional infrastructural elements and incorporates the human body into the energy equation (which is already part of it, as energy standards are based on, mostly male and white, human bodies). The human body, with its inherent diversity, is already an integral part of the energy system (from the design phase to its commissioning). Recognizing this diversity underscores the need for a nuanced approach that accommodates various thermal preferences and requirements.

In contemplating the integration of clothing into the energy system, we open avenues for more inclusive and adaptable solutions that account for the multifaceted nature of human experiences within a given environment.

"If we know/understand, we do it."

The notion that "if we know, we do it" surfaced in discussions, suggesting that awareness leads to action, whether it involves bringing a jumper to combat cool temperatures or understanding technology to ensure compliance. However, we challenge the validity of this assertion. The belief that knowledge alone drives behaviour overlooks the complexity of human decision-making. This relates to a Marxist argument that knowledge equates to power. However, empirical evidence from fields such as psychology, sociology, and anthropology contradict this notion. Research in these disciplines underscores the intricate interplay of various factors influencing human behaviour, revealing that individuals often fail to act on knowledge, even when it aligns with their best interests. For example, despite knowing the health risks associated with excessively consuming meat, many continue to do so. Similarly, usage of complex technologies like iPhones, Google, and cloud services persists among individuals who may not fully comprehend their inner workings.

While the idea that knowledge is power holds theoretical merit, practical realities demonstrate that the relationship between knowledge and action is far more nuanced. This recognition underscores the potential for ELEXIA to challenge the assumption that knowledge (alone) drives behaviour. This would mean adopting a holistic approach that considers not only awareness but also the myriad social, cultural, and psychological factors in the intersection of knowledge, technology, and behaviour.

Market Acceptance

Market acceptance, according to Wüstenhagen et al. (2007) can be understood as the processes how the market adopts new technologies, noting a potential disconnect between market acceptance and social political acceptance and community acceptance. In this section we collated our reflections on market acceptance, connecting them to the other social acceptance dimensions where appropriate.

Capacity payment

In some of the interviews, a proposition emerged to shift the fee structure from energy consumption to load imposed on the system, advocating for capacity payments. While this approach may offer a more nuanced way of managing the demand on the system, the question arises: does it inadvertently penalize customers/users (private or industrial) who may not have the flexibility to adjust their load (for example individuals and families, hospitals, or critical services such as waste management)? Evoking a discussion at the beginning of this chapter on flexible tariffs and asking who is responsible for the loads.

Charging based on system load places emphasis on the impact users have on the overall system capacity rather than just the energy consumed. While this might incentivize more strategic and efficient use of resources, it raises concerns about potential consequences for those with limited flexibility. Individuals or entities with less adaptable energy usage patterns may face increased costs under a capacity-based fee structure, potentially placing a disproportionate burden on them.

Balancing the need for a fair and flexible energy pricing system, while avoiding unintended penalties for less flexible users, becomes a crucial consideration in the ongoing discussions in ELEXIA surrounding energy consumption and fee structures. The opportunity lies in crafting approaches that encourage efficiency without exacerbating inequalities or disproportionately impacting certain groups.

Heating and cooling

The connection between heating and cooling, especially in the context of the town hall requiring more cooling than heating as mentioned in the interviews, raises intriguing considerations. The challenge becomes apparent in contemporary building designs, where efficiently getting rid of excess heat poses a significant difficulty. A well-designed building with an efficient energy system, as pointed out by a participant in the Dokken interviews, does not have any “waste”.

The connection between heating and cooling systems underscores the delicate balance required in building design. Buildings that are unable to effectively "breathe" face challenges in managing temperature fluctuations and air circulation. This lack of ventilation not only impacts energy efficiency but also raises concerns about indoor air quality and occupant comfort.

Understanding the interplay between heating and cooling is pivotal in creating sustainable and comfortable built environments. A balance that ensures that buildings not only meet the energy demands for heating and cooling but also facilitate effective ventilation, contributing to overall environmental well-being and comfort for occupants seems to be important here. The challenge lies in designing structures that harmonize these diverse elements, ensuring a balanced and energy-efficient approach to indoor climate management, with digital technologies as well as offline/analogue technologies (such as simply manually openable windows).

Heating and electricity

While in Høje-Taastrup, the overall case is district heating, we would like to put forward the question if the separation and distinct discussions around heating and electricity, with participants seeking clarification on whether the questions referred to heating networks or electricity, might signal a potential lack of integrated thinking. This question tries to counter the potential for a siloed approach to conceptualising and planning energy systems. A segregation could indeed influence system planning by limiting a comprehensive understanding of the synergies and interactions between different energy vectors. Integrated thinking involves considering heating and electricity as interconnected elements within the broader energy landscape. Breaking down these silos could lead to more holistic system planning, where the implications and efficiencies of one component are considered in relation to the other.

Addressing a lack of integrated thinking by users is essential for creating more effective and sustainable energy solutions. It involves recognizing the interdependencies between heating and electricity and fostering a mindset that promotes a unified approach to energy system design and implementation.

Collaboration

The collaborative approach mentioned in interviews among district heating suppliers and companies, where they collaborate instead of competing, suggests paradigm of solidarity within this landscape. These business dynamics offer intriguing questions about the evolving nature of competition, the role of legislation, and its potential implications for the market.

This cooperative stance challenges traditional notions of intense competition and prompts a re-evaluation of the role of legislation in fostering collaboration. It hints at a model where businesses prioritise shared goals and work together for collective benefits. This divergence from traditional market dynamics calls into question the conventional market-oriented approaches; it might be worth to explore the reasons for this in the context of district heating.

The question then arises: can this collaborative model in district heating, be translated to the electricity sector? A wish for knowledge exchange was voiced by several stakeholders. Exploring such possibilities involves assessing the feasibility of fostering a sense of solidarity among electricity suppliers and companies. This might require a reconsideration of market structures and regulatory frameworks to accommodate and incentivise collaborative efforts. The potential impact extends beyond the individual companies involved, ideally shaping a new narrative for the market characterised by cooperation and shared goals rather than cutthroat competition.

Comparing Findings Across Pilots

Through all the focus groups and 1-to-1 interviews, our aim has been to identify any potential barriers that may hinder the realization of a flexible and integrated energy system at the pilots within the three dimensions of socio-political acceptance, community acceptance, and market acceptance.

In this final chapter, we want to shift our perspective and consider these barriers as opportunities for the ELEXIA project in its ongoing technology development process. With this perspective in mind, we have singled out five recurrent categories, which we wish to highlight through some concluding reflections.

Trust

Trust, one of the social acceptance indicators for Task 1.1, and key aspect of all three social acceptance dimensions, emerges as a prevalent theme in the interviews, reflecting the importance of having confidence in the system's reliability and stability.

This trust extends to various aspects, including trust that the system operates as intended and trust in the consistency of its operation, for example with relation to temperature levels, influencing decisions such as clothing choices. This observation resonates with insights from Dokken interviews, which also highlight the significance of predictability in fostering trust.

The connection between trust and predictability underscores the fundamental role of reliability in understanding user perceptions and behaviours. When individuals trust that the system will function predictably and consistently, they feel more confident in their interactions with it. This trust forms the foundation of user satisfaction and engagement, contributing to a positive user experience.

Recognizing the importance of trust in system operation, particularly in relation to predictability, underscores the need for robust and dependable energy systems; here it is important to establish how ELEXIA partners within the project understand “robust and dependable”. Building trust requires not only technical reliability but also effective communication and transparency to instil confidence in users. By prioritizing trust and predictability, energy systems can enhance user satisfaction and support sustainable behaviours and decisions.

A second dimension of trust pertains to relationships between project partners within ELEXIA, and between external actors (external) stakeholders and the consortium. Here, trust between partners translate into e.g., effective collaboration, open communication, and the willingness to share knowledge and resources.

This is a difficult dimension to capture in real-time interviews and might be more comfortable to answer anonymously. The survey results in Appendix 6 can provide valuable insights across the three pilots. In the survey, we first asked a general question about whether participants trust the capacity of the consortium (project partners) to create a flexible and integrated energy system. We then asked questions regarding trust in the local authorities and industry partners within five different social aspects. The survey dataset can be segregated by pilot if project partners desire to view results for a particular pilot separately.

System integration horizontally and vertically

The concept of an integrated system expands beyond horizontal integration across various energy vectors, systems, infrastructures, and buildings; it also necessitates vertical integration across time. This temporal dimension involves considering the lifetime of a system, understanding the history of existing systems, and incorporating considerations for the future, which may or may not come.

Temporal integration becomes particularly interesting in the context of retrofitting buildings. Retrofitting involves modifying or upgrading existing structures to align with contemporary energy and efficiency standards. In this process, understanding the historical evolution of the building and integrating existing/old systems with future expectations becomes crucial. This integration across time requires a comprehensive approach that considers the legacy of existing systems, the current needs of the built environment, and anticipates potential changes in the future.

Emphasizing temporal integration highlights the dynamic nature of energy systems and the built environment (urban, architecturally and its social space). It underscores the importance of holistic planning that encompasses the past, present, and potential future developments. Such an approach not only ensures the sustainability of the integrated system but also facilitates adaptive strategies that can accommodate evolving energy needs and technological advancements over time.

Spatial aspect of a flexible and integrated energy system

The overarching theme of space, architectural and urban planning at Dokken brings attention to the connection between space and energy, involving economic and governance challenges. Exploring literature on the geography of energy could provide valuable insights into these complex dynamics.

In Dokken's real estate actor interviews, the integration of energy systems is hindered when different companies in one building are registered independently. This regulatory and spatial challenge highlights the difficulties in achieving seamless integration within shared spaces. Additionally, sharing energy between buildings and areas faces regulatory gaps and spatial complexities.

The spatial implications of energy storage, particularly in the context of a net-zero transition, raise questions about who bears the cost for the necessary space, including the location of batteries. This concern is echoed in the Høje-Taastrup interviews, emphasising the economic dimensions of energy storage and its spatial requirements.

Considerations about the space needed for technology within buildings and the associated risks, such as those posed by batteries and ethical risks around sensors, bring forth economic, ethical, and governance challenges. Decisions about the allocation of space for these technologies and the associated responsibilities underscore the need for a comprehensive approach to space-energy dynamics in urban planning.

Regulations regarding urban planning, including architectural restrictions in regulations that limit supposed innovative designs like solar panels on facades, contribute to the broader discourse. Balancing the need for (space for) renewable technologies with considerations for green space raises questions about how much green space, equalling wellbeing in a city as pointed out in interviews, can be sacrificed. The transition to net-zero poses a complex challenge of balancing cost, carbon, and comfort.

OpEx and CapEx, and long-term planning

The observed disconnect between capital budgets and operational budgets, as exemplified by the trade-off between building costs and subsequent operational expenses, highlights a systemic challenge. The conventional separation of capital expenditures (CapEx) and operational expenditures (OpEx) by engineers and their models contributes to these challenges. The consequence is often buildings constructed on a tight budget that may lead to higher maintenance costs and reduced operational flexibility.

Addressing this issue might necessitate a paradigm shift in financing. The call for integrated energy systems goes beyond technological considerations to include a restructuring of financial models. A truly integrated approach would involve aligning budgets to create a holistic understanding of the costs involved throughout the lifecycle of a building or energy system.

The mention of a need for change in financing models, as echoed by stakeholders in both pilots where interviews were conducted, emphasises the significance of integrating financial considerations into the broader framework of energy system design and operation.

Moving away from traditional financial silos towards integrated finance models could pave the way for more sustainable, efficient, and flexible energy solutions that will stand the test of time. This shift acknowledges the interconnectedness of financial decisions and the long-term viability of energy systems. For ELEXIA this might pose an opportunity to consider what the integration of CapEx and OpEx means for business models and markets.

Collaboration and innovation

At the heart of successful technological collaboration is a shared vision and mutual trust. Partners must be able to communicate effectively and understand each other's unique perspectives in order to create a unified approach and deliver projects that meet the needs of all stakeholders involved. In addition, effective collaboration requires strong leadership, clear roles and responsibilities, and open communication channels. By building a culture of transparency and continuous improvement, partners can foster creativity and innovation, resulting in more efficient and effective outcomes. Collaboration also enables partners to pool resources and expertise, allowing us to tackle issues that may be beyond the scope of any one group individually. By leveraging the strengths of different partners, the consortium can create more comprehensive solutions that deliver significant benefits to the society as a whole.

Our project utilizes a tripartite collaboration model involving the public, private, and academic sectors, which has been positively received during pilot interviews and focus groups as an effective solution for promoting innovation and solving challenges together. In our survey, we asked questions pertaining to technology cooperation and found that 87% of respondents indicated a high degree of satisfaction with the tripartite collaboration model utilized in ELEXIA. Moreover, 73% of respondents believe that the consortium can collaborate to create an integrated energy system that is applicable in the future at Dokken, Høje-Taastrup, and Port of Sines.

Regarding the involvement of end-users in the early stages of the technology development process, the survey data reveals divergent opinions regarding their role in this phase of the project. As a final recommendation from the Task 1.1-team, we suggest that the consortium addresses the matter of engaging end-users in the subsequent stages of the technology development project. This will allow for their valuable insights and feedback to create a more effective and user-focused energy system.

As a conclusion to this chapter, we would like to emphasize that these were just five of the many possible topics that we could have highlighted based on the interview outlines and audio recordings. Our goal has been to make the interview data easily accessible to the project partners. As a consortium comprising a diverse set of stakeholders, each with distinct expectations and reasons for joining the ELEXIA consortium, we acknowledge that there may be other topics of interest to certain partners which we did not cover. We look forward to continuing our collaboration and addressing any additional topics that may be of relevance for *the social world of technologies*.

References

Al-Debei, M. M., & Avison, D. (2010). Developing a unified framework of the business model concept. *European Journal of Information Systems, 19*(3), 359–376. https://doi.org/10.1057/ejis.2010.21

Batel, S., (2020). Research on the social acceptance of renewable energy technologies: Past, present and future. *Energy Research & Social Science, 68*, 101544. https://doi.org/10.1016/j.erss.2020.101544

Bourne, L. (2005). Stakeholder Relationship Management: A Maturity Model for Organisational Implementation. John Wiley & Sons Ltd.

Bunders, J. F. G. (1999). Transitions in development cooperation: Accelerating the transformation to sustainable development? *Technological Forecasting and Social Change, 60*(1), 1-13. doi: 10.1016/S0040-1625(98)00090-6

Casiraghi, E., Silva, A. L., Vaccari, M., & Groppi, S. (2021). Participatory scenario planning to explore social acceptance of innovative energy transition practices: An application to the circular economy. *Sustainability, 13*(10), 5441. doi: 10.3390/su13105441

Chen, H., Liu, Y., & McLaughlin, M. (2018). A data-driven approach to identifying state-level public acceptance of distributed solar photovoltaics. *Energy Policy, 118*, 316–327. doi: 10.1016/j.enpol.2018.03.024

Freeman, R. E. (1984). *Strategic management: A stakeholder approach*. Pitman Publishing Inc.

Friedman, A. L., & Miles, S. (2006). *Stakeholders: Theory and practice*. Oxford University Press.

Juma, C. (2005). Long-range public investments: The neglected ingredients of successful science and technology policies in Africa. *African Development Review, 17*(2-3), 445-457. doi: 10.1111/j.1467-8268.2005.00115.x

Lall, S. (2004). Reinventing industrial strategy: The role of government policy in building industrial competitiveness. In D. E. Rapkin & M. G. Mastanduno (Eds.), *US economic statecraft for survival, 1933-1991: Of sanctions and strategic embargoes* (pp. 90-113). Routledge.

Leucht, D., Lee, E., Maiden, R., Meys, R., & Burdeli, E. (2010). Understanding public acceptance of hydrogen and fuel cell technologies: A validation of the 'Mental Models' approach (p. 5). International Journal of Hydrogen Energy, 35(13), 7167-7176. doi: 10.1016/j.ijhydene.2010.02.002

Mallet, S. (2007). Understanding home: A critical review of the literature. The Sociological Review, 55(1_suppl), 68-89. doi: 10.1111/j.1467-954X.2007.00661.x

Mallet, S. (2007). The concept of technology cooperation revisited. In B. Guile & D. F. Finegold (Eds.), *From globalization to world society: Neo-institutional and systems-theoretical perspectives* (pp. 177-196). Routledge.

McGrath, S. K. and Whitty, S. J. (2017). Stakeholder defined, *International Journal of Managing Projects in Business, 10*(4), pp. 721–748. https://doi.org/10.1108/IJMPB-12-2016-0097

Merriam-Webster. (n.d.). *End user*. In Merriam-Webster.com dictionary. Retrieved January 22, 2024, from https://www.merriam-webster.com/dictionary/end%20user

Morgan, D. L., & Bottorff, J. L. (2010). Advancing Our Craft: Focus Group Methods and Practice. *Qualitative Health Research*, *20*(5), 579–581. https://doi.org/10.1177/1049732310364625

Pietrobelli, C. (2000). Cooperation and governance with enterprises in developing countries: Intellectual property rights issues. Journal of Policy Reform, 4(2), 115-143. doi: 10.1080/13841280008523472

Rogers, E. M. (2005). Diffusion of Innovations. Simon and Schuster.

Simpson, N. (2020). A lonely home: Balancing intimacy and estrangement in the field, in: Lenhard, J., Samanani, F. (Eds.), *Home: Ethnographic Encounters*, Bloomsbury Academic, pp. 59–72. https://doi.org/10.5040/9781350115972

Slovic, P. (1993). Perceived risk, trust, and democracy. Risk Analysis, 13(6), 675-682. doi: 10.1111/j.1539-6924.1993.tb01329.x

Stantcheva, S. (2023). How to Run Surveys: A guide to creating your own identifying variation and revealing the invisible. Annual Review of Economics, 15, 205-234. https://doi.org/10.1146/annurev-economics-091622-010157

Vernooij, E., Koker, F., Street, A. (2022). Responsibility, repair and care in Sierra Leone's health system. *Social Science & Medicine, 300*. https://doi.org/10.1016/j.socscimed.2021.114260

Walter, I. (2000). Industry, innovation and infrastructure: Indicator 26--Diffusion and penetration of new technologies: Some measurement issues. United Nations Publications.

Wilkins, T. (2022). *Technology cooperation for innovation*. Routledge.

Wolsink, M. (2018). Social acceptance revisited: Gaps, questionable trends, and an auspicious perspective. *Energy Research & Social Science, 46*, 287–295. https://doi.org/10.1016/j.erss.2018.07.034

Wolsink, M., & Pepermans, G. (2006). Changing wind power implementation practice in Belgium and The Netherlands: the importance of beliefs and attitudes. *Energy Policy, 34*(18), 3536-3545. doi: 10.1016/j.enpol.2005.06.015

Wüstenhagen, R., Wolsink, M., & Bürer, M. J. (2007). Social acceptance of renewable energy innovation: An introduction to the concept. *Energy Policy, 35(5)*, 2683–2691. https://doi.org/10.1016/j.enpol.2006.12.001

Appendices

Appendix I: Interview Outline – Pilot Høje-Taastrup

Theme 1: The energy system of the future

The two ELEXIA partners, VEKS (District heating company) and DTU (Technical University of Denmark), as well as HTF (District heating company), all fall under the Provider category and were asked the same questions throughout the interview. In theme 1, they were asked to reflect on what they consider an ideal, flexible, and integrated (district heating) energy system.

Participant A (VEKS) believes that in a flexible energy system, focus must be on two tracks: 1) Reducing energy consumption in consumption sectors. If this is not done, the green transition becomes too expensive. Currently, there is too much focus on the production side and too little on consumption and acting in an environmentally responsible way. Governments dropped the requirement for 19 degrees Celsius in public buildings because there – just now - is enough water in Norwegian water reservoirs and enough gas in storage. Thus, politicians signal to the public that we don't need to focus on resource consumption because we have enough energy available. This is not long-term thinking. For every degree raised indoors, heating energy consumption increases by five percent. Politicians should lead and motivate the population to change behaviour. Instead, it is often the population putting pressure on politicians. Furthermore, one must develop an energy system that ensures sustainable energy production in the production sector. It is necessary to avoid developing a capacity greater than needed and ensure all energy resources in society are utilized. This means looking into heat and electricity systems, transitioning from central production to greater decentralization to utilize local resources. The future electricity system will not be demand-driven but production-driven, depending on wind and weather, allowing society to adjust consumption to available production. There are no good solutions for this yet, but it is essential to have the capacity to store.

Participant B (HTF) also emphasizes the importance of considering local resources when planning a future energy system. HTF suggests that the definition of an ideal energy system is individual and influenced by the specific location and available resources. In instances where a new district area is being developed, the system can be tailored accordingly. However, in HTK's situation, the existing infrastructure and resources in the area must be considered. If there are additional energy sources that align with the company's, customers', and society's interests, they can be integrated for mutual benefit.

Participant C (DTU) emphasizes the importance of running with low-temperature district heating and temperature zones to integrate surplus heat from local supermarkets, Microsoft, and data centres effectively. Out of the 54 data centres in Denmark, only four provide surplus heat; the remaining 50 release heat into the environment. Many choices depend on the local area and current framework conditions. Participant C also highlights that for a balanced energy system in Denmark, we need the flexibility that the district heating sector can provide. District heating must be part of the green transition.

The actors in Users – Administration received a similar question under Theme 1: From your point of view, what does an ideal district heating system (energy system) look like?

The participants in this focus group were CEIS, represented by Energy Manager Participant D, Driftsbyen, represented by Operations Manager Participant E, and MindFuture, represented by Facility Manager Participant F. All participants in this group are familiar with the technical operational side of the energy system, answering the question from a user perspective.

Participant D (CEIS) began by stating that the system should be "as simple as possible." Careful consideration should be given to what the system needs and what can be dispensed with. Additionally, Participant D believes that one should stick to what is known to work rather than introducing all sorts of experimental control functions. In other words, a relatively simple standard system with as few effective components as possible, with the right sensors, inputs, and outputs placed in the right locations. Sometimes, systems are made so complicated that even engineers may have difficulty managing them. One should also consider whether someone else has already developed good solutions that work instead of reinventing everything.

Participant E (Driftsbyen) fully agrees with Participant D. The simpler the system, the easier it is to operate/repair. Participant E has experience with advanced systems created by skilled staff who later left the organization. When competent staff leaves, knowledge leaves the organization, and those taking over have difficulty understanding how the systems work. This makes the organization very vulnerable.

Participant D (CEIS) follows up and emphasizes that it is crucial to consider the operational situation (management) when designing an energy system. The systems must be as transparent and intuitive as possible for those who will operate them for the next 50-100 years. Not everything that is smart is necessary. If an unexpected situation arises, large and interconnected systems can often pose more problems on the operational side than simpler, smaller systems. Sometimes, one wishes to go back to the simpler systems we used to have.

Participant F (MindFuture) wants a greater focus on reducing return temperature (cooling) and that this should happen automatically. They often experience that the return temperature is a bit too high in their office building. Some days the system works excellently, other days they must manually adjust the temperature. This is frustrating. Furthermore, Participant F suggests testing sensor control in advance (room temperature and CO_2 meter) for heating. He believes it could be practical to have systems that can shut down completely outside of usage hours if it is economical for the company. He thinks this could be an advantage for both the environment and the budget.

Participant D (CEIS) mentions that they sometimes bypass the huge domestic hot water system (control check this). In some cases, it may be unnecessary to pay a million for a very complex hot water system that runs hot water around the clock, all year. This depends on the type of building. If talking about homes, one must, of course, generate heat for household use throughout the year. Participant D explains that the reason they have heat on in office buildings even in the summer months is to produce hot water for domestic use. Therefore, the entire system runs, even though strictly speaking, it is not necessary. Participant D suggests turning off the exchangers completely for four months a year. This way, district heating systems and pumps do not need to handle this water, saving a lot of work.

Participant E (Driftsbyen) highlights cooling as a central part of the heating system. Good cooling options provide better operational economics. He shares an experience from a building he worked in previously where hot water tanks had extremely poor cooling in the summer. Hot water can come in and be the cause of poor cooling for district heating.

Participant D (CEIS) agrees with Participant E and believes it is essential to deliver good cooling. There is a lot of management behind delivering the heat we need when it is needed and ensuring good cooling. If we can control this, we don't need to control everything else. Having accurate data also enables us to implement presence-based management, ensuring delivery (heat/hot water/ventilation) only when required.

The actors Users_Townhall received a slightly more practically oriented question under Theme 1: From your point of view, what is a good indoor climate?

Participant G (Economic Case Handler) believes a good indoor climate is about having the right temperature and a feeling of fresh air and an open environment.

Participant J (Energy Manager) also bases a good indoor climate on temperature and air quality. Sometimes the air can feel a bit pressured. If the air quality is good, and it's not too hot or too cold, it's a good indoor climate.

Participant H (Business Manager) thinks a good indoor climate is primarily about fresh air but also reasonable temperature. The temperature should regulate itself. She finds it challenging that it is not possible to open windows in the new Town Hall.

Participant I (Building Case Handler) thinks a good indoor environment means there are no significant drawbacks concerning the essential elements. By essential elements, he means noise, glare from outdoor lights, smell, temperature, and air exchange. If the occupants/residents are generally satisfied with these elements, it's a good indoor environment. Participant I thinks, like

Participant D (CEIS) and Participant F (Mindfuture) in the User-Administration group, that it is impossible to please everyone. There is always a margin of error of 5-10 percent who are not satisfied no matter what you do. So, you can say it is very individual. Also, in terms of preference. Some are very sensitive to noise, others to light. But often, it's about whether it's cold or hot, if there are drafts, and air circulation.

The moderator followed up and asked what they think about no longer having control over being able to open and close windows or adjust the heating.

Participant I (Building Case Handler) thinks it is practical in terms of energy efficiency to control everything from an overarching level (operational side). Concerning individual needs, top-down management of the indoor climate is less favourable. Human beings are very individual.

Participant J (Energy Manager) agrees with Participant I that it is far better in terms of energy to remove user influence. But yes, satisfaction decreases as well. Especially now in the start-up phase in the new Town Hall where things are not quite top-notch yet. Perhaps about 25 percent are dissatisfied currently.

Participant H (Business Manager) thinks that together we can be a bit more flexible. As an employee, for example, you can have a sweater in the office if you feel cold. Participant H highlights "smell" (indoor air pollutants) as a strong criticism in the new Town Hall. When they moved into the new Town Hall, she was very concerned about the strong smell of new furniture and new interior. It felt like a very unhealthy work environment to be in. New furniture and interior can significantly contribute to off-gassing. In addition, technological solutions also evaporate many toxic gases. When there are insufficient ventilation/ventilation options, this is very unfortunate.

Participant G (Economic Case Handler) thinks that if we want to be here (in the Town Hall), we must accept that some people control these things. We can only hope that one day we have a system that works. Participant G says she copes well with someone deciding that the temperature should be 19 degrees, etc. If you know what to expect, you can adapt. It is immediately a bit worse if the temperature is constantly changing. She says that there are significant differences in the building, and indoor climate varies depending on where you sit. She sits on the seventh floor, but often has meetings in the lower floors. It is cooler further down in the building. In addition, there is no ventilation in the meeting rooms. Currently, there are too many temperature changes in the Town Hall, but if the temperature and air quality can be kept the same throughout the building, it makes sense for the system to be controlled from above.

Theme 2: New business models in the future energy market

In Theme 2, the providers were asked about their interest as technology providers in a flexible district heating system.

Participant A (VEKS) states that VEKS's main interest is to ensure having customers in the future. They aim to deliver a product to customers that is 1) reasonably priced, 2) has a stable supply, and 3) is environmentally acceptable. It can be challenging to align these three parameters. Sometimes, the desire is to have a green and stable delivery, but it may not be possible to also lock the price at a low level. If two of these three mentioned parameters are locked, the third becomes a consequence. Politically, all three are often locked, but that equation does not always work out. Participant A provides a concrete example of attracting customers. A year ago, there was a strong desire to move away from natural gas to district heating. However, the same interest is not seen today, mainly because the price of natural gas has fallen, and we hear that the supply crisis has subsided. Even though the supply crisis has subsided, there is still a climate crisis that needs attention, but it seems to have taken a back seat. Participant A believes it is crucial for politicians to be clearer in their formulation and to explicitly state that they have decided to phase out natural gas from a specific date. Only then will society understand the seriousness, and businesses can plan according to the political visions. In the automotive industry, for example, Volvo has taken a clear stance on electrification (based on political visions) by stating that they will not produce any more diesel-powered cars after 2025.

Participant B (HTF) explains that HTF is concerned with what is economically profitable for society and their business. He mentions various factors, including being subject to the district heating law, which states they should not have a surplus. Participant B emphasizes that they are not a technology provider but a heat supplier. Nevertheless, they are open to adopting new technology because they are aware that much can be done in new and smarter ways. HTF has investigated heat pumps because they are close to their distribution system, presenting an energy-efficient alternative that can be seamlessly incorporated into their system, enhancing the flexibility of their supply.

Participant C (DTU) adds that the heat pumps HTF has helped install contribute to capturing more wind energy. Previously, around 15% of wind energy was wasted as wind turbines had to stop due to excess energy. If you have heat pumps connected to, for example, groundwater, you can start these groundwater-based heat pumps when there is excess electricity, and wind turbines are turned off. This is efficient and contributes to promoting green transition. Participant C emphasizes the importance of having more large, professional heat pumps rather than small individual heat pumps. The small ones are far less effective, and managing them is challenging, hindering the green transition. Other downsides of individual heat pumps include noise in densely populated areas. However, in more remote areas without a district heating system, small heat pumps can be highly advantageous.

The second question to the provider group under Theme 2 was: "What needs, opportunities, and barriers do you think will affect the process of developing new/necessary business models in relation to hourly energy prices and CO_2 emissions?"

Participant A (VEKS) points out that when using electricity, there is an immediate connection between production and consumption. There is no time delay. Thus, it is easier to establish a timely tariff that is transparent and simple. However, electricity is delivered through a distribution network, and recently, the price for using the network increased from 0.59 DKK/kWh (between 17 and 21) to 1.20 DKK/kWh. To gain acceptance among ordinary people, it must be explained that you are not paying an energy tax (expressed in kWh) but for the load you impose on the network. We must transition to customers paying for the power they have the right to draw. If you want to draw more, you pay an additional fee for it. This is something we did in the agriculture sector 100 years ago. Farms had an ammeter that showed the maximum they had drawn from the power grid so that farmers wouldn't run milk and threshing machines simultaneously. Payment was based on the maximum power drawn. In this way, people learned that it was profitable to spread farm work and energy consumption throughout the day and night. Participant A believes it is essential to make changes in the fee structure (avgiftsregiment), moving towards capacity and energy payment instead of energy payment alone in the future energy system. This will likely cost the business sector some money since they have highly fluctuating electricity consumption, often using a lot of energy in shorter periods. In a somewhat exaggerated sense, it is the small consumers who are paying for this today. It's all about energy policy and business policy and how one chooses to handle it.

Participant C (DTU) also highlights the existing energy taxes and grid tariffs as a problem in the green transition. The energy taxes are constant, slightly below 1 Danish Krone. Constant energy taxes do not encourage flexible electricity usage. The current energy tax system does not facilitate flexible use of various energy sources because the energy taxes do not distinguish between "green" and "black" electricity. In this case, the incentive is entirely lost. Participant C suggests that the energy taxes should be redesigned to be low when the electricity is green and the alternative is to turn off wind turbines, and vice versa, high when the electricity is black. This could be implemented tomorrow; we know how to do it. This proposal would also be well received by actors like Greenpower Denmark. They prefer to have the energy taxes removed entirely, but Participant C believes they should be retained when the electricity is black and lowered when it's green. This way, people can be encouraged to charge their cars when the energy is green. The current energy taxes were designed 35 years ago to be energy-efficient and solely aimed at reducing energy consumption. Today's situation is different. In addition to being energy-efficient, we also need to become more energy-flexible. There is an interplay between electricity, district heating, etc. that needs to be considered. The tariffs face a similar problem. Participant C believes there are several opportunities, but they are tied to the existing regulations, including CO_2 quotas and certificates, especially when burning waste. In this context, it is the district heating customers who pay for the CO_2 emissions, and one can discuss whether it should be those getting rid of household waste who should pay for its disposal, or a more equitable sharing. It is crucial for a country like Denmark to have the flexibility that large and well-managed district heating systems provide. And not only use district heating but also cooling. Policymakers need to consider these various energy forms together to achieve optimal synergy.

Participant B (HTF) agrees with Participant C (DTU) and adds that politicians must make it attractive for large companies to invest in programs like Neogrid, for example. Neogrid is a machine learning program that familiarizes itself with the building and knows when the building needs heat. We have what we call morning load, meaning the demand for energy increases in the morning. If we can shift it, we can adjust the temperature in our network and the demand on VEKS, thus spending significantly less on transporting energy. Perhaps even smoothing it out. If we can achieve that, we can go a long way, Participant C believes. The (energy) taxes inhibit innovation rather than promote it.

Participant C (DTU) complements Participant B (HTF) and adds that we can also use the district heating network because there is a large district heating capacity. This is what we are looking into in the ELEXIA project. In district heating, night reduction is of little help. Ideally, one would like to avoid gymnastics in the network because temperature variations affect the lifespan of the district heating network. It should be calm and peaceful. If we are to lower the temperature (in the electricity network?) at night as Participant B (HTF) suggests, we must do it wisely and in advance. In some cases, there can be a twelve-hour delay from where the heat is produced to when it reaches the end-user. In Høje-Taastrup, which is more compact, perhaps four hours is more common. Time delay must be taken into account for sensible night reduction.

The actors from the Users – Administration group received a slightly more consumer-oriented question under Theme 2: "As part of the project, we will investigate introducing hourly prices for district heating, in the same style as the variable electricity prices. How do you think it will affect your consumption?"

Participant D (CEIS) believes it is somewhat easier to incorporate flexibility in heat supply than in power supply because it is a bit easier to heat buildings. A building like the Town Hall in Høje-Taastrup municipality can be heated in the middle of the night, in the afternoon, or in the morning. And the heat can last for a long time. However, Participant D is unsure whether hourly prices for district heating will change CEIS's consumption. Their control is designed so that they can use heat when it is cheap. In that case, a good system would have to be created. Currently, they have a system that can turn on the heat when it is cold, but the system does not indicate when the heat is cheap. Participant D adds that new and modern buildings like the Town Hall can tolerate temperature regulation throughout the day, while an old school would not tolerate turning off the heat during the day. Participant D highlights the limitation of not being able to control one's own building according to needs and not being able to choose specific rooms/areas to heat as two possible constraints.

Participant F (MindFuture) also believes that the hourly rate will not dictate the operations in his building. He anticipates that they won't schedule or alter meeting times, etc., even with the introduction of hourly prices for district heating. For instance, there must be heat accessible in the event of an investor meeting or board meeting taking place in the evening.

Participant E (Driftsbyen) suggests that larger radiators or similar could be installed in the relevant premises that need heat outside regular opening hours.

Both Participant F (MindFuture) and Participant D (CEIS) like the idea of radiators that can be turned on in the evening/night. Participant D envisions that this could be relevant, for example, in the Town Hall, where it takes a long time to heat up after night reduction.

Participant E (Driftsbyen) highlights another potential weakness with hourly-based district heating prices: the large amount of energy required to restart the system after it has been shut down (night reduction).

Participant D (CEIS) envisions that everyone will want heat simultaneously in the morning after night reduction, creating a huge peak in demand early every day.

In Theme 2, the Users_Rådhus group were asked the question: "As part of the project, we will investigate introducing hourly prices for district heating, this could perhaps mean that it would be cold (19 degrees) in the morning when you arrive but get warmer during the day. What do you think about that?"

Participant I seek some clarification about the question. Are we talking about whether what is best in terms of energy might outweigh comfort and indoor climate? The moderator clarifies that the question revolves around the idea that green transition could also be a matter of comfort. In practice, it could involve raising and lowering the temperature at different times of the day, and it might be a bit colder when you arrive at work in the morning. Then, the temperature gradually rises to the set temperature.

Participant H (Business Manager) believes it depends on how long the heating time is. There's a difference between having to sit in 19 degrees for one hour or four hours. If you know this happens every day, you will dress accordingly, if it remains constant.

Participant J (Energy Manager) thinks we must accept that we just have to dress for this in the future, if we know about it in advance.

Theme 3: A sustainable energy system

Theme 3 was not considered as relevant for the provider group in the Danish pilot. However, questions related to sustainability were posed to the two user groups. The group "Users – Administration" received the questions: "What opportunities and limitations will a green heating sector give you as building managers?" and "How can other sustainability initiatives influence the choice of technical systems in your buildings?"

Participant D (CEIS) highlights the opportunity to improve their CO_2 footprint.

Participant F (MindFuture) also believes it could help them meet the (climate) goals for 2030 or 2050. He mentions limitations in their own system due to the facility not being entirely CO_2-neutral. The system is not bad, but there is room for improvement. On a positive note, he thinks new rules or methods can bring businesses closer to zero emissions, making it more attractive.

Participant E (Driftsbyen) mentiones "commissioning" (Norsk: innregulering) as a major challenge due to difficulties in ensuring proper regulation from the start. Another challenge is constant changes in usage patterns, such as removing radiators (?), posing integration challenges they struggle with.

Participant D (CEIS) envisions another potential challenge. It could be that, as the district heating operators lower the temperature in the district heating system, we will encounter issues elsewhere in the system due to e.g., lack large enough heat emitters. In the old schools there are small radiators that have the potential of becoming 85 degrees Celsius hot, and now they are only 70 degrees Celsius. This can result in being unable to properly heat the building. One should always be aware that the external actions taken may impact existing buildings differently. In a building like this (Town Hall), they use more cooling than heating. However, to achieve zero emissions, they must have a CO_2-neutral district heating supply. They cannot use heat, and they cannot produce it themselves. If they want to achieve zero emissions, the supply must be...

Participant E (Driftsbyen) suggests solar panels as an option to supply energy to the building.

Participant F (MindFuture) believes it would require a considerable number of solar panels, referencing a costly solar project they invested where at least the electricity prices did not balance to zero. Participant F suggests solutions, such as placing a cooling machine on the roof, but doubted there was a strong enough reason to install solar panels solely for that purpose. However, he acknowledges that certain locations, like Driftsbyen, could benefit significantly from solar panels. They already have solar panels in their swimming pools and some schools, providing positive impacts on their operations and budget.

Participant D (CEIS) and Participant E (Driftsbyen) points out obstacles in current legislation preventing them from installing new solar panels, especially for municipal entities subject to special rules in the municipality.

Both Participant D (CEIS) and Participant F (MindFuture) express interest in district cooling for their operations, with CEIS currently having district cooling in the Town Hall.

Participant E (Driftbyen) highlights "Køringshuset" (should it be "Læringshuset"?) where they have been involved in solar and district cooling.

Participant D (CEIS) believes the challenge often lies in control (management) and how to distribute district heating among their buildings. In schools (old buildings with old systems), they often leave the heat on all the time because the buildings lack control solutions and data monitors (actuators and sensors). At the Town Hall, there are slightly better opportunities to control where and when they want heat. In schools, they have tried alternative solutions like room sensors to understand where it works well, where it works poorly, and how much they can lower the temperature without making the outermost part too cold. It should be warm enough all the way to the end, and there should be plenty. They lack this type of information in schools. The input they receive today is very unregulated, subjective, and incomplete. Participant D wishes for more control and monitoring options to manage schools better.

Participant E (Driftbyen) concludes with the saying "We are only as strong as the weakest link."

The second question about whether sustainability initiatives influence the choice of technical systems in their buildings caused some confusion in the group. The moderator used keywords from the interview guide to get them on the right track, such as replacing a gas boiler with district heating, waste sorting and management that can take up space from other technical systems (conflict points between different considerations), or whether they are limited by governance actors.

Participant D (CEIS) mentions the keywords price and architecture/aesthetics. If you want the building to be very energy efficient, you usually do more with the cost of construction than with its operation. Often when we build, we want to build it cheap, and then we leave the management to the operation, which is covered by another budget. Another thing is that architects are not so thrilled when people (developers, the municipality, etc.) come and say that we need 1.60 meters above the roof for ventilation ducts. Technical installations take up space. People are often indifferent to technical installations if things work as they should, and it is cheap when you build it. It should work, but ideally, you shouldn't see it.

Participant E (Driftbyen) mentions an example from a building in France where they have included technical installations in the architecture. (Power House in Trondheim is another example suggested by Entra. It is not necessarily the case that architects oppose this, as Participant D assumes. Some have embraced it as an opportunity). So, it is possible to include technical installations in architecture if you're willing, but it requires some effort.

Participant F (MindFuture) mentions that they have spent money on solar panels and installed temperature-reducing UV film on most windows in meeting rooms facing the sun. Their building has a heat pump that can provide free heating in individual rooms, based on the power coming from the solar panels. Participant F believes that district heating cannot compete in this aspect at all. With a heat pump, there is an installation cost, and then the solar panels do the rest. Participant F therefore thinks that (individual) heat pumps can be a direct competitor to district heating. In places where this can be installed, you can almost generate heat for free. However, he is unsure about what is cheaper, the electricity bill, or district heating.

Participant D (CEIS) adds that they would like access to the potential for district heating, but this is something they must pay for today.

Participant E (Driftbyen) points out that in Høje-Taastrup municipality, they have made it easy to use district heating. In municipalities that are more supplied with gas (e.g., Holbæk municipality), they may not have started their district heating project yet. As district heating gradually spreads to other municipalities, Participant E thinks it will cost more for individual actors in these municipalities in terms of entry fees.

Participant F (MindFuture) sees electricity as a competitor to district heating and maybe even a better investment. In general, there will be a greater need for power in the future. He further explains that electricity will have a significant post on their budget in the coming years.

Participant E (Driftbyen) mentions that in their building, they have a much larger electricity bill compared to district heating. Partly also because they have a ventilation system and a cooling machine that uses a lot of electricity.

Participant D (CEIS) mentions that here at the Town Hall, they use much more on cooling than heating, and much more electricity than heating.

Participant E (Driftbyen) cites the unfortunate idle loss1 (Norsk: tomgangstap) as a problem, and it is growing because er have more and more sensors that provide us with a lot of good information but also draw a lot of power. We have not found any good solutions to this yet.

Participant D (CEIS) follows up with the keyword area efficiency. He believes there is a lot to save on building a few fewer square meters.

Participant F (MindFuture) highlights waste sorting, which is mandatory today. This is something that costs and takes up space. But he has never experienced that waste sorting becomes more expensive than the electricity bill.

Under theme 3, Users_Townhall received the question: "A green transformation of the heating sector, where oil and gas are taken out of the supply, can also mean short periods without heat. How do you relate to that?"

Participant I (Building case manager) thinks that this could be problematic concerning the building's health. If you cool down walls, etc., in the building, interior condensation may occur, leading to mould and poor indoor climate. This is an issue that needs attention.

Participant J (Energy manager) agrees with Participant I that the building's condition and humidity must be considered. He adds that newer buildings are much better at retaining heat. It can be incredibly difficult to get rid of heat in the new buildings here. However, turning off the heat for an hour in an old building like Borgerskolen would make it cold. He concludes that short periods without heat could work at the Town Hall.

Participant H (Business manager) believes information is the keyword here. As an employee, you can live with many things if you are informed about what is happening. It is essential to provide good information that employees can relate to and understand.

Participant J or Participant I (uncertain) suggest notifying employees in the morning if there are any changes/problems in the system so they can address it before leaving home.

Theme 4: Regulation

Under Theme 4, the provider group was asked the question: "What barriers and challenges do you experience standing in the way of smart district heating systems today?"

Participant A (VEKS) views the price ceiling on surplus heat as unnecessary regulation and a significant barrier to delivering smart district heating systems. This new regulation was politically decided to protect district heating consumers against overpricing, defining a price ceiling for excess heat. This regulation hinders many new projects utilizing surplus heat from, for example, data centres and other businesses. What makes it even worse is that this is a retroactive agreement. So, starting from January 1, 2024, it also applies to already concluded agreements. This means that there might be agreements made under reasonable conditions, but after January 1, 2024, if the agreed settlement price is higher than the defined price ceiling, the district heating company cannot include the additional costs in the heating price. VEKS previously argued that if there were to be a price ceiling, it was not in the interest of district heating companies that it would be too low because it would prevent sensible projects. This regulation prevents them from utilizing local resources. Instead, they must create a system where they have to produce heat more expensively or draw on resources such as biomass or green electricity. Even though electricity is green from wind or solar, it should not be used more than necessary. What is not used by us, could be used by our neighbours.

There is currently a strong political debate about a possible removal of the price ceiling on excess heat.

Participant C (DTU) thinks there is a lot of regulation. If legislation is created that considers the electricity sector, the district heating sector, and the gas sector separately, it will not become optimal. Unfortunately, this is where we are today. Participant C says he had a meeting with Microsoft, which is building a large data centre nearby and would like to contribute to the green transition by delivering cooling heat to the district heating system. This faces resistance in the regulations. Similar examples can be found elsewhere in Denmark. The oil refinery Crossbridge Energy A/S, for example, cannot deliver surplus heat to the cities of Frederica and Kolding due to the current rules. Instead, the refinery releases the heat into the air.

Participant C (DTU) highlights building regulations, which he believes favour heat pumps over district heating. When you want to place heat pumps, you can do quite a lot architecturally. But if you want district heating, there are many more obstacles. Additionally, there are some rules about energy sharing with neighbouring buildings that make it very difficult to get permission today. Energy sharing between buildings is something we should have more of. Participant C mentions having solar panels on his own roof. In the summer, he could have supplied 4-5 of his neighbours, theoretically, but most of the solar energy was instead wasted. He is afraid that there are lobby organizations fighting to keep energy within their own domain and not contribute to promoting sector coupling. Participant C believes it is important that we understand the significant role district heating must play, at least in our latitudes, where it can be windy for a day or two and then calm for a few days. District heating plants have accumulator tanks to provide flexibility that matches this variation. Electrical systems cannot do this at all, not even battery systems, Participant C claims.

Participant B (HTF) recalls that they have previously been affected by potential energy recovery from Kohberg, something tax legislation prevented them from having to pay tax on gas. This meant that HTF could not take surplus heat because it was created on a tax basis. Fortunately, this is supposed to be phased out now.

The moderator follows up with another question, asking about the political actions necessary for their business to become part of a flexible and integrated district heating system.

Participant A (VEKS) believes that the challenge with new technologies is that today's regime around pricing states that only the necessary costs should be included in a district heating price. This is fine if you pour gas, oil, wood pellets, or straw into a boiler, and something comes out the other end. But when we investigate a future where we get, for example, carbon capture (CC) that generates surplus heat, it becomes challenging to define the necessary costs to utilize surplus heat in a CC process. It will become even more complicated to define "necessary costs" in real terms when we start utilizing excess heat from PtX processes. Here, politicians might choose to impose a price ceiling, which can mean that projects are not realized. It will be necessary that the politicians provide leeway for a commercial/market-led negotiation.

The moderator wonders if Participant A sees anything that could argue against more market-driven negotiations.

Participant A (VEKS) responds that there may be many (small) district heating companies that, competence-wise, are not able to handle such a task themselves. Danish District Heating Association is currently trying to build up expertise as an industry and as an organization, which its members can benefit from. Participant A believes that organizationally in the Danish District Heating sector, closer collaboration between district heating companies needs to be established to reach a critical mass. Often, a certain volume is needed to keep up with everything that is happening. The large district heating companies have been good at establishing networks where they can help each other and share good and bad experiences. So, there are some organizational challenges in the sector, but nothing that is insurmountable, according to Participant A. The first step is to acknowledge them. Then we are already well on our way to the solution.

Participant B (HTF) believes politicians need to become better at understanding what district heating can do. He thinks many politicians become paralyzed, because, from the outside, it can seem very technically heavy. More knowledge is needed about the potential in being able to utilize the water that is already pumped around and using it as a buffer. Or go even further and get a thermal storage, and even build it on a larger scale than we have done in VEKS. We must start thinking outside the box, and politicians must allow district heating companies to think (act) more freely. Many politicians advocate for being more sustainable, but it's just talk, it's not put into action.

Participant C (DTU) adds that when they think about sector coupling at Christiansborg, they think of PTX, which are technologies that will be ready in 10 years. But the larger and well-operated district heating plants are already used to dealing with various sources. They have heat pumps, and they have waste they can burn. There are many ways to produce heat. There are many fuel sources that we can already utilize today. We don't need to wait for PTX. We can be greener now. But there is a problem, who should pay for the CO_2 quotas when burning waste? Is it the district heating customers? Then district heating becomes more expensive. Or is it those who have to dispose of the waste? Participant C himself believes that it is those who have to get rid of the waste who should pay for the

CO_2 they emit. Then the financing of Carbon Capture almost comes by itself. These are large expenses that are shifted onto district heating customers today. In general, Participant C thinks we should pick the low-hanging fruit and prioritize it. Digitalization, district heating, sector coupling, etc., are a big part of it. And biogas! Gas should not be used primarily for heating (district heating can do that), but it can be used in industries that need high temperatures, and maybe in some of the transport.

Participant B (HTF) adds that legislation is moving in the direction that the intention is for fossil fuels, at least gas, to be phased out of private homes and switch to green biogas at the process level. But we must stop this silo thinking. Instead, we should think flexibility and integration between them.

Participant C (DTU) believes politicians lack understanding of integration and should leave it to the industry (expert rule). The real challenge in the green transition is to achieve sufficient flexibility. District heating already delivers a lot in Denmark. We have come a long way, but we must complete what we started! The future energy system can also include green gases, as gas is something we can store seasonally. With an expansion of the thermal storage built in Taastrup, it can begin to resemble seasonal heat storage, but we also need seasonal energy storage. And that can be green gas. Participant C thinks people tend to forget that. Participant C sees no drawbacks in leaving these things to the market. Politicians can then ensure to create taxes, tariffs, and regulations that enable the industry to create efficient sector coupling and reward those who use electricity when it is green and punish those who use electricity when it is black. Then we can really save money. If we get enough flexibility into the system, partly through sector coupling, we could save up to 80% of the need for expanding the power grid in Europe. Plans are being made to invest billions in the power grid, but up to 80% of the many billions can be saved if we make it smart and flexible, including with district heating, sector coupling, and digitalization.

Participant B (HTF) refers to a recent report from NVE in Norway about electrification. Electrification helps reduce some of the electricity costs we all are affected by. The power companies have not been good enough at investing in their power grids and expanding the demand/capacity that, for example, electric cars are starting to demand, plus many are starting to choose heat pumps.

Participant C (DTU) supplements Participant B, saying that when it comes to charging electric cars, there are many subscription solutions that are too dumb. You pay the same regardless of when you decide to charge. Many of us are lazy, so we charge the car when we get home from work at 5 and at the same time start the induction stove. It shouldn't be like that. The design of tariffs should punish those who really want to charge the car while cooking. Those with a lot of money can choose to pay extra for this, and hopefully, it is also these who pay for the expansion of the power grid. Those who want to save a little in daily life can wait until after midnight. (Check with the audio file if this entire statement was said by Participant B. Here, Marie (autotext, and Louise were assigned different names.)

Participant A (VEKS) announces that it will cost money to expand the electricity distribution network, and we must be honest about that. Today, there is often a signal that the green transition must not cost citizens or businesses money. This attitude makes the development of a flexible and integrated energy system very difficult.

The moderator summarizes and says that it seems to be a job to both change behaviour regarding energy consumption and to change the regulations.

Participant B (HTF) believes that there should be a carrot (incentive) to chase if you want to involve citizens. He personally believes that reward is a better motivation than punishment. A few years ago, saving water was on the agenda. People saved for a while, but then we had to increase fees because there was not enough investment for daily operations. So, it must add up, according to Participant B. We have this morning load, peek, and if we had a network that was so flexible that HTF could easily disconnect the house of Mr. and Mrs. Hansen for 45 minutes (because they were not at home), then we would not have to send 80 degrees hot water there. Instead, we can settle for 70 degrees and thus reduce our costs. Everyone would benefit from this.

Participant C (DTU) says that this is what we are looking at in the ELEXIA project. How we can dynamically lower the temperature, with the help of measuring instruments in the pipeline network. He adds that the temperature must be changed slowly to avoid too many gymnastics in the district heating network. We must ensure just enough heat at the right time, but no more.

Theme 5: Flexibility

Under the theme of flexibility, the provider group was asked, "What are the advantages and disadvantages of operating within a flexible (district heating) system?"

Participant A (VEKS) explains that earlier in the day, he made a presentation for some Canadians on the integration between an electricity system and a heating system. He uses Bræstrup District Heating as an example:

> *Bræstrup District Heating have a gas engine, an electric boiler, solar collectors, daily heat storage, and a borehole heat storage about 40 meters below ground. It warms up the soil material. This means that they can operate the district heating system in conjunction with the power system. When the electricity price is high, they produce heat on the gas engine and generate electricity into the grid. If heat production is greater than the heat demand, the heat stays in the daily storage or the large storage. This happens with a high electricity price. When the electricity price is low, they don't produce on the gas engine because they don't get paid for it. Then they produce on the electric boiler. Again, they produce more than they need. They then use the storage. When the sun is shining, they produce heat on the solar collector. That can also be stored. When they want to extract heat from the borehole storage, which is at 40 degrees, they do it when the electricity price is low, as they use the heat pump to raise the temperature from 40 degrees to what is required in the district heating system. They have built this system to provide cheaper heat to customers than it would have been if they only had a gas boiler or a gas engine. Bræstrup District Heating is a district heating company with 1700 customers. So, down to such a small scale, you can work on utilizing the market mechanisms in a power system and a district heating plant.*

Participant A believes that biogas can be used as peak load fuel at times that make sense in relation to the electrical system. But not as a base load. For that, biogas is far too valuable. This means that we can use the infrastructure we already have, from the natural gas network, and not just scrap it. When we use (bio)gas, we can use the excess heat from the gas engine in the district heating system. Then we have not only integration between a power system and a district heating system but between electricity, district heating, and biogas. In this way, one can optimize the efforts of the products one has. VEKS has worked on strategic energy planning, where 33 municipalities succeeded in a common vision, a region succeeded in reaching an agreement with the municipalities, and ten energy companies covering waste, gas, and district heating succeeded in cooperation, even though they are competitors in everyday life. Participant A believes that the reason they have succeeded with this is that they have agreed on a common goal. He sees no disadvantages to operating within a flexible and integrated (district heating) system.

Participant B (HTF) also sees significant advantages in a flexible and integrated energy system. The easiest thing is, of course, to operate it as we always have. But if you have this flexibility, you also can adjust your energy needs and energy consumption and delay the demand. In a large helicopter perspective, if everyone had the opportunity to reduce energy, then there wouldn't be such a large demand. It's like a small snowball you push down a hill, which just gets bigger and bigger. And the snowball is positive in this case. So, flexibility is clearly important, but it requires that you know how to use the flexibility. If there is an opportunity to incorporate some smart learning to let the building get better acquainted with itself, you have a better chance of utilizing the flexibility. Participant B believes that it is the large customers with high energy consumption that will experience the greatest effect. Participant B cannot immediately see any other disadvantages than those related to capital investments, but he believes that in the long run, the advantages will clearly outweigh the disadvantages. Participant C (DTU) believes the major advantage is that we can utilize the entire system more efficiently. District heating plants can operate, understand flexibility, and keep an eye on what's happening. There are also heat accumulator tanks in many places. Here in Høje Taastrup, we also have a steam heat storage, which could possibly become even larger, and which can effectively generate flexibility. Participant C sees no disadvantages at all with operating in a flexible energy system, but he agrees with Participant B (HTF) that there are, of course, some plant investments that are needed. Beyond this, there may be some expenses for digitizing new software for some of the things we create in the ELEXIA project. On the other hand, these tools could really provide intelligent temperature zones and even better estimates (forecast) of heat needs, which is a significant advantage. Participant C explains that they have created a new version of the heat demand for "Varmelast," which is the organization planning production here in Copenhagen, where we reduce uncertainty in their forecast by 40%. This is also something that can be done at the secondary plants, according to Participant C, including on Blancs Rig's transmission system.

The moderator follows up and asks Participant B (HTF) how he assesses his company's ability and motivation to release surplus energy/flexibility to the district heating plant?

Participant B (HTF) replies that their motivation is that they operate a well-run and efficient heating system for the benefit of their customers. Because our customers are our bosses. Our starting point is that we want our customers to be satisfied. Then everyone wins.

Participant C (DTU) adds to Participant B (HTF) and explains that Høje Taastrup District Heating has been nominated for the District Heating Prize 2023 because they serve as a role model. Another very positive aspect of the district heating industry is that district heating companies are not in direct competition with each other. They can invite each other in and say, "hey, come and see what we have done. This is how we failed, and this is how we won." The district heating industry shares knowledge on a completely different level than what Participant C has experienced earlier in his career within other sectors.

Moderator follows up with a question, asking what is more important, indoor climate or flexibility in the district heating system?

Participant B (HTF) believes these two are interconnected.

Participant C (DTU) agrees that it is connected. Improved control of indoor climate helps us gain flexibility in the game. And we have fewer people dissatisfied with the indoor climate. Then we can also better utilize the thermal mass and flexibility of the building from district heating.

Participant A (VEKS) explains that he must be able to deliver the comfort inside homes that customers expect. He believes customers are less concerned with how heat is produced than with its availability. If he can also say that the heat that comes is a result of different sectors working together and that it is as green as it can be, they become even more satisfied with the comfort they have. Regarding the price, we must not always think that everything should be cheap. The price should be acceptable in relation to what you get for your money. Participant A concludes with a comparison of biomass and electricity:

> *When we look at biomass, historically, it has been relatively cheap. There was a price increase last year when we experienced a general scarcity of resources for heating (gas/oil prices). The price also rose due to the war in Ukraine because biomass raw materials from Belarus and Russia could not be obtained. Since then, the price has remained at a certain level. Biomass will be attractive and demanded by other sectors in the future, which have a willingness to pay higher than what we have with the quantities we use today. Then there will be a decrease in the consumption of biomass controlled by the price, but also politically, one wants to avoid burning too much. When we look at electricity, it is considerably more complicated. Today, we see large fluctuations in electricity prices*

> *when the wind blows and the sun shines. But with the ambitions to electrify society, and with the enormous amounts of electricity that must be used to produce these green fuels in PtX production, PtX is only economically attractive if there is cheap electricity. And cheap electricity is typically a sign that there is no balance between production and consumption. So, at some point, we reach the point where no one is interested in building more wind turbines because they get too few operating hours. And that means the market has an interest in getting as high a price as possible for what you produce. So much of what we are looking at today only fits together if there is access to unimaginable amounts of cheap electricity. And I don't think a market alone can solve it because that's not how a market usually behaves. So, if you want large amounts of cheap electricity to be available, it is necessary for states to step in and ensure that there is excess capacity, because in reality, you don't have cheap electricity.*

Participant A believes that sometimes it is more important for us to put a cheese bell over Denmark and not think about the big picture. What is happening in Denmark is suboptimization for our own satisfaction. But it is not something that helps the world on the large scale. For example, it is decided that we should market the waste sector to force some plants to close because we do not want to burn so much waste and emit CO_2 on our accounts. The fact that the waste then lies and emits methane in England, Scotland, etc., where we import it from today, is not considered our problem.

Participants in the focus group "Users_Administration" were also asked the question "What do you think is most important? Indoor climate (user experience of indoor climate) or the flexibility of the district heating system?" during theme 5.

Participant F (MindFuture) states that the most important aspect is always the user experience from their perspective. For example, if there is a meeting between a start-up company and investors, they must be able to trust that the temperature and indoor climate are satisfactory. It should be a seamless experience to be in the building and work there. He emphasizes the significance of low sick leave in their work environment. It is crucial to retain people, especially in their innovative start-up industry.

Participant D (CEIS) agrees with Participant F (MindFuture) and asserts that their main responsibility is to provide good indoor climate. They need to do it as cost-effectively or efficiently as possible and address other needs afterward. Their primary role is to ensure a good indoor climate. Participant D adds that they also need to follow the political guidelines given, such as the requirement for 19 degrees in public buildings when it was mandated.

The moderator follows up with the question: "If you imagine some digital solutions where both buildings and users can communicate with the district heating system. What value would that have for you as a building manager and the users of your buildings?"

Participant D (CEIS) wonders if the question only pertains to district heating. The moderator responds yes, stating that it is the district heating case we are working on in this project.

Participant F (MindFuture) believes that users of their building are not concerned with or interested in being able to regulate temperature/indoor climate themselves. He also doesn't think this would be smart, necessarily. Participant F believes users are indifferent to whether it's a heat pump or district heating. What users in their buildings are concerned about is electricity and how much they have to pay to charge their cars.

Participant D (CEIS) believes many people don't care about remote controls. It is also challenging to manage buildings if everyone presses different buttons. He thinks some self-regulation could be possible (and positive) because those residing/working in the buildings feel they can accomplish something on their own. But mainly, he believes users are indifferent if there is warmth.

Participant E (Driftsbyen) shares an experience he encountered some time ago where the heat was on at one end of the classroom and off at the other. In addition, the window was open. This shows that one should not leave these things solely to users.

Participant D (CEIS) mentions that the temperatures (here in the Town Hall) are suspiciously similar. There is a distinction between people feeling cold and the actual temperature being cold. It's not the same. Some may find it cold at 22 degrees, but that's within the accepted temperature range according to national regulations.

Participant F (MindFuture) says that they have around 150 employees in their building. On average, perhaps four people comment that it's too cold. These are mostly the same people, often women.

Participant D (CEIS) believes we must accept that a small group will never be satisfied. You will never satisfy the last eight percent. But if only eight percent are not entirely satisfied, you have done a good job, he adds.

Participant F (MindFuture) agrees. He sets the average temperature in his building at 23 degrees. He finds it quite incredible that people can notice the difference between 23.3 degrees and 24 degrees. But they can. He emphasizes again that it is often women who complain/comment on the temperature.

Participant E (Driftsbyen) is more uncertain and emphasizes that there is a significant difference in perceived comfort among people. He is one of those who gets easily cold and prefers a lot of heat.

Participant D (CEIS) believes that's why you need professional operational management because people cannot manage this themselves. They would never agree.

Participant F (MindFuture) is curious about how long it would take to change the temperature if, for example, a woman wanted 26 degrees in the meeting room, and the next man wanted 19 degrees. How long would the meeting room have to be closed in that case? Participant F adds that this would not happen in their case.

Participant D (CEIS) mentions that sometimes they must remove the functions for self-regulation because people ruin them. For example, if a person comes in the morning and turns up the underfloor heating to 25 degrees, and two hours later, another person comes and turns it off completely. That's not how it should work. People press the button if there's a button. He adds that operations also have the option to set a limit on the radiators (sensor control) so that it does not increase the temperature by more than three degrees even if the user requests five.

Participant F (MindFuture) says their radiators are also sensor-controlled, but individual users have no opportunity for self-regulation. There is a thermostat with a network cable.

Under Theme 5, the Users_Town Hall received an introductory question: "What do you think is most important? Comfort or green heat? (Comfort before CO_2 emissions)."

Participant J (Energy Manager) believes that green transition must come first, and the rest must be solved from there. However, he thinks there is a limit for everyone. No one wants to sit and work in 15 degrees. People must comply with the working environment conditions set by the authorities.

Participant H (Business Director) does not want to push it so far that it compromises the productivity of the employees or that everyone starts working from home. Then we would lose the social aspect. Participant H envisions an unfortunate scenario where everyone sits at home heating their houses to 22 degrees. Then you have 500 households at 22 degrees and a cold Town Hall where no one wants to be. Participant H adds that this is one of the most difficult questions she has been asked.

Participant I (Building Inspector) expresses uncertainty about the overall impact of these considerations. He questions whether adjusting comfort levels might lead to a reduction in productivity, especially when compared to the significance it holds in the context of energy savings. He wonders if this is the appropriate place to implement such cutbacks. While he acknowledges the potential impact on a national scale, as seen during last year's energy crisis, where decisions were made at the authority level, he doesn't believe that implementing such measures in a single building would have a significant effect.

Participant G (Economic Case Officer) believes that comfort is the most important. She wants it to be comfortable to come to work. While environmental concerns are important, if all her colleagues are wearing thermal underwear and find it freezing, it's not worth it.

Finally, the participants in this focus group were asked the question: "Imagine a heating solution here at the town hall, where both building, and users can communicate with the heating system. What value would it have for you as users of the building? Positive/negative."

Participant H (Business Director) thinks this would lead to “neighbour conflicts” and that it wouldn't be possible.

Participant J (Energy Manager) thinks it might be relevant in individual offices but not in large open office spaces.

Participant H (Business Director) agrees that it might be relevant to allow users to regulate the temperature in small rooms, for example, inside meeting rooms. That would be welcome.

It is noted that the meeting room at the Town Hall where they are sitting is already starting to feel stuffy.

Theme 6: The technology development process

The last theme, 6, was not prioritized during any of the Danish interviews. The topic of technology development will instead be addressed in the follow-up survey.

Theme 7: Open question

Finally, the participants are asked if there is anything they would like to add that they haven't had the opportunity to talk about yet? Perhaps some thoughts or ideas they got during the conversation?

This question was only given to the two User groups because they still had a few minutes available before the time was up.

Users_Administration had these closing comments:

Participant F (MindFuture) thinks it's cool to see collaboration between private and public sectors again. He would like to see more of that in the future.

Participant D (CEIS) emphasizes the need for increased communication, especially among municipalities. There's a significant lack of sharing experiences regarding what works and what doesn't. This leads to each municipality crafting its individual test manuals, overlooking the potential efficiency of having a unified manual. The same pattern repeats in developing control systems, where a tendency to innovate persists despite the fundamental similarities in requirements. Consistency, rather than constant reinvention, is crucial for effective heating systems, Participant D claims.

Participant E (Dridtbyen) recalls that in the old days, in the HVAC industry, you created standards like e.g., BBS, and described how such a standard should be and sent it out. In the HVAC childhood, they were a bit smarter. Much of this has disappeared now, unfortunately.

Users_Town Hall had these closing comments:

Participant I (Building Inspector) poses the question: What can the building do for the environment? Sunscreen is hopeless because it causes overheating in some places, which then requires increasing ventilation. This applies especially to large areas with glass surfaces. What can be done about it? Is the current solution optimal? This is worth looking into. The small practical things where you challenge the system. Is it appropriate for small rooms to become so hot that you must use energy to change the air to make it possible to stay there? We must ask ourselves: What can the building do to avoid using unnecessary resources?

Participant J (Energy Manager) thinks self-regulation in meeting rooms is a fun idea. However, user control in larger areas should not be allowed.

Participant H (Business Director) repeats that information is essential. We can live with a lot if we are well informed.

Appendix 2: Interview Outline – Pilot Dokken – Users

Stakeholder Subgroup: Real Estate Actors

Participants: Sammen, Bara, Obos, Entra, UiB Eiendom, GC Rieber, Bonava, Statsbygg and Norconsult

Theme 1: The energy system of the future

Context:

Society's energy needs are increasing, and a steadily increasing demand for renewable/emission-free energy production is expected in the future. In parallel with meeting challenges related to meeting an increasing energy demand using various forms of renewable energy, efforts are also being made to find solutions that can increase energy efficiency and flexibility in the energy system. Sector coupling is an opportunity to decarbonize certain sectors such as transport and heating. By integrating various renewable energy carriers such as hydropower, wind power, district heating and solar power into a common energy system, one can extract unredeemed flexibility in connection with supply and demand of electricity and reduce peak demands, resulting in lower investment costs and lower energy prices.

Question:

What does an ideal smart (flexible and integrated) energy system look like for you as builders or building owners in the real estate industry?

Participant A (Sammen) highlights flexibility as the most important aspect in the future energy system and emphasizes that switching based on price and energy source should happen automatically without the need for constant intervention from the operational side. Users must have accessible tools that allow them to assess the cost-benefit value. In principle, an ideal energy system can be compared to today's Fiber network: First, the infrastructure must be in place, then, users can choose their suppliers (in this case: energy type) themselves. It would ideal, but someone must take responsibility if energy is to become a service at Dokken.

Participant B (Bara) explains that price is their primary concern and how well the system is set up for buying and selling. He envisions a hub/central on the technical side, consisting of heat pumps and a battery bank. Solar panels require space and must be installed on the building.

Participant C (Obos) believes that the first step is to clarify the delivery aspect. In other words, who will provide what in such a system? How will it be financed, and when will the financing take place? What is the operational model? To have an integrated energy system, everything needs to be interconnected right from the beginning, starting with the area planning and infrastructure. Participant C agrees with Participant A (Sammen) that having a hub/central to enable switching between different systems would be beneficial, thus avoiding a proprietary system that all buildings or facilities must have. He believes that flexibility is important, but so is predictability. He supports Participant A's (Sammen) proposal to consider energy as a service, but to achieve this, there needs to be predictability. That means when you purchase a service, you should know what you are ordering. If you know what you need, you can get a price for it. If you need more power/energy than planned, you will have to pay more for the extra consumption.

Participant D (Entra) explains that one of Entra's strategies is to think in terms of "clusters" when developing areas. Previously, they used to think more on a "building by building" basis. With a cluster strategy, they can benefit from synergies in terms of energy, operations, and management. The challenge with the cluster concept is that the property industry is divided into separate companies per building, each with its own organizational number and limited company (AS). This has created challenges when it comes to sharing electrical energy. In practice, it is difficult to share electrical energy between properties, even if they are owned by the same entity. With thermal energy (such as water-based cooling/heating), there are no such issues, as the sharing threshold is much higher. Participant Dmentions that they have several buildings and projects with thermal energy where they have a common energy centre serving multiple buildings. However, the situation is different with projects involving electrical energy:

> *When it comes to electrical energy, if, for example, we produce energy in one building and want to share it with a neighbouring building that is also owned by us, it is not straightforward in terms of laws and regulations. You actually need a license to be able to do such things. You need to report what you will be producing the day before. If, for example, you do not use that electricity for the neighbouring building, you may have to sell it back to the grid. The regulations in this area are quite outdated. They need to be renewed and adapted to facilitate the development of this sector going forward. The current regulations were primarily designed for hydropower and the building up of infrastructure 50-60 years ago. This is perhaps one of the biggest challenges I have seen in the development of these types of concepts within the building industry in recent years. Participant D*

Participant E (Entra) also mentions that the ideal scenario for Entra is to be able to share and utilize synergies between buildings. They aim to design central facilities where they can utilize excess heat from cooling production in one building for heating or pre-heating in another building. Additionally, they want to use integrated facade elements for electrical production, such as solar panels or other technologies. The goal is to fully integrate any applicable features into the building structure. For example, instead of using conventional materials for roofs or walls, they can utilize solar panels as part of the outer shell. They can also leverage the foundation pearls to extract or dissipate heat into the loose soil beneath the building. In this way, they can avoid wasting heat from the rooftops, Participant E explains.

Participant F (UiB Eiendom) says that they focus on having redundancy in their energy supply and prefer multiple available energy sources for both economic and practical reasons. In the area near Nygårdshøyden Nord, which borders Dokken, they have a diverse energy system that includes solar energy, free cooling, a heat network based on seawater, district heating, and electricity. The proximity to Puddefjorden (explain: an inlet or fjord in the central part of the city of Bergen) provides access to a valuable energy reservoir. The availability of water at a consistent temperature throughout the year makes it suitable for both heating and cooling purposes. The geographical location is favourable for solar power, including solar panels and solar collectors. In summary, Participant F envisions an ideal energy system consisting of multiple independent systems packaged together, allowing for the selection of one or more energy sources based on availability or specific needs.

> *In the facility we have down at Dokken and Nygårdshøyden Nord, we extract seawater from a common intake line near Eviny Termo. During the summer, we use this water for free cooling, which means we simply pass it through an exchanger and let it circulate around Nygårdshøyden. This allows us to avoid using cooling machines in the individual buildings connected to the system. In the winter, we have two large heat pumps located in the Law Building (University of Bergen) that raise the temperature of the seawater to 15-25 degrees Celsius, which is then distributed through the same network. In the associated buildings, there are secondary heat pumps that further raise the temperature to the desired building temperature. Together, we estimate that this system generates around 30 gigawatt-hours of energy annually. Currently, we are in the process of building a similar facility for Nygårdshøyden South, but this time we have scaled it up and are constructing a larger and more robust system that can simultaneously provide both heating and cooling. When it comes to electricity, which we use, among other things, to operate heat pumps and cooling machines, and also to some extent electric boilers, we do not participate in the spot market, but instead engage in financial contracts. This means that we are not very exposed to daily fluctuations in energy prices, and for us, only district heating has any significant price movement over a daily and short-term basis, so district heating is largely considered as peak load, top load, and backup. We prioritize using other*

energy sources because, in terms of cost, district heating is many, many times more expensive than, for example, self-generated energy. Participant F

Participant F (UiB Eiendom) explains that there have been significant advancements in energy systems and building infrastructure over the past 10-20 years. There is now a clear distinction between heating, cooling, and electricity needs, and a cooling water system with district heating is used in Bergen Municipality. He mentions that UiB Eiendom has a cooling water system in a large portion of their buildings and use almost 100 percent district heating for traditional heating needs. This is a system that offers great flexibility. UiB's electricity consumption is partially covered by solar panels, but there are limitations. Even if they cover an entire roof with solar panels, it may only meet about 15-20 percent of their electricity consumption. Testing of battery systems has not been successful so far because it was connected to a poor system, but it may be a possibility in the future to manage energy peaks. In that case, it is necessary to determine the appropriate use of space and money for the battery system, he adds. The ideal energy system, in his opinion, is one that distinguishes between different needs while avoiding overly complex solutions. Smarter control of systems within the building and thorough planning of infrastructure above and below ground are crucial to implement. Participant F notes that their buildings are well-insulated and have good UV values for windows and roofs. He believes that the focus should be on how to efficiently manage energy going forward, rather than solely focusing on the building's physical aspects.

Participant G (GC Rieber) suggests that we don't get too caught up in the idea of integrated energy systems and how it will be "the solution to" achieving lower consumption. He still believes that the focus to efficiently reduce and manage consumption should be on a building-level approach According to Participant G, there can often be challenges when systems become too integrated, such as transferring excess heat from one building to another. Additionally, such systems tend to become complex and expensive. Participant G finds it important to BREEAM certify[1] each individual building, even though they are involved in area development. He feels that area-level certifications don't quite hit the mark in terms of achieving value.

Participant H (Bonova) believes that the main challenge is to achieve good energy storage systems. Bonova have made some attempts to store energy in concrete and batteries, but the systems are not quite mature yet. One of their experiments involved storing electricity in a fleet of electric cars at Minde, by utilizing the cars' ability to produce power. This would benefit the customers while creating a large battery bank that could be used when needed. Another experiment involved utilizing the heat from a suction system, originally used for heating, by insulating the structure and allowing the heat to radiate out, thus providing passive heating. He adds that this was also approved as heat utilization according to the regulatory plan. Participant G believes that there are often simple solutions that may not necessarily be costly. Furthermore, he mentions the development of transport system infrastructure in Bergen, where Bonova chose to create a culvert to collect waste suction, electricity, geothermal heat, water, and sewage. This was a cost-effective solution (and helped avoid complicated pipe systems). He also talks about how they have used a combination of water-based heating and geothermal heat to heat ventilation air in a building, which has proven to be cost-effective. Currently, they use monoblock technology to save energy and reduce the need for vertical ventilation. Finally, he mentions that they have managed to achieve a heating rating of 30 without making significant insulation adjustments to the building.

Participant I (Statsbygg) express that Statsbygg is generally positive about sector coupling and exchanging energy between different sectors. He highlights that Statsbygg, like others, experiences an increasing energy demand. It is important for them to find good solutions to meet the overall energy needs, especially in the type of building planned at Nye Dokken (Institute of Marine Research[2]). Their buildings (laboratories) require a continuous supply of energy throughout the day and cannot be shut down at night.

Participant K (Norconsult) explains that they have only briefly addressed the topic of connecting their energy systems to the municipality's energy system. Ideally, they would like to be responsible for handling only the peak loads, if the local energy system can manage those peaks, allowing them to focus on the base load. They have already planned to have their own energy production and a separate energy center. However, for integration into a shared energy system, it would be necessary for energy to flow in both directions, he argues. Currently, they have not considered utilizing energy sources that are not self-produced. He specifically refers to the need for cooling and heating.

The moderator follows up and asks if this means that an ideal energy system for Statsbygg is focused on meeting their own needs within their building stock, rather than being closely integrated with the energy system in the surrounding area.

Participant I (Statsbygg) informs that Statsbygg is involved in multiple sectors, and for some of these sectors, it is highly desirable to be able to share energy. In other cases, it may not be as relevant. Currently, Statsbygg does not have a unified strategy for sharing energy across the sectors they operate in.

Participant K (Norconsult) explains that there are special circumstances related to the project they are working on at Dokken (Institute of Marine Research). Since they will be producing tempered seawater and freshwater for a research station focusing on farmed salmon, they need to establish an infrastructure to supply seawater to the building regardless. Therefore, it makes sense to utilize this infrastructure for energy production as well. What is also unique for the Institute of Marine Research is that the energy they will produce is at a very low temperature, which is ideal for heat pumps but not as suitable for district heating. Using district heating in their Dokken project would have resulted in high costs due to the need for high power output. Currently, they have a production capacity of around 4 megawatts from the heat pumps. It would have been very expensive to subscribe to 4 megawatts of district heating, which they occasionally require, even though they rarely operate at such high energy levels. Now, they have not found a favourable way to utilize district heating, except that it might reduce the need for technical space in the building. However, due to the need for low-temperature heat and the infrastructure they need to establish anyway, heat pumps are more suitable for their needs, Participant K concludes.

Theme 2: New business models in the future energy market

Context:

The energy system of the future means that we must rethink market solutions and business models that are able to exploit the flexibility of the energy system. The new energy system also requires the preparation of energy exchange agreements between several actors across sectors and vectors (energy carriers), and to find solutions for how flexibility is to be priced and financed. With many different players in the equation, new business models are needed that promote cooperation and earning opportunities for both small and large players.

Questions:

- **What is important for you as a builder/building owner to be part of this business model? What are your needs?**
- **What factors do you think determine the acceptance of a smart (flexible and integrated) energy system in your industry?**

Participant A (Sammen) emphasizes price as a key word for both questions. Whether it is the price of the services you are purchasing, or the cost you have for receiving the service. Additionally, predictability is important to everyone, such as students, home buyers, and commercial property owners.

Participant C (Obos) thinks most people today would agree that it makes sense to use self-produced energy at the building level. However, even at the district level, it would be a sensible idea to use self-generated electricity, he assumes. If it is also cheaper and more predictable, Participant C believes it is a good way to gain acceptance.

Participant A (Sammen) wonders what consequences self-produced electricity at the district level will have on land costs. Where is the limit for what is included in land costs and what developers have to bear beyond what applies to their own plot?

Participant C (Obos) agrees with Participant A (Sammen) that it is important to know what is included in the investment cost. He also highlights district heating as a potential barrier to acceptance. If you have a local district heating system that follows the global electricity prices, it will not be profitable when electricity prices rise.

Participant A (Sammen) explains that they are meeting with Eviny (Norwegian power company based in Bergen) to discuss this very issue. Sammen is considering disconnecting from district heating in many of their buildings because it is cheaper to use electricity for the students. He explains that Sammen can pre-purchase electricity today at a much lower cost than the spot price for district heating.

Participant C (Obos) explains that local energy centers have to connect to district heating and pay a high price for the peak load. He thinks it is reasonable to have local energy production, but it alone will not be sufficient, as the design criteria should not be based solely on peak demand. Therefore, it needs to be supplemented with district heating. In the case of district heating, it may cost more than if it were the primary source. However, overall, it is likely to be more cost-effective and energy-efficient due to less energy loss during transportation. As an additional comment, he says that Obos has started exploring opportunities for geothermal energy.

Participant B (Bara) explains that Eviny changed their pricing model last fall. Today, the pricing model for district heating is intended to follow electricity prices but stay slightly below them. Last fall, electricity prices skyrocketed, and the fixed price of 59 øre per kWh increased significantly. As a result, this also had significant consequences for the price of district heating as a result of the new pricing model. In practice, several tenants in their buildings received considerably higher bills (both for electric and thermal energy?).

Participant D (Entra) explains that future business models related to energy sharing are an important question they have been working on in the Smart City project in Trondheim[3] over the past years, as well as in a large-scale demonstration[4] project thy did for Enova[5]. This is a difficult and complex topic. There are many restrictions in the current regulations regarding what can be done with energy, and energy sharing is quite complex. The question then is whether property operators like Entra should be responsible for having this know-how and knowledge in relation to their property portfolio. Because it requires a lot of in-house knowledge. Participant D believes the simple answer would be to provide property developers like Entra access to simple systems that manage this. Everyone, small or large property operator in Norway and the world cannot possess this knowledge in-house. Similar to how we have it in our homes, where we pay for grid rent and electricity. We need to be part of a collective settlement. Everyone cannot build their own settlement models because then we would not be able to manage this. Entra has buildings in different cities in Norway. It would be very demanding to have to deal with different markets in our various locations. Participant D further emphasizes the importance of pilot projects and demonstration projects that showcase new technologies and new market and business models surrounding these areas. However, if every small area or city in Norway, or in Europe, tries to develop these things on their own, we won't move forward. He believes that we also need to broaden our perspective and facilitate an environment where it is easy for multiple stakeholders (such as energy and technology actors) to join such projects. We are not there yet today. These actors (Providers) also need to make changes to adapt to the future energy market and explore new business opportunities.

Participant E (Entra) adds to her colleague Participant D's point, stating that the focus should be on achieving these changes on a larger scale rather than individual actors like Entra who want to stay ahead in the game. They have noticed that it is quite challenging to drive these processes on their own. If there are initiatives that need to be implemented on a broader scale beyond specific areas or projects, it may require the establishment of national models. It also needs to be financially feasible for developers to make these investments. Either they should see the value reflected in the building itself or they need to generate income through selling energy and flexibility that benefits the tenants. Lastly, Participant E also emphasizes the need for predictability so that they can factor in these considerations in their calculations and planning.

Participant F (UiB Eiendom) reflects that if we consider Dokken in isolation, it would likely be advantageous for the developer or tenant to deal with a single energy provider. This means that the entity responsible for operating the system has underlying agreements with energy producers, allowing customers and users to have one entity to interact with. This entity would also manage and regulate the facility based on both financial considerations and availability. Participant F believes that it would become very complicated and inefficient if each building or property owner had to regulate and manage these aspects on their own.

Moderator interrupts and mentions two different company models that came up in another focus group. One model involves building owners acquiring shares in a joint venture (cooperative models), while another model involves new actors stepping in to take on the role between building owners and tenants.

Participant F (UiB Eiendom) explains that they have come across both models. If it is under consideration to choose an energy provider for local energy delivery in Bergen, it may be natural to opt for Eviny, but it could also be a private company.

Participant H (Bonava) reiterates that their energy system is based on district heating. The system also incorporates solar solutions and considers supply and flexibility. Additionally, energy storage is important for achieving flexibility and the ability to turn the power on and off as needed. Regarding renewable energy systems, Participant H points out that with wind power, you only get wind power and no other type of energy, and the same goes for solar energy. The challenge lies in harnessing the flexibility of the systems, while the grid supplier (BKK) often does not favour solar energy due to potential issues with grid stability and frequency fluctuations. Participant H believes it is crucial to maximize the use of local energy in the planned energy system.

Participant G (GC Rieber) shares that they have started considering solar power as an option for their energy delivery. They are in contact with providers that offer solar power in exchange for borrowing their tenants. This creates a kind of marketing opportunity for their tenants, he explains. Participant G believes that it is important for business models to be understandable and straightforward. Even grid fees are becoming difficult for ordinary people to comprehend, he says. The most crucial aspect is that the system is fast and reliable because the consequences of errors can be significant. Regarding the second question under Theme 2, which relates to acceptance of a flexible and integrated energy system, Participant G believes that energy delivery must be understandable, efficient, and economically attractive for customers. Energy prices can fluctuate, but if the prices are perceived as relevant and reasonable for customers, acceptance will be higher. Participant G believes it is important to consider the role that the energy provider can play in this project beyond just supplying electricity or district heating. This may include a coordinating role and the ability to ensure affordable prices. He recommends exploring this possibility further, as involving too many actors can lead to confusion and less oversight.

Participant J (Statsbygg) thinks the issue of business models is a significant question but adds that he has not yet been able to find an answer on behalf of the company. In general, Statsbygg manages various buildings with different functions. His opinion is that the new business models must align with the company's needs, the frameworks they have to adhere to, and how they are financed.

Participant K (Norconsult) believes it is interesting to explore business models that involve energy exchange if they can accommodate the unique energy needs of the Institute of Marine Research. They mention district heating as an example, where the Institute may require energy at different times of the year compared to the rest of the area (the Institute will need energy in the summer and cooling in the winter). This means that the infrastructure can be utilized in a more optimal way, such as offering other actors the chance to use the planned seawater pipeline during periods when the Institute itself needs less energy. This allows for a mutual exchange of energy, benefiting both parties. Participant K also believes that this approach can contribute to increased operational reliability because the energy system today is not just about energy production but also about maintaining a reliable energy supply.

Theme 3: A sustainable energy system

Context:

In order to achieve national climate targets and local ambitions for a zero-emission society, the entire energy system (infrastructure, production, distribution, storage and consumption) must become sustainable. This means that all these parts of the energy system must become "cleaner" and more efficient in the future. Many now see local smart (flexible and integrated) energy systems as a way to go to achieve zero-emission societies. In such an energy system, we need renewable energy such as solar energy, hydropower, bioenergy and thermal energy.

Imagine that you are going to build a building/own a building at Dokken that contributes to achieving the zero-emission vision.

Questions:

- **What opportunities and limitations will this give you as a builder/building owner?**
- **How can other sustainability considerations influence the choice of energy concepts in new buildings?**

Participant A (Sammen) believes that the limitations lie in investment levels and costs. Sammen makes decisions based on the framework conditions for a group that is not as resourceful (students). When it comes to opportunities, Sammen has a vision to have four properties in Bergen with self-produced energy by 2030. They believe that an energy-efficient and environmentally friendly building will eventually become a more affordable place to live. They already require fossil-free construction sites, among other things. Sammen aims for the entire process to be emission-free. Participant A adds that they also have a mandate to consider social aspects and make decisions that benefit the students.

Participant B (Bara) points out the dilemma that property companies bear the responsibility for energy efficiency in their buildings on behalf of their tenants. This means that Bara incurs the investment costs, while the tenants enjoy the benefits. However, if they do not prioritize these aspects, it can be difficult to attract tenants in the future. Regardless, the industry is being pushed towards energy efficiency, and it becomes part of the business model to remain competitive. Participant B notices a strong environmental focus among tenants today, with many inquiring about the energy performance of the buildings they lease. A tenant in one of their ongoing projects has challenged them to upgrade the building from energy class B to energy class A in the next phase. The plan is to construct a smart powerhouse that can accommodate various smart functions, including future ones. Consequently, there are significant investments required solely in the preparation in terms of infrastructure. Generally, Participant B mentions that Bara hasn't focused much on solar cells etc., and that they do the energy labelling per building and make decisions based on that.

Participant C (Obos) emphasizes that during the construction phase, they make investments on behalf of future owners. He believes that the company usually manages to recover these investments when selling the apartments by being competitive in the market. He suggests green loans for green energy as part of the new business model. Not only does one get green energy, but they also get a payment method that is lower than a normal loan. He is also concerned about looking at the entire ecosystem: how is the energy produced? How is the energy stored (on a building-by-building basis or collectively)? Can energy be borrowed from each other? If all of this can be integrated, he believes that a lot is achieved on the technical side, but they must be able to develop a business model that is adapted to the new system. In addition to economic and climate considerations, Obos also prioritizes social purchasing power. It is not helpful to build buildings that no one can afford to buy. Obos wants to build for all their members.

Participant A (Sammen) mentions that in some countries, you can get very favorable loans if your property has the right rating. In Norway, we still have very favorable loan conditions, he adds, Participant A believes that this could significantly enhance the environmental focus for large developers.

Participant C (Obos) highlights that current certification systems, like BREEAM certification, only address a small portion of the requirements outlined in the taxonomy. In Norway, there is some flexibility in choosing certification systems. He expresses a desire for an approach similar to the one employed in Sweden with "taxonomy proof", which would encourage more property actors to undertake sustainability initiatives right from the beginning.

Another crucial aspect he emphasizes is material reuse and the notable trade-offs associated with material choices. The selection of materials has a direct impact on the carbon footprint. According to Participant C, this further supports the argument for considering entire areas (the overall CO_2 footprint) rather than solely focusing on individual buildings.

Participant A (Sammen) completely agrees with Participant C (Obos) that we need to consider the overall CO_2 footprint for the entire project. He believes it is about starting to set requirements so that these aspects become a natural part of everyone's approach. He ends by mentioning that in the 80s, buildings were constructed with a projected lifespan of 20-25 years. Nowadays, buildings are designed to last 50 years or more, which means we need to think more long-term. Similarly, it is crucial to take a long-term perspective when developing Dokken.

Participant E (Entra) highlights Brattørkaia in Trondheim as the project that resembles Dokken the most. Brattørkaia is also located by the sea and was previously an industrial area. The ideal solution in both cases would be to design systems based on low-temperature, heat pumps, seawater, and free cooling, Participant E states. Many places in Norway can take advantage of free cooling from the sea for almost the entire year if designed for slightly higher temperatures than what is common in current cooling systems. Participant E encourages long-term thinking, both in terms of energy source choices and local building and facility design. Utilizing waste heat from buildings or designing larger heating and cooling systems provides opportunities to use free cooling or other sustainable processes for most of the year. She is also concerned about thermal energy and identifies district heating as a central issue in this field. This is because tenants usually have to pay for district heating through their energy bills. Participant E points out that their tenants have become quite aware that district heating results in higher energy bills compared to, for example, heat pumps. Therefore, they often argue for heat pumps because they know it often leads to lower operating costs. Regarding the sustainability of district heating, waste incineration is a significant source of district heating in Oslo. It is important to assess whether this results in low or high emissions. Looking ahead and aiming to reduce emissions, they also hope that the sources of district heating will be reduced.

Participant D (Entra) shares that on Brattørkaia, they developed two buildings, BI Trondheim and Powerhouse Brattørkaia, which shared thermal energy, resulting in significant cost reductions. They established a central cooling system for the entire building complex consisting of 6-7 buildings and implemented solar panels on both structures. Subsequently, they received a visit from a Chinese actor who wanted to understand their success with solar energy on buildings. Entra emphasized the importance of considering the overall design and operation rather than just placing solar panels on facades and roofs and thinking the job is done. Participant D believes that one must think about opportunities within the buildings themselves or in areas outside of them. Participant D attributes the success on Brattørkaia to the fact that they not only focused on energy production but also consumption and facilitating energy efficiency. Additionally, collaboration and coordination are crucial. Participant D provides an example of collaboration from the Smart-City project in Trondheim. When the wave machine at Pirbadet (a large bathing facility) in Trondheim activates, they switch off the heat cables on a bridge over the railway. He believes it is wise to address these aspects in the early stages, as partners do in the ELEXIA project. The results on Brattørkaia demonstrate significant energy savings, especially with the BI building which uses one-third of the energy compared to other BI buildings in the country. With new and smart solutions both inside and outside the buildings, Participant D believes that they have managed to push the industry forward. Challenges include the management of energy production and the distribution of costs between buildings. When one building produces energy, how much should the other building pay? The question of whether to become a professional actor like Statkraft or Eviny, invoicing for capacity and energy, or to produce for self-consumption and charge buildings and customers for real costs, remains unresolved.

The moderator wonders if Entra has any reflections on how the zero-emission goal is balanced in relation to other sustainability considerations.

Participant D (Entra) explains that this is something Entra continuously discusses. It encompasses everything from facilitating transportation and access to the location of the buildings. The infrastructure and access to the building and the area are all part of this picture. He once again highlights the similarities between Brattørkaia and Dokken. Both areas are old industrial areas with boats coming in to load and unload. Most of the buildings constructed at Brattørkaia are BREEAM certified[6]. We set these environmental goals early in the project, and they have helped shape and develop the area.

The moderator follows up and asks if Entra frequently encounters conflicts of interest between various sustainability considerations when working on energy concepts in their buildings.

Participant E (Entra) believes that the classic conflict of interest between user control and energy efficiency is no longer as challenging. Their focus on energy efficiency has provided certain guidelines for lease agreements, where tenants have to accept the directives given, such as regulating indoor temperature in accordance with outdoor temperature.

Participant D (Entra) explains that it is in their own financial interest to use as little energy as possible, especially in cases where energy costs are included in the rent. Therefore, Entra focuses on making investments that provide the best solutions. He emphasizes that they do not simply pass the bill onto the end user.

Participant F (UiB Eiendom) initially doesn't see any limitations other than building physics when asked to reflect on the possibilities/limitations that the zero-emission vision presents for them as a developer (question 1). The current challenge lies in the relatively low efficiency of solar cells and the significant space requirements to supply a multi-story building with energy. However, he doesn't see any issues with other energy systems, such as thermal heat pumps, and points out that UiB only uses natural refrigerants in heat pumps and cooling machines. They have tested dozens of systems without any negative experiences. Participant F does express concern about the availability of locally produced electricity and mentions wind turbines as a possible solution, although he acknowledges the challenges of installing large wind turbines in the middle of a city. Small wind turbines would take up space that could be used for solar cells. Regarding possibilities, energy systems, energy consumption, and environmental impact are areas that UiB is highly focused on. The university has significant ambitions in terms of climate neutrality and reducing its footprint both locally and globally.

When it comes to weighing sustainability considerations against each other (question 2), Participant F finds it challenging because each new building has a significant impact on the carbon footprint. He envisions much more focus on renovation rather than new construction in the coming years. They have already tested the renovation of the administration building in Nygårdsgaten 5, and they aim to make extensive use of existing buildings. However, it is important to ensure that the end result is both sustainable, energy-efficient, and provides a good indoor climate.

Bonava mentions Lona Park in Åsane (a district in the north of Bergen) as an example of how sustainability considerations influence their choice of energy concept. Lona Park is a modern housing cooperative consisting of 700 apartments and some retail activities. Bonava developed most of the park. In the area, there are 17 wells that supply the entire park with heat. They have a heat pump system, additional pumps for each section, and dynamic valves.

Participant G (GC Rieber) highlights one of its own cases where they have constructed a building with NollCO_2[3] certification, which is a Swedish certification scheme with a strong focus on climate. To achieve NollCO_2 certification, the entire climate impact of the building throughout its lifecycle needs to be documented and balanced with climate measures to achieve net-zero climate impact. The lifecycle includes production and transport of building components, construction processes, use, and disposal of the building). In GC Rieber's new building, they will compensate for the CO_2 emissions using solar panels. Their plan is to minimize the use of central energy resources, both in terms of physical resources and building management. Participant G believes that while we do many things right in the construction of buildings, we are not as proficient in their operation. Proper operation and use of technology allow us to exploit the potential of the buildings, *he* argues. *He* also brings up the BREEAM certification scheme, which ensures that the most important aspects of sustainability are considered within the nine categories: management, health and indoor environment, energy, transport, water, materials, waste, land use and ecology, and pollution. GC Rieber's focus is primarily on reducing the CO_2 footprint (pollution) as this is something they can directly influence in the building itself. They can make decisions regarding the choice of materials, machinery used, construction period, the longevity of the building, and the flexibility of the building. Other considerations such as site selection and transportation systems are the responsibility of other decision-makers. Participant G concludes with some advice for the Dokken project, emphasizing the importance of local authorities imposing appropriate requirements that align with the context and area. For example, if a seawater solution for cooling is chosen, it is essential that all buildings can adhere to the temperature levels without requiring additional cooling systems. He believes it is crucial for authorities to require minimal consumption and maximum flexible consumption.

Participant H (Bonova) complements Participant G's (GC Rieber) points and highlights that thermally exposed panels can also be used in the building. A masonry building (made of bricks, concrete blocks, or stone) will always be cooler, and that can be leveraged by incorporating thermally exposed panels, they explain. Participant H further informs that 95% of their CO_2 footprint is associated with transportation after the building is completed. In Bonova, they have developed three or four different CO_2 calculations following two different BREEAM standards. Additionally, they have prepared a calculation for the municipality, which is necessary for the construction process. This calculation is significantly influenced by commuting and the indirect footprint from the construction site and materials used. In the chosen Swedish model, which is the fourth method for CO_2 calculation, they can focus more directly on material choices and factors such as replacing concrete with solid wood, or the types of fossil fuels used. He emphasizes the need to appropriate methods (calculations/certifications) to exert influence over factors that are within one's control.

3 More information on NollCO_2 certification can be found here: https://www.sgbc.se/certifiering/nollco2/vad-ar-nollco2/

Participant I (Statsbygg) explains that they currently have an energy concept that is based on buildings in isolation (building by building). He emphasizes the need for a secure energy supply, especially considering that they are an atypical actor at Dokken (Institute of Marine Research) with a high energy demand throughout the year. He adds that in their financing model, it is crucial for them to maintain excellent control and effectively manage their own requirements. Moreover, financial factors also come into play when deciding on the energy system, including considerations of district heating versus heat pumps.

Participant I (Statsbygg) affirms that Statsbygg, as an organization, is dedicated to achieving sustainability goals and is actively adapting its behaviour and strategy to align with these objectives. However, implementing such measures, which are planned at Dokken, will entail financial considerations. Currently, Statsbygg is unable to propose any specific measures as they are still in the preliminary project phase. However, it may become relevant in the future as they progress towards the implementation stage, he adds.

Participant K (Norconsult) expresses that it would have been easier to follow regulations or standards if they were to establish a residential building, commercial building, or school at Dokken. By adopting a passive house or positive energy house approach, for example, they could have guided their ambitions based on these regulations. However, when it comes to the specific building at Dokken (Institute of Marine Research), the participant believes they need to develop their own environmental plan. This is because they want to be both ambitious and up to date when it comes to environmental issues. At the same time, they want to avoid incorporating regulations or guidelines that may be counterproductive. They do not want to invest more in energy-efficient solutions than the potential energy savings will justify. The building at Dokken has energy-intensive processes, such as pumping seawater, which may not necessarily be influenced by regulations. Therefore, the participant is concerned with identifying which opportunities to implement in the project and which ones to reject. The goal is to have a concept that has ambitious future-oriented energy goals and realistic energy savings. This will make the building perceived as innovative in terms of energy and environment when it is completed. At the same time, it will be financially beneficial for the Institute of Marine Research by saving a significant amount of energy and investing in the right areas to reduce operating costs.

Theme 4: Regulation

Context:

For us to succeed in developing smart (integrated and flexible) energy systems that are also sustainable, it is essential that existing legislation can be adapted to the new reality. This may entail new environmental requirements, labelling, regulations, and tariffs on the part of the authorities that make it easier to make environmentally friendly choices.

Questions:

- **What barriers and challenges do you experience stand in the way of a smart energy system today?**
- **What kind of political action is needed for you as a building owner/builder to want to become part of a flexible and integrated energy system?**

Participant A (Sammen) believes that the government needs to intervene and provide increased subsidy limits for the student welfare organizations. This was proposed in last year's national budget but was removed by the then Minister of Research and Higher Education, Ola Borten Moe. Instead of increasing the subsidy, he chose to raise the cap from 1 million to 1.4 million, which effectively resulted in higher rent for the students. The student welfare organizations have a societal task and a strong desire to build environmentally friendly (and already do so as much as possible), but they often face obstacles due to small political measures that have not yet been implemented. At the local level, Sverre believes that the student welfare organizations need to have a separate purpose clause in the municipal plan, which would make it easier to build student housing. Currently, he experiences obstacles from all directions. They must go through the political process and persuade them to override building regulations in order to be allowed to construct. This is very cumbersome, and could be resolved with a separate purpose clause, he claims.

Participant B (Bara) states that for them, it is about incentives and economics. Developers must bear the costs of building smart and energy-efficient, but they receive little return. In the Netherlands, it is no longer allowed to rent out a building that does not have a good enough energy rating. Denmark is also moving towards implementing this. If one has a low energy rating for a building, the authorities will say that one cannot rent it out until the owner has made necessary improvements. Entra is willing to do this, but are there any support programs they can apply for? Furthermore, Participant B raises concerns about the SIMIEN model[7] used as a common standard in Norway for energy calculations of residential and commercial buildings. His experience is that there is often a significant difference between the actual energy consumption and what the SIMIEN calculation predicts the building should use. As an example, he highlights that one of their oldest buildings has an energy calculation of 500,000 kWh per year, but the actual consumption last year was 140,000 kWh.

Participant C (Obos) also raises the issue of incentives. If there were no guidelines, many developers would choose to install their own separate energy systems in the buildings and focus on individual energy production to meet the certification requirements. However, from a collective perspective, each building should not have its own energy system when connecting to district heating or the power grid. But in that case, they may not have the usual incentives to ensure the system works effectively. Therefore, incentive schemes are needed that apply to the entire area, and multiple actors should be able to be part of the "stakeholding" in the collective energy system, he urges. Participant C brings up a concrete idea to establish an agreement with tenants on the allowed amount of electricity usage. If they use less, it can result in incentive rewards. Conversely, if they exceed the agreed amount, they will have to pay additional charges for the electricity. This approach could be feasible with a local energy system, such as the one planned for Dokken, and it ties into the earlier mentioned need for predictability.

The moderator asks Participant D to elaborate a bit more on the barriers and challenges related to the mentioned environmental requirements, certifications, regulations, tariffs, and political actions that he thinks should be in place, prioritized, or given increased attention in this landscape.

Participant D (Entra) explains that Entra has been pursuing two parallel paths. One involves engaging with the Norwegian Water Resources and Energy Directorate (NVE/RME), which is the energy authority responsible for enforcing regulations and setting guidelines for the energy industry in Norway on behalf of the government and parliament. The other path involves interacting with the political environment, often in collaboration with other stakeholders. Participant D mentions that several politicians, including former Prime Minister Erna Solberg, have visited Brattørkaia. Entra has sought to highlight the necessary elements and conditions that politicians must establish for us to succeed in the future. Participant D notes that politicians often appear uncertain themselves. This is a challenging topic, and politicians require significant persuasion to become deeply engaged. Regarding enforcement, the responsibility currently lies with the NVE, as well as county municipalities or municipalities that own certain regional energy companies (Bergen Municipality has ownership in both BKK and Eniny). Participant D reflects on the fact that revenues from the conventional energy system serve as a substantial income stream for the public, especially at the local level. This creates a certain level of safeguarding around this source of income.

Participant E (Entra) adds to her colleague's point. Regulation of the Energy Act is one aspect of the issue. Another important aspect is the planning and regulation in areas. Often, planning and building authorities only consider height and width when assessing proposal plans. This can result in other values in projects and applications, such as community engagement or area development, not always being adequately evaluated. Municipal zoning plans may not always consider energy supply to areas or look at larger infrastructure challenges. The treatment of properties often happens in isolation, where visual and architectural factors become decisive for the success or rejection of applications.

Participant D (Entra) believes that it is crucial to increase the level of competence among politicians, identify passionate individuals who are dedicated to these issues, and put pressure on decision-makers. Politicians rarely speak up about matters they are uncertain about. He explains that Entra has worked extensively on this competence development and has made significant progress, particularly by engaging in dialogue with municipalities and explaining their objectives for projects and areas they work in. He stresses the importance of fostering understanding among the authorities responsible for handling these matters and ensure they have a mandate to act. He adds that the last 3-4 years have been marked by changes, especially at NVE. It is now easier to communicate with them than it was 3-5 years ago.

Participant E (Entra) believes that NVE now understands that local solutions must be part of the overall solution and that they now look at energy supply and particularly peak loads differently than before. She points out that there is an acknowledgment that expanding the grid extensively is not feasible. However, there is still a substantial advocacy for grid expansion and energy legislation in general. Participant E believes it is essential to recognize that municipalities should also assume more responsibility for infrastructure development, not just at the national level. She concludes by emphasizing that their specialized buildings require specific considerations in regulations and other areas to promote the advancement of new solutions. To achieve this, they need the support of the authorities.

Participant F (UiB Eiendom) believes that the biggest barrier to flexible and integrated energy systems is the current energy law, which makes it difficult for multiple independent building owners to collaborate on energy supply. The constitutional obligation on energy supply further complicates the situation, and there is a lack of facilitation in both legislation and regulations for local energy production. He believes that working with public authorities can be challenging when trying something new. There are many obstacles along the way, including long waiting queues for applications. He believes there is a need for streamlining the application processes and more support, rather than obstacles, from public agencies.

> *Is it difficult today for a single actor to establish a local energy grid that can supply an entire area. Therefore, there is a need for simplified application processes and preferably more assistance rather than obstacles from public actors. Participant F*

When it comes to incentives for building owners or developers who want to participate, he believes that using the stick approach is more effective than the carrot approach in this case. When developing an entire area, it is important that everyone is on the same page and works together instead of making individual decisions based on personal desires and positions.

Participant G (GC Rieber) explains that it can often take seven years to regulate an area and 10-20 years to develop it. During this seven-year period, many things can change. Therefore, it is crucial that the requirements and frameworks developed stand the test of time. Participant G emphasizes the importance of ensuring that regulatory plans do not hinder good (energy) solutions. Regarding the regulation of the energy market, he presents several specific proposals. It is crucial to minimize the obstacles faced by grid companies in order for them to facilitate new sharing solutions and charge for them. Furthermore, there should be a thorough examination of building regulations concerning solar panels, as many rejections based on aesthetics seem arbitrary. Participant G believes these requirements should be relaxed. He also highlights the potential barriers posed by new regulations regarding district heating. In summary, Participant G emphasizes that regulations present both limitations and opportunities. It is important for municipalities to incentivize and support developers' inclination towards innovation rather than impeding them. Support schemes and reducing bureaucratic barriers play a significant role in achieving this goal.

Participant H (Bonava) agrees with Participant G (GC Rieber) that regulations can impose significant limitations on good and forward-thinking ideas, thereby impacting the implementation of projects.

The moderator concludes (after listening to Bonava) that it may be better to regulate the intention rather than the solution.

Participant K (Norconsult) believes that the biggest barrier lies in having a rigid system where tariffs for energy and capacity are set independently of which actor buys the energy. He believes that if each actor is considered in relation to the surroundings and nearby buildings, there may be an opportunity to find optimal energy exchange solutions that work for everyone. However, this can be a barrier if not handled correctly, he adds. Participant K is concerned that the surroundings, whether internally in Statsbygg, by the municipality or other public actors, or by the state itself, set constraints on their project regarding an energy concept that does not serve them well. For example, if there were an obligation to connect to cooling and heating, and the conditions for delivery were the same for all actors at Dokken, it would not serve them well.

Participant J (Statsbygg) points out that concession conditions can also lead to negative consequences. He brings up a specific example from Trondheim where issues related to pricing and determining the right temperature to achieve energy efficiency arose. Furthermore, he emphasizes that even though it may be ideal to use energy during summer when there is surplus, it would not be economically beneficial if the price remains the same as regular electricity. *Participant* J highlights regulations as crucial factors in achieving a favourable mechanism where energy can be utilized at a reasonable price when others do not have a demand for it.

Participant I (Statsbygg) adds that Statsbygg has initiated an innovation project where sustainability is one of the main motivations. He believes that it could be an idea to establish collaboration (with the Dokken pilot) in this regard.

Participant J (Statsbygg) reflects on the system boundaries for energy sharing and wonders if it could be relevant to share energy and models with two or more actors in proximity. He envisions situations where it would be beneficial to exchange energy with a neighbour. In such cases, a local solution that is not necessarily connected to the larger system could be advantageous. He highlights a specific example from Drammen where this approach has been successful.

Theme 5: Flexibility

Context:

A flexible energy system can be crucial for the transition to a zero-emission society. Utilizing the flexibility of the energy system can be a more profitable and efficient way of dealing with power peaks in the infrastructure instead of developing new infrastructure (Enova). Flexibility can be achieved through interaction between energy forms and actors, but also through the development of new technological solutions that make it possible to exploit consumption and storage flexibility in the energy system. The ELEXIA project aims to exploit the opportunity for better interaction between energy forms and new digital solutions aimed at achieving smart, safe, resilient, and cyber-secure energy systems.

Part 1: We start by taking a closer look at the interaction between different forms of energy and actors

Context:

At Dokken, the goal is to develop an integrated and flexible energy system right from the start of the development phase. Here it will be possible for more players to not only consume energy, but also become producers of energy by installing, for example, solar cells on their own roof. Any surplus energy can be sold into the market or stored locally.

Imagine that you as a builder/building owner will become an active part of an integrated and flexible energy system where you both produce and consume energy according to your needs and ability.

Questions:

- **What will this entail in terms of advantages and disadvantages for you as a builder?**
- **How do you assess your own/the company's ability and motivation to produce and release surplus energy, and possibly contribute solutions that can provide flexibility to the system (locally at Dokken/central parts of the city centre, etc.)? (This may entail the installation of technical solutions such as solar cells/solar collectors/district heating/battery storage, or it may also apply, for example, to entering into agreements that can ensure flexibility in the local system).**
- **What limitations do you have as a flexible energy player or energy consumer? (Example: Change of usage pattern, switching to other times of the day when electricity prices are lower, or infrastructure capacity (grid) is better).**

Participant A (Sammen) highlights the concept of flexible energy and the possibility of having a shared accumulator tank to handle peak loads over a larger area (e.g., at Dokken). In certain situations, they have tenants who consume a significant amount of hot water during specific periods, such as in student housing. Instead of every individual building having their own accumulator tanks, hot tap water could be integrated into a flexible model that multiple actors can benefit from.

Participant C (Obos) and Participant B (Bara) agree that there are many opportunities for collaboration, including within infrastructure. Participant C exemplifies that commercial buildings require cooling while residential buildings require heating. In this scenario, business parks and residential blocks could establish a win-win collaboration. (Participant A (Sammen) adds that this becomes even more feasible if district heating starts to adjust its tariffs).

Participant B (Bara) believes it is wise to think long-term and invest in infrastructure that others can connect to later. There are significant opportunities for collaboration and potential cost savings in doing so.

Participant D (Entra) once again refers to Brattørkaia as an example. Entra has 6-7 buildings in this area, which is like Dokken, albeit slightly smaller in scale. In Brattørkaia, there are two buildings with good solar exposure, and Entra has identified other buildings with suitable rooftops for solar installations. Additionally, they are planning to renovate the facade of one building. In this context, they need to consider whether they should install as much solar capacity as possible for their own consumption or whether they should also install solar to share with others. Currently, it is not economically viable for Entra to install solar for sharing purposes because they face charges for both purchased electricity and self-produced electricity. There are challenges in sharing energy between different organizational entities. So, the question is, what would it take for Entra to invest a significant amount of money in establishing solar energy? Participant D says that they could seek financial support from Enova, but he feels there is a lack of incentives for why they should undertake these initiatives. Ultimately, it is the end-user who pays the energy bills regardless, and they may not be willing to make the investment in solar power generation on their rooftops or facades. Participant D believes that it should be obvious that all new buildings have energy production as part of their solutions. He closes by providing a concrete example of a dilemma they faced in one of their projects in Trondheim:

> *In one of our projects in Trondheim, we installed contactors to utilize surplus heat during the summer. The idea was to use this heat in buildings when it was available and save money by reducing the need for other forms of energy. However, we encountered issues with pricing and finding the*

> *right temperature to achieve energy efficiency. Additionally, while it may be ideal to use surplus energy during the summer when it is available, it would not be economically advantageous if the price remains the same as regular electricity. Regulatory factors like these are crucial in achieving a favorable mechanism where energy can be used at a reasonable price when others do not have a demand for it. Participant D*

The moderator follows up and wonders if they have looked at establishing a battery park to be able to tap at peaks or at high prices, and if they see any dilemmas with regard to battery life and the capacity and limitation and land use that will be required in such a solution.

Participant D (Entra) mentions several factors, including fire safety and design considerations related to battery placement. In many industries like shipping and offshore, there are strict regulations in place. For buildings, it falls under building regulations, although it is not extensively regulated. He mentions that they conducted two or three risk assessments for the placement of batteries, and it turned out that they ended up placing them outside the building in a container between the buildings.

Participant E (Entra) shares some reflections on flexibility and its limitations. She mentions being approached by various initiatives interested in testing different solutions for selling power capacity. However, in well-optimized and well-managed buildings, such as Brattørkaia, there are limitations in extracting a large amount of power. This is because trading power capacity can potentially affect the comfort of tenants since the system is already optimized to operate when needed. The buildings already have demand-controlled ventilation and water systems in place. While batteries are a solution, as mentioned by Participant D, long-term storage is challenging, especially with large batteries required to utilize summer production from solar panels when demand is low. Therefore, their flexibility is limited by the presence of tenants, and their desire to expand operating hours for alternative uses outside of office hours also faces limitations.

Participant F (UiB Eiendom) reflects on the challenges of buying and selling energy between different actors. He argues that the simplest approach is to retain a central owner who is responsible for both energy production and storage. Furthermore, he points out that the concept is not "rocket science" and already exists in the form of technologies that have been in use for many years, such as thermal storage using surplus heat from the sun and phase change tanks. Participant F suggests battery storage as a possibility, especially for balancing the load on the power grid by charging batteries at night and using them in the morning when demand is high. He sees no reason why the proposed solutions in the given context could not be implemented, but he emphasizes the importance of having a system that takes responsibility for the entire area rather than many small, separate parts. Participant F also points out the challenges associated with the space requirements for storage (both thermal and electrical), especially in relation to the private sector, which may be reluctant to allocate large areas for buffer tanks and batteries due to future property and square meter prices. He emphasizes the importance of planning and constructing a central network for the entire area from the beginning, which makes it easier to manage later. A small property developer engaged in building rentals does not possess the operational expertise required to maintain such facilities. It requires expertise from both users and property developers if one intends to manage all of this independently. Therefore, he specifically proposes the establishment of a connecting actor, such as "Dokken Energy Service," which would handle both thermal and electrical production, storage, and distribution.

Participant H (Bovava) emphasizes once again that storage is a central concept to achieve flexibility and utilization of energy peaks from solar and wind. One way is to utilize battery capacity, as already mentioned. Another way could be to create wells for storing heat in the ground, where heat is injected during the summer and extracted during the winter. He stresses that if you want flexibility in the system, you need the ability to store energy.

Participant G (GC Rieber) believes that the advantage of something like this when purchasing a plot of land is that the developer feels they are part of something new and innovative, having a stake in the future. However, the downside is that energy is just a small part of the bigger picture and a small portion of the total cost when constructing a building. So, the question is how much internal capacity should be used to adapt to something whose price and outcome are uncertain. Regarding the second question, Participant G believes that GC Rieber has both the ability and motivation to produce energy. However, he admits that they do not spend much time internally on this aspect of their business because energy, as mentioned, is only a small part of what needs to function. What has been important for them so far is that the systems work and that the prices are reasonable. He further explains that it can be challenging to anticipate future developments, such as storage technology. They have, for example, tested the use of used car batteries in "Skipet," where Eviny and BKK are located. Their idea was to be somewhat ahead of the curve and utilize used car batteries that still have some remaining lifespan for stationary purposes but not for mobile use. However, the question arises as to whether it is beneficial for each building to have its own battery system or if there should be a shared facility where multiple buildings can be managed together. If so, should another entity take on this role, and how should costs be distributed among the actors? Participant G believes these are important questions to delve into. He also points out that during the planning phase of the new Dokken, the municipality has a great chance to make important advancements that would enhance flexibility in the project. Lastly, he raises concerns about cybersecurity. With the introduction of numerous new systems that lead property operators towards web-based solutions, there is a risk of losing control. The old systems were typically physically located in the building and easier to control. Participant G suggests that thorough risk assessments should be conducted regarding cybersecurity and data flow.

Participant K (Norconsult) discusses the possibility of solar energy and power exchange in the new building, Institute of Marine Research, in Dokken. They have emphasized maximizing the use of solar energy and believe that the building will largely benefit from this energy source internally. Therefore, power exchange is considered less relevant in their case. However, the participant highlights the need for a water-based energy production system that can have available capacity during periods of low demand. *He sees potential for exchanging heat and cool with the district heating system, as well as the opportunity for direct cooling using cold seawater.* He thinks it could be interesting to exchange energy with other actors on Dokken, particularly through direct cooling in ventilation systems.

Part 2: We go further and look at flexibility in the sense of developing digital solutions that exploit the flexibility of the energy system

Context:

In the ELEXIA project, three different systems for planning and operation of the future energy system will be developed. These consist of a "System Planning Toolbox" to support efficient sector coupling in three selected pilots, an "Energy Management System" for flexible, cost-optimized operation of sector-connected pilots, and a "Digital Service Platform" to facilitate energy management and planning. In addition, the project aims to include/demonstrate a "user in the loop" experience (e.g. CLIMIFY) in one or more public buildings so that also users will have the opportunity to influence the indoor environment and the energy system from a user perspective. In practice, this may mean that a building owner will have the opportunity to "live"-monitor energy consumption, temperature, and indoor environment in a unit in their building. A resident/employee, on the other hand, will have the opportunity to adjust their indoor climate, within certain limits. A feedback app will enable both building owners and users to give their subjective feedback on the indoor environment.

Imagine that you as a client must facilitate such digital solutions to make it possible for both buildings and users to communicate with the energy system.

Questions:

- **What positive/negative effect can this have for the building owner and for the users in "your" buildings?**

- **What considerations do you think it is important to take into account in the development of these digital solutions in order for building owners and users to get the most out of such solutions?**

In the focus group, consisting of Participant A, Participant C, and Participant B, the participants believe that the things mentioned in the context description are already readily available off the shelf.

Participant A (Sammen) highlights a student project in another Norwegian city where residents receive individually produced small tablets with traffic light indicators (green, red, or yellow) that show the amount of energy they have consumed. The students' consumption is measured in terms of tap water, electricity, hot water, and cold water. This approach allows students to develop a better understanding of their own energy usage and empowers them to influence their consumption habits. Furthermore, the best collective effort is rewarded. It is important to create tools, meters, tablets, or similar devices with standard APIs so that the interfaces are accessible regardless of the platform they are connected to.

Moderator follows up with a question and asks if the other participants in the focus group have similar flexible "user-in-the-loop" solutions in their buildings where users can, for example, adjust and provide feedback on the perceived indoor climate, etc.

Participant B (Bara) explains that they do have such systems in place, and tenants make use of these possibilities regularly. Tenants can adjust within a certain temperature range, time, and area. He mentions that in open office landscapes with predominantly sedentary work, there is a considerable variation in how people perceive indoor temperature and climate. He shares an example from a company working on indoor climate at Fantoft. The operator had initially designed the indoor temperature to be ideal at 21-21.5 degrees, but they ended up setting the temperature at 22.5 degrees to accommodate 90-95% of the users.

Moderator wonders if Obos, as a company that constructs and sells homes, includes this type of communication in their buildings today or if it is something they need to discuss in relation to energy usage, etc., in the complexes they sell.

Participant C (Obos) is unsure if this has been discussed within his company. He reiterates the importance of predictability, that is, knowing how much energy is expected to be used and having mechanisms in place for that. Additionally, he emphasizes the importance of visualizing the user's progress. With smart measurements, users can learn from their own consumption patterns and figure out why they are using more or less electricity this month compared to the previous month or the same period last year. It also enables them to compare different zones and assess local differences.

Participant B (Bara) shares a project where they measure the energy consumption of each individual space, per tenant. They compare the consumption of each space to the energy class of the building and compare it tenant by tenant. The purpose of the project is to encourage tenants with high energy usage to reduce their consumption. Sometimes, the explanation for higher usage can be attributed to having more employees in one space compared to a neighbouring space, for example. In such cases, the differences in energy consumption have a natural explanation.

Participant A (Sammen) believes that the most crucial aspect is being able to measure all energy carriers and segment them down to each rental area. He considers "shared measurement" between buildings and dividing it by area to be problematic. It is difficult to communicate this to tenants and get their acceptance. He also suggests installing loggers to measure water usage. Water costs have become a significant topic in Norway recently.

Moderator steers the conversation towards technical possibilities and sensor technology. She asks each participant to share their thoughts on what they believe is important in the development of such solutions to maximize their benefits. (Input for Climify)

Participant C (Obos) believes that what we are currently discussing might not be the most significant factor. According to him, the most impactful aspect in terms of flexibility is how we utilize spaces (space efficiency), both in residential and commercial buildings. Can we manage with smaller areas? He believes that certain premises, such as spatial utilization, need to be established before delving into "user-in-the-loop" discussions regarding energy solutions. Questions regarding the level of flexibility in office and commercial buildings, how we construct residential buildings, opportunities for shared spaces/common areas, and the intended usage and expected activities during daytime and evenings need to be addressed first. These are the essential considerations that lead to significant outcomes. Participant C brings attention to a significant problem in the current system, which is the measurement of energy and parking spaces per square meter. The problem arises when attractive tenants, who have a low number of employees occupying large areas, result in a surplus of parking spaces and favourable energy measurements due to the lower density. On the other hand, commercial businesses looking to establish themselves as tenants in the city centre of Bergen are required to have 15 square meters per employee. This leads to a limited number of parking spaces and poor energy measurements due to the higher density (more users and computers per square meter). Consequently, there is an increased need for cooling and higher density in the cafeteria, among other issues. To address this problem, Participant C suggests that the focus should shift from measuring per square meter to measuring per person. The issue of parking coverage is currently being intensely debated in the Minde area of Bergen. Obos plans to reduce the number of parking spaces by half and increase the number of people on the same area fourfold. This would result in an 88% reduction in parking spaces, but when considering the measurement per square meter, it is not a significant reduction. Participant C emphasizes the importance of considering the people who will be occupying the area rather than solely relying on square meter measurements.

Participant A (Sammen) highlights the importance of diversity and who gets to live in Dokken. The moderator (BGO) responds that it is not part of the ELEXIA project. Participant C (Obos) disagrees, arguing that living conditions are linked to the energy system. He believes that urban development cannot be separated from energy system planning.

The conversation shifts towards "Proptech" (Property technology) and "Disruptive technologies," including "Airthings" (air and radon monitor) and various technological solutions used to varying degrees in Bergen today. One participant mentions that with sensors and new technology, they have achieved significant changes in energy consumption without complaints from people.

Participant A (Sammen) shares that they often receive complaints from the day-care centres (day-care for students with children), despite having sensors that measure temperature, humidity, and other factors that comply with the regulations for day-care centres. He believes that different personal experiences will always result in some tenant complaints.

Participant B (Bara) adds that by providing individual employees or residents with the opportunity to provide personal feedback, there will be as much different feedback as there are people.

Participant C (Obos) discusses a common complaint raised by their residents regarding the bathrooms. Residents feel that the bathroom floors are cold compared to what they had in their previous detached houses. The difference is that their detached homes had underfloor heating, whereas the new homes they bought have water-based heating. Participant C also addresses the issue of complex technical rooms and systems in modern buildings. He explains that buildings today often rely on various energy sources, such as solar panels, district heating, and other sources. However, these systems can pose challenges for residents when it comes to operating and managing them effectively. In many cases, external assistance may be required to handle the building's operations. The problem arises when multiple technicians are involved, each with their own contracts and responsibilities. As a result, there is a lack of comprehensive understanding of the overall system, which leads to suboptimal performance and increased downtime. To prevent this, it is crucial to consider the management of these systems within the broader context when planning an integrated energy system. By doing so, the maximum potential of the building's energy systems can be realized, ultimately improving its overall performance.

Participant D (Entra) shares some thoughts on the decision to build Powerhouse, Brattørkaia, a net-positive energy building, and how the growing trend of smart technology, apps, digital platforms, and artificial intelligence inspired them to explore how this could contribute to sustainability, user experience, and smart energy management. Entra challenged the industry to come up with innovative solutions for both end-users and energy/environmental considerations. Through the development of their own app and participation in the Cityxchange project, they attempted to integrate the building and systems in smart ways. However, experiences have shown that the integration of different data platforms in different segments has been challenging, with issues related to the quality of collected data and the complexity of interfaces and integrations. Data flow has been one of the significant challenges in the Brattørkaia project.

Participant E (Entra) reflects on user input and its significance. She acknowledges the importance of engaging in dialogue with users while also recognizing the challenges it can create for operations and (increased) energy consumption. She highlights the need to create understanding among users about comfort and the necessary boundaries to maintain low energy consumption in buildings. Participant E emphasizes the challenge of managing individual preferences and experiences, especially when all users want to provide input on the climate experience in an office building.

Moderator adds to Participant E's reflections and mentions CLIMIFY as a collaborative partner in ELEXIA and suggests that it could be interesting to engage in a dialogue with them to learn about the solutions they have developed.

Participant F (UiB Eiendom) explains that UiB has already developed systems for energy management and monitoring. Anyone with a UiB email address can access the system and monitor their own indoor climate if they wish. Users can also adjust, for example, the indoor temperature up by typically two degrees and down by typically two degrees. However, everything else operates automatically, such as the lights turning on and functioning on their own. Steinar mentions that UiB has also tested autonomous buildings where the entire building is demand-driven. It requires nothing from anyone. If no one is present, nothing happens. In two example buildings, in operation since 2016, autonomous operation has reduced energy consumption significantly; Participant F reports that they have no feedback (complains?) and sees no drawback to autonomous systems.

> *I can give you an example from our "climate cluster". The building around Allégaten and Jarlebakken underwent a rehabilitation process in two phases between 2016 and 2020. It is an old building from the 1950s that was completely renovated, including both building components and technical infrastructure. When the first building was completed in 2016, it was already equipped with our latest standards in terms of instrumentation and control capabilities. We then measured the energy consumption for approximately two years before reprogramming and making the building autonomous. The autonomous operation has reduced energy consumption by approximately 14% compared to its initial state, which already represented a significant improvement from most buildings today. So, we achieved a reduction in energy use of about 70% through the rehabilitation process. By reprogramming and making the building smarter, we further reduced it by an additional 14%, building upon the existing infrastructure. The building is connected to Yr (national temperature forecasting), enabling it to prepare if there is a significant temperature change, whether it gets warmer or colder. It measures air quality in all rooms, as well as temperature and lighting. We have had this system in place for five years, and the feedback from users in that building is almost non-existent compared to what we experience in other buildings. We achieve a more stable indoor climate while reducing energy consumption overall. I don't see any negative aspects to this at all. Additionally, we have also made provisions for switching between different types of energy carriers if needed. Participant F*

Moderator wonders if UiB Eiendom has implemented any learning into the system so that it develops on its own without needing someone to identify optimization needs.

Participant F (UiB Eiendom) responds that this is something they are planning to do. They have been collecting logs for many years already, generating several hundred thousand data points per second. The idea is to use machine learning to enable the buildings to control themselves in a better way over time. For this purpose, they have developed their own system based on the top automation system, Niagara[8], created by GK Gruppen[9]. They have an ongoing contract with GK for further development. Participant F clarifies that all the resources involved in their project operate within UiB's premises, following their guidelines. They have personally modelled, configured, and designed the system, integrating it with older and less advanced systems in older buildings. They gather data from various types of systems that deliver data to their central system. Additionally, Hordaland County Municipality has implemented parts of this system as well. The system operates on the principle of demand control. Information is logged in one central location per room, with larger rooms having multiple logging points. This allows for heat and cooling adjustments to be made at the room level. They also customize sun shading based on specific needs, lowering it where necessary. For example, if a room becomes warm due to sunlight, cooling is only provided to that room, without affecting others that do not require it. Cooling is distributed through either the ventilation system or separate cooling units known as cooling baffles in each room. In a typical meeting room, ice water is circulated, and there are active or passive cooling baffles present. This enables localized cooling instead of the entire ventilation system being cooled down.

Participant H (Bonava) explains that he has previously worked in "Futurehomes"[10] and has experience in technology development within the smart home market. He believes that the most important aspect when developing new digital solutions for a flexible and integrated energy system is a good database model where all the data is collected and stored, and that they can be easily retrieved when needed.

Participant G (GC Rieber) shares some insights about their building systems. They still employ some older systems in their buildings, and it is crucial for their central control systems to be based on a specific platform to effectively manage all their properties. They have in-house operations and maintain control over the management, allowing them to swiftly address any tenant dissatisfaction. Participant G highlights that GC Rieber maintains an open channel of communication with tenants so that they can easily reach out to operations in case of complaints. They can make necessary adjustments based on the feedback received. However, Participant G notes that the situation is a bit different for homeowners. Since the company does not have the same level of monitoring for homeowner properties, homeowners usually require the ability to regulate things themselves. Participant G expresses scepticism about allowing others to operate their systems if they were to construct a commercial building today. It would mean losing control over a significant factor that directly impacts customer satisfaction, namely the indoor environment and well-being. The option of having external management would need to be flexible enough to ensure they can regain control if needed. When it comes to sharing building data, Participant G believes it is a less problematic matter. However, he mentions that GC Rieber maintains scepticism towards unfamiliar systems. While the technology may be promising, their past experiences have shown that things do not always work as expected. Therefore, they prefer to stick with systems they are familiar with to avoid potential issues.

Participant I (Statsbygg) acknowledge that the organization has limited experience with this (exchange of energy through digital systems), although they have been involved in projects where there has been a strong focus on this topic. Moreover, they have conducted certain property projects to examine functional areas in buildings and assess their suitability. Participant I believes they are in line with the market when it comes to demand-driven control of buildings and floors based on the number of people present. However, he admits their architectural and logistical framework may not be optimal for this now.

Participant K (Norconsult) believes that creating an accurate energy system is not very expensive or difficult. It's about carefully considering the needs and developing a strategy at the right level.

Participant J (Statsbygg) wonders how it is practically feasible to share energy with other actors. Is this coordinated through the district heating company and a connection point that allows us to receive and sell heat in the same way we do with electricity?

The moderator suggests inviting Statsbygg to a conversation with the infrastructure owners in the Dokken pilot to discuss the possibilities when the new building (Institute of Marine research) is constructed.

Theme 6: Technology development and cooperation

Context:

The ELEXIA project, pilot Dokken, involves collaboration between research actors, public actors (mainly municipalities) and private energy and technology actors who contribute their expertise and perspectives to the development process.

Questions:

- **What advantages and disadvantages do you see in a trilateral collaboration between academia, the public and private sectors for the development of new energy systems?**
- **To what extent and in what way do you as a builder/building owner want to be involved in development processes like this?**

Participant A (Sammen) points out that it can be a challenge for them not to receive VAT refund. This becomes an issue when they need to collaborate with others, and they must find an accounting solution to manage this. He also mentions that they have started inviting neighbors to minimize local traffic when building or renovating student housing, as part of an urban mobility initiative. In response to the final question, he states that Sammen would have liked to be involved in projects like the ELEXIA project. It would have been a valuable learning experience and an opportunity for them to stay ahead of the development, he concludes.

Participant B (Bara) states that their approach is that if they were to enter an ownership role in an integrated energy system at Dokken, they would prefer to purchase the service through a subscription or connection fee. Like how it is today, where you pay a construction contribution to buy into the system and receive energy as a service. However, he is not opposed to contributing something back to the system, such as solar panels.

Participant C (Obos) expresses a positive attitude towards participating and contributing to this type of project. Regarding the development of the energy system at Dokken, he emphasizes the importance of establishing certain organizational aspects first. For instance, it is essential to consider ownership and operation of such a system. Furthermore, he suggests considering "area regulation for energy" when establishing an energy system for an entire area. This would involve conducting hearings and involving stakeholders in the process. He believes that these aspects need to be in place before the area plan is finalized.

Participant D (Entra) reflects on the collaboration between research communities, NTNU, energy suppliers, and end-users in the Brattørkaia project. He observed that the energy suppliers, who primarily provided electricity, district heating, and cooling, had limited knowledge about buildings. Originally, they had the idea of taking full control over the buildings, but the project evolved in a way that led them to send requests to the buildings to reduce power consumption for short periods of time. However, the buildings had top priority when it came to environmental conditions, temperature, and lighting, and the building's system could approve or decline the requests. Participant D highlights the challenge of balancing technical optimizations with the consideration of end-users and their leasing experience, and he suggests that the understanding between all stakeholders may have come a bit late in their project.

Participant E (Entra) highligts their involvement with Enova, who is one of the tenants in the new Powerhouse Brattørkaia building. Entra was actively engaged in the dialogue with authorities regarding permits and restrictions during the construction project. She explains that even Enova was surprised by the lack of opportunities for energy sharing and the resistance they faced in conducting tests or demos in an already regulated market. As for energy billing, Entra has entered into agreements, for example, with Rockheim (?), for purchasing electricity through museums in Sør-Trøndelag. Their focus has been on contractual arrangements, procurement, and sales, with the goal of achieving cost advantages and buying electricity from the local energy market. However, Participant E mentions that the administration around these agreements has required significant effort.

Participant F (UiB Eiendom) is highly positive about a three-way collaboration between the public sector, private sector, and academia. He emphasizes the importance of leveraging local expertise from both private actors and the public sector to tackle complex energy-related challenges. Furthermore, he views the university/academia as a valuable contributor to such collaborations. The University of Bergen educates master's students in energy and the environment. He believes UiB would be interested in participating in collaboration initiatives like this, both as a building owner and as a research institution. Participant F also expresses concern about the possibility of individuals acquiring ideas and privatizing them. He emphasizes once again the importance of openness and sharing of knowledge to achieve common goals. It is crucial that ideas and solutions are accessible to all actors, so that they can be used for the benefit of society as a whole. When it comes to involving end-users (in their case, students, and university staff), he believes it is important to give them some leeway, but he doesn't think they need to engage too much with the systems. If users can make some adjustments to the indoor climate, he thinks most people are reasonably satisfied. UiB follows the labour law, which states that indoor temperature should be between 19 and 26 degrees Celsius. Their experience is that 80 percent of people are satisfied if the temperature is set to 22 degrees, regardless of age and gender. He recognizes the need for a good system that doesn't require unnecessary intervention from end-users and emphasizes the importance of having an open mindset to try new approaches that can contribute to solving energy challenges.

Participant G (GC Rieber) believes that a three-party collaboration is crucial for developing these things because all three parties are dependent on each other. Therefore, he emphasizes the importance of having a shared system in the future that everyone can use. However, when it comes to GC Rieber specifically, they will not be as involved in this in their business (degree/offer?). They also do not have the same expenses as BKK or ??, so they do not have those experiences, he clarifies. (It is difficult to understand what is being said in the recording).

Participant H (Bonava) finds it extremely positive that this has become a collaborative project and that the Dokken pilot is choosing to address these things before developing the area. He emphasizes the importance of recognizing that it is not just a matter of delivering a system, but rather understanding the customers behind the system. It is necessary to listen and understand what is important and what motivates stakeholders to participate in the project. He refers to an example from his own company where they have invested in new software for energy monitoring systems. While the technology itself may be good, it is crucial to have people to set up, follow up, manage the systems, and communicate with customers. He stresses the importance of operation and management, arguing that technology can solve a lot, but replacing the human processes to reduce or maintain energy consumption may not be a good idea. Furthermore, he mentions the ongoing energy discussion, which focuses on increased utilization of hydropower (renewable energy) and more energy efficiency. Participant H highlights the significance of identifying challenges and figure out how to balance the desired (overall) outcome to achieve real results. He is particularly positive about BKK's involvement in this collaborative project because BKK has started thinking differently about business models and focuses on what is good for the customer. "I cheer for you!"

Participant I (Statsbygg) thinks there are many advantages to discussing these important topics and establishing new collaborations. This is one of the reasons why Statsbygg has initiated its ByggBOKS innovation program, specifically to engage with the market in various fields. Statsbygg aims to be at the forefront, and therefore, the participant believes that Statsbygg must be involved in the collaboration at Dokken. He mentions that Statsbygg already has a strong network with academia and private actors in other relevant fields, and he reiterates his desire to connect the ByggBOKS program with the ongoing collaboration at Dokken.

Participant K (Norconsult) also believes that Statsbygg will benefit from engaging in this process because it is in this process that systems, principles, and preconditions for energy exchange and design are formed. If they do not get involved, he thinks there is a risk of decisions being made that are detrimental to the Institute of Marine Research and Statsbygg.

Participant J (Statsbygg) agrees with Participant K (Norconsult) on the claim above.

Theme 7: Open-ended question

- **Anything you would like to add, comment on, etc.?**

Participant D (Entra) expresses enthusiasm for how ELEXIA is already actively facilitating and planning collaboration and strategies for the development of the area in the early stages of the project. He believes that addressing these types of issues that have been discussed today in the early phase is crucial to ensuring a holistic and successful development of the area.

Participant E (Entra) also expresses enthusiasm for the way ELEXIA has chosen to involve stakeholders, facilitate dialogue, and include experts in the early stages of the project to discuss the entire process. A final tip: Participant E believes that several major energy companies today are actively seeking new business models and products, and she thinks it is crucial to engage them early on to ensure they consider the needs of others in addition to their own.

Participant F (UiB Eiendom) finds the concept of an integrated and flexible energy system very interesting and finds it exciting that we are choosing to look at transforming an entire area in this way. He believes that this pilot project will be very positive for the development of Dokken. He points out that most major players have set climate ambitions that they need to fulfil, and therefore, we need pioneers who lead the way. He reflects on the potential for the ELEXIA project to become a star player in this game. A piece of advice he offers is to have an open mind and not be afraid to try new approaches that can contribute to solving energy challenges.

Participant G (GC Rieber) concludes by mentioning that GC Rieber[11]."

Participant H (Bonova) concludes by advising (the Dokken development project) to establish a comprehensive infrastructure plan early in the project to prevent issues later on.

Participant I (Statsbygg) asks for more information about the project that he can share with colleagues in the innovation program "ByggBOKS." Additionally, he raises an aspect that has not been extensively discussed, namely the requirements related to port and harbour functions (shore power, etc.).

Moderator concludes by asking if Statsbygg is interested in participating in an open workshop or similar event to listen to the experiences that have emerged in these interview rounds, especially experiences from actors who work quite specifically with these types of questions that have been discussed today.

Participant I (Statsbygg) responds that they are positive about meeting and discussing further. He also suggests bringing some representatives from their own innovation program "ByggBOKS" when the time comes.

Participant J (Statsbygg) wonders if there is already an established forum that meets regularly to discuss the future energy system at Dokken that they can be a part of, to align their project with what is happening at Dokken in general.

Stakeholder Subgroup: Large-Scale Users

Invited actors: BIR, Bybanen, Eviny Termo (in the role of large-scale consumer), Plug1

Participating actors: BIR, Bybanen, Eviny Termo

BIR, Bybanen, and Eviny Termo all participated in 1-to-1 interviews at Bergen City Hall. They were asked the same questions throughout the interview in their roles as large-scale users/consumers at the new Dokken site. Additionally, Eviny Termo was asked questions in their role as an infrastructure owner and energy provider in the same interview. In this summary, we have tried to extract the most relevant information regarding their role as large-scale users at the new Dokken site, while the answers in their role as infrastructure provider and energy provider is consolidated in Provider summary, Appendix 3.

BIR (Participant A) (Bergen Inter-municipal Waste Disposal Company) is a municipal company owned by 11 municipalities in the Vestland County, including Bergen municipality, which is the majority owner. The company is responsible for waste management and sanitation services in the region. BIR also has a responsibility to inform and motivate residents to participate in waste reduction and recycling. The company operates an incineration plant (Rådalen), ten recycling stations, a paper sorting facility, a landfill for receiving bottom ash/slag from the energy plant, and a central waste collection terminal in downtown Bergen (Jekteviken). As a stakeholder at Dokken, their role as a large-scale energy user in relation to the operation of the waste collection terminal is most relevant for the ELEXIA project.

Bybanen (Participant B) is a light rail transport system in Bergen. Bybanen AS is 100% owned by the Vestland County Municipality and is responsible for the operation and management of infrastructure and rolling stock. Several tasks of the company are subject to competitive tendering in accordance with the Public Procurement Act. Therefore, planning, operation, and maintenance of the light rail system are carried out by multiple organizational units. In connection with the development of Dokken, new tracks are planned to be laid on the outskirts of the area. Our participant works in Bybanen Utvikling, which hands over the operation of Bybanen to Bybanen AS when the facilities are completed.

Eviny Termo (Participant C and Participant D) (in the role of large-scale user when they use the electric boiler for heating). Eviny Termo is a subsidiary of Eviny AS and provides district heating from BIR's waste incineration plant in Rådalen, Bergen. Eviny Termo is owned by Eviny AS (51%) and waste management company BIR AS (49%).

In the following interview outline, the three actors will be referred to as Participant A, Participant B, and Participant C. Their answers are organized under Themes 1 to 6(7). In the case of Eviny Termo, two participants from the company's management were present taking turns in answering questions. Their answers are therefore presented as Participant C and Participant D.

Theme 1: The energy system of the future

Context:

Society's energy needs are increasing, and a steadily increasing demand for renewable/emission-free energy production is expected in the future. In parallel with meeting challenges related to meeting an increasing energy demand using various forms of renewable energy, efforts are also being made to find solutions that can increase energy efficiency and flexibility in the energy system. Sector coupling is an opportunity to decarbonize certain sectors such as transport and heating. By integrating various renewable energy carriers such as hydropower, wind power, district heating and solar power into a common energy system, one can extract unredeemed flexibility in connection with supply and demand of electricity and reduce peak demands, resulting in lower investment costs and lower energy prices.

Question:

What does an ideal smart (flexible and integrated) energy system look like in your industry?

Participant A (BIR) believes that an ideal smart energy system is one that meets their energy supply needs and handles any surplus energy in a way that safeguards their business interests while considering the flexibilities that BIR and other actors in the area may have.

Participant B (Bybanen) takes the opportunity to explain how their energy system currently operates and what their needs are. He mentions that Bybanen is powered by a 750-volt DC (direct current) system. The power is supplied through rectifier stations located along the Bybanen approximately every 2-2.5 km. This supply comes from BKK's high-voltage system, typically an 11-kilovolt system. They are working to ensure that the system has redundancy, with each rectifier station having two supply points from BKK's 11-kilovolt system. The plan is for the light rail to be transferred and operated by Bybanen AS (limited liability company) once the facilities are fully developed. The facilities will be able to operate even if a rectifier station is temporarily out of service, in what is known as an "N-1" situation. Regarding Dokken, Participant B is unsure about the exact placement of a new rectifier station, but it is possible that there will be one on the city side of Dokken. In that case, it would be approximately 2 km from the station that will remain in the city centre. The size of these rectifier stations has typically been around 2 megawatts, or 2000 kilowatts. Participant B does not have precise consumption figures, but the sizing is based on the power they require from BKK's electricity grid.

Participants C (Eviny Termo) and D (Eviny Termo) engage in a general discussion about an ideal flexible and integrated energy system at Dokken when responding to this question. Further information on Eviny Termo's response can be found in the Provider summary, Appendix 3.

Theme 2: New business models in the future energy market

Context:

The energy system of the future means that we must rethink market solutions and business models that are able to exploit the flexibility of the energy system. The new energy system also requires the preparation of energy exchange agreements between several actors across sectors and vectors (energy carriers), and to find solutions for how flexibility is to be priced and financed. With many different actors in the equation, new business models are needed that promote cooperation and earning opportunities for both small and large actors.

Questions:

- **What is important to you as a professional/large scale user that is part of this business model? What are the needs of your systems and business?**
- **What needs, advantages and disadvantages, opportunities and barriers do you think will affect the process of developing new business models?**

Participant A (BIR) responds that their terminal at Dokken has a predictable energy demand regulated by the waste disposal patterns of the residents. When the filling level in the waste chute approaches a certain level, the terminal plans for emptying. This emptying process needs to be carried out within a specific timeframe that can communicate with the surroundings. The emptying itself is highly energy intensive. Participant A would therefore like a solution where they can run the facility at the least cost possible, within a defined time window, in coordination with the overall energy needs at Dokken. In response to question three, Participant A states that BIR needs the lowest possible energy costs and sufficient energy to operate the facility during planned periods. Participant A highlights the advantage of energy demand planning, which provides flexibility for the Dokken area and predictability in terms of costs. The downside is that all actors would desire to use the cheapest energy at the same time.

Participant A also mentions some potential barriers: Who will manage and prioritize available resources? Will a control system be allowed to connect to Eviny's infrastructure? Lastly, Participant A explains that BIR's terminal at Dokken is subject to strict regulations regarding the facade, which may have limiting effects on current regulations of the area. This could pose challenges for the installation of solar panels and the associated battery bank to accommodate greater flexibility in their operations.

Participant B (Bybanen) explains that "Bybanen Development" is responsible for constructing the light rail line. Once the facilities are completed, Bybanen AS takes over. This means that Bybanen AS is responsible for paying the electricity bill when the light rail is in operation, while Bergen Development pays the electricity bill during the construction phase. Both entities are subordinate to Vestland County Municipality. Participant B cannot answer on behalf of Bybanen AS in terms of operational questions, but he mentions that Bybanen Development is exploring the possibilities of electrifying the construction phase to reduce CO_2 emissions. Specifically, they are looking into establishing charging stations for construction machinery adjacent to the rectifier stations that are being installed in the new areas, as the electrical power from BKK needs to be brought to the operational area anyway. If BKK can start the transmission a little earlier, Bybanen Development can utilize these charging stations during the construction phase to charge their construction equipment.

Participant C (Eviny Termo) starts by explaining that they do not consume energy if they have no one to deliver it to. The energy they produce is transformed into new forms of energy. For example, they can use electric boilers to provide peak load as a backup, or they can use heat pumps to produce hot water. Furthermore, he explains that as a large-scale user, their biggest challenge is dealing with peak demands. They have a large 25-megawatt electric boiler on Dokken. Running it for one-hour costs them 600,000 kroner, and they have to pay for the first hour every month. If they run it for the last hour in a month, they can only receive a very small number of kilowatt-hours. The price per kilowatt-hour for this energy is extremely high, he emphasizes. Sometimes, we have negative prices due to an oversupply of power that needs to be disposed of, which is positive for the energy system if someone can take it. The challenge is that the distributor can choose to put a stop to this because it doesn't fit into their business model.

Participant D (Eviny Termo) adds to Participant C's comment and makes the point that it is incredibly important to agree on the big-picture cooperation. He stresses that without this alignment, complex solutions can disrupt at a lower level. For instance, some actors may opt for technical solutions that do not interact with the broader context. Participant D believes it is crucial to consider a more technical business model while also being aware that there are potential factors that can disrupt the grand plans and visions for the Dokken area.

Theme 3: A sustainable energy system

Context:

In order to achieve national climate targets and local ambitions for a zero-emission society, the entire energy system (infrastructure, production, distribution, storage and consumption) must become sustainable. This means that all these parts of the energy system must become "cleaner" and more efficient in the future. Many now see local smart (flexible and integrated) energy systems as a way to to achieve zero-emission societies. In such an energy system, we need renewable energy such as solar energy, hydropower, bioenergy, and thermal energy. In the energy system of the future, it will also be possible for new actors to enter the market on the production side, for example by capturing/producing surplus energy that is sold into the market.

Questions:

- **What opportunities and limitations will this give the business you represent?**

- **How do sustainability considerations affect choices related to design and energy solutions in your business?**

Participant A (BIR) expresses a positive attitude towards considering e.g., solar energy development on their property, but mentions that this is currently heavily regulated through requirements for green spaces. Participant A further explains that sustainability is deeply embedded in BIR's vision and strategy and will always be evaluated in relation to available energy resources.

Participant B (Bybanen) believes that one future scenario could be to harness the energy generated by Bybanen when it is not drawing power from the grid for storage in rectifier stations, as during braking or downhill. The energy stored in the rectifier stations could initially be used to power Bybanen, while any surplus energy could be sold back to the grid to an energy provider. Moreover, B highlights that Bybanen has a strong focus on sustainability goals, which is clearly reflected in their contract with the contractor. They prioritize recycling and environmentally friendly energy, especially when it comes to the use of electric propulsion in their machinery fleet. Participant B informs that they have already started a pilot project to explore the possibilities of electrifying the construction phase in phase five towards Åsane, and they will take these experiences into account if/when they eventually build tracks over Dokken.

Participant D (Eviny Termo) acknowledges the potential benefits brought by a sustainable energy system for their business. However, they do not specifically address the opportunities and limitations related to their role as a large-scale consumer in the future Dokken development. Further information on Eviny Termo's response can be found in the Provider summary, Appendix 3.

Theme 4: Regulation

Context:

In order for us to succeed in developing smart (integrated and flexible) energy systems that are also sustainable, it is essential that existing legislation can be adapted to the new reality. This may entail new environmental requirements, labelling, regulations and tariffs on the part of the authorities that make it easier to make environmentally friendly choices.

Questions:

- **What barriers and challenges do you experience stand in the way of a smart energy system today?**
- **What political action is needed for your business to become part of a flexible and integrated energy system?**

Participant A (BIR) highlights three barriers/challenges that could hinder a future smart energy system: 1) Complexity in prioritizing desired energy needs in relation to available resources. For instance, all those with battery storage or significant energy requirements will seek maximum power utilization when electricity prices are lowest. 2) Energy management will require access to Eviny's infrastructure. Currently, this is governed by legislation for national infrastructure and may be difficult to implement without establishing new infrastructure between transformers and local grids. 3) Willingness to comply with defined prioritization rules. Should business considerations take precedence over public interests? For example, should BIR have sufficient energy access while most residents are cooking and charging electric vehicles? Regarding the necessary policy measures for their company to be part of a flexible and integrated energy system, Participant A believes that the regulatory plans for the Dokken area must align with the future energy system, and appropriate priorities for distributing energy resources need to be established.

Participant B (Bybanen) is not familiar with the specific policy measures required to implement energy storage from the light rail system in rectifier stations or to sell excess energy back to the grid.

Participant C (Eviny Termo) and Participant D (Eviny Termo) respond to the regulatory questions in their roles as infrastructure and energy providers. Further information on Eviny Termo's response can be found in the Provider summary, Appendix 3.

Theme 5: Flexibility

Context:

A flexible energy system can be crucial for the transition to a zero-emission society. Utilizing the flexibility of the energy system can be a more profitable and efficient way of dealing with power peaks in the infrastructure instead of developing new infrastructure[2] (Enova). Flexibility can be achieved through interaction between energy forms and actors, but also through the development of new technological solutions that make it possible to exploit consumption and storage flexibility in the energy system. The ELEXIA project aims to exploit the opportunity for better interaction between energy forms and new digital solutions aimed at achieving smart, safe, resilient, and cyber-secure energy systems.

Part 1: We start by taking a closer look at the interaction between different forms of energy and actors

Context:

At Dokken, the goal is to develop an integrated and flexible energy system right from the start of the development phase. Here it will be possible for more players to not only consume energy, but also become producers of energy by installing, for example, solar cells on their own roof. Any surplus energy can be sold into the market or stored locally.

Imagine that you as a builder/building owner will become an active part of an integrated and flexible energy system where you both produce and consume energy according to your needs and ability.

Questions:

- **What will this entail in terms of advantages and disadvantages for your business?**
- **What limitations do you have as a flexible energy actor or energy consumer?**

Participant A (BIR) considers it very positive to be part of the flexible and integrated energy system at Dokken. However, they acknowledge the limitations discussed earlier, specifically regarding their facility's high energy demand within short periods. These periods typically occur for less than 1 hour per day, spread over 15-minute intervals. They have minimal energy usage for the remaining 23 hours. Participant A wants to operate their facility at the lowest possible cost within these timeframes. They add that power requirements and time frames can be communicated to ELEXIA (the overarching system?) to create flexibility in the area.

Participant B (Bybanen) finds this to be an exciting issue, also for Bybanen. To handle peak power demands, he suggests storing excess energy from Bybanen either in a rectifier or in batteries for the Bybanen vehicles. This could technically be possible through an energy management system that monitors the power across the entire Bybanen system. If the power becomes too high, the batteries could be used more or the energy from the rectifier stations could be depleted. Participant B mentions that a similar approach was used in the maritime industry in the past to maintain control over energy usage and load. By levelling out the load on the grid, this could be advantageous for the grid owner, as they would not need to size the grid based on the consumption peaks. However, there are limitations in terms of costs and technology development, especially regarding rectifier stations. Currently, we do not have a power system that can control these things, Participant B concludes.

The moderator adds that the infrastructure in the Dokken area, especially what will be underground, is likely to be planned before the light rail system is ready to be planned through this area. Therefore, there is a time lag that could potentially limit this proposal.

Participant B (Bybanen) believes it would be useful for Bybanen to participate in discussions when the development strategy for Dokken is being made.

Participant C (Eviny Termo) responds to the first question in their role as an infrastructure owner and energy provider. Further details on Eviny Termo's response can be found in the provider summary on page x. Regarding the second question under Theme 5, Part 1, Participant C responds in their role as a consumer at future Dokken. Participant C emphasizes payment models as a potential limitation. The consumer needs to receive the energy they require, but how does the system know what they need, and how can the consumer pay to receive it at the right time? What if the consumer has been promised energy but it is not delivered as planned? How do we solve these types of problems, he asks. Participant C suggests working towards finding good and simple solutions. Technically, he believes it is fully possible to do so.

Part 2: We go further and look at flexibility in the sense of developing digital solutions that exploit the flexibility of the energy system

Context:

In the ELEXIA project, three different systems for planning and operation of the future energy system will be developed. These consist of a "System Planning Toolbox" to support efficient sector coupling in three selected pilots, an "Energy Management System" for flexible, cost-optimized operation of sector-connected pilots, and a "Digital Service Platform" to facilitate energy management and planning.

Question:

What considerations do you think are important to take into account in the development of these digital solutions in order for your business to get the most benefit from such solutions?

Participant A (BIR) once again highlights the importance of having regulations for prioritization. What considerations should be considered regarding reported needs? How should allocation and access to power be managed? Who should own the allocation and power management? Management data and data communication require secure solutions. How can we ensure this communication is maintained, and how can we ensure that BIR always has sufficient access to power to meet their business needs?

Participant B (Bybanen) refers to the previous question regarding the storage of excess energy from Bybanen in rectifiers or in the batteries of the Bybanen vehicles. They envision an energy management system that can monitor the total power consumption of Bybanen and utilize this excess energy as it approaches peak demand. In terms of operation, they suggest considering not only driving time / runtime? and similar factors but also the energy usage relative to the location of the different vehicles at different times (time schedules). Currently, there are no battery-operated light rails in Norway, but Nice (France) has a battery-operated light rail in the city center. It may be possible to obtain data from there regarding battery operation, which could assist the ELEXIA project in testing this type of flexibility.

Moderator asks a follow-up question to Participant B (Bybanen). Is it possible to obtain data that can be used to assess the energy load on the electrical grid in cases where two Bybanen vehicles cross the new Pudderfjords Bridge (worst-case scenario)? Can the situation in Florida (an urban area near Dokken) provide a good picture or data for testing this? And can you help us gather information about the load on the rectifier in Solheimsviken?

Participant B (Bybanen) suggests that the Municipality of Bergen should reach out to the Procurement Manager in Bybanen Utbygging, to obtain answers to these questions.

Participant C (Eviny Termo) and Participant D (Eviny Termo) respond to the flexibility questions in their roles as infrastructure and energy providers. Further information on Eviny Termo's response can be found in the provider summary on page x.

Theme 6: Technology development and cooperation

Context:

The ELEXIA project, pilot Dokken, involves collaboration between research actors, public actors (mainly municipalities) and private energy and technology actors who contribute their expertise and perspectives to the development process.

Questions:

- **What advantages and disadvantages do you see in a trilateral collaboration between academia, the public and private sectors for the development of new energy systems?**
- **To what extent and in what way do you as a builder/building owner want to be involved in development processes like this?**

Participant A (BIR) states that BIR has a long and successful experience with this type of tripartite collaboration and looks forward to continued contributor to ELEXIA and similar development processes in the future.

Participant B (Bybanen) expresses that they are positive about being involved in this type of development process and as mentioned before, have already investigated electrifying construction sites. They have been in contact with Eviny and another supplier of mobile battery packs. Participant B finds it exciting to explore the possibilities available. He mentions that Bybanen has been involved in a project focusing on power mapping and electrification of construction sites, for which they received funding from the Norwegian Environment Agency to conduct a pilot study.

Participant C (Eviny Termo) explains that basic research is not something they engage in or finance in Eviny Termo. However, they can act as a testing and implementation partner for new technologies. They often receive inquiries from entities looking to delve deep into theoretical aspects, but this is outside the scope of Eviny Termo's business model. The triggering factor for Eviny Termo to participate in a project is when they encounter actors with a specific need that they can address; in other words, projects that can serve as marketplaces to connect with other private sector entities. When it comes to the public sector, it can be more challenging, as there are different procurement frameworks in place. Participant C adds that they need to have the time to engage in these projects, or else there will be no value in their involvement. They do not have the capacity to sit down and read research reports and extract the essence from them. In response to a follow-up question about the role of the end-user, Participant C emphasizes the importance of considering the input of end-users when developing and establishing regulations for the new Dokken area. He stresses the need for end-users to feel like active participants in the process, rather than simply bearing the burdens afterwards. Participant C highlights "Akvariet" and the "Marine Research Institute" as examples of end-users (at the building owner level) who should be included in the collective effort. By involving these large-scale users in shaping the system, it could ultimately make it easier for smaller end-users who come later.

Theme 7: Open-ended question

- **Anything you would like to add, comment on, etc.?**

Participant A (BIR) has nothing to add under Theme 7.

Participant B (Bybanen) brings up another aspect regarding battery operation of the Bybanen vehicles. If the vehicles were battery-powered, it would avoid the need to establish large rectifier stations every 2-2.5 km in the city centre, where it can be challenging to install electrical infrastructure due to visual and space constraints. Instead, the vehicles could be charged in areas outside the city centre where access is easier.

Participant C (Eviny Termo) suggests considering Eviny Termo not only as a district heating operator but also as an energy actor that could function as an inside facilitator. Eviny Termo can have multiple roles in the project, he adds. Participant C predicts that BKK (Bergen Kommunale Kraftselskap) will have a different view and may primarily wish to operate from the outside. He recommends adopting this mindset when communicating with other stakeholders in the project.

Appendix 3: Interview Outline – Pilot Dokken – Providers

Stakeholder Subgroups: Infrastructure and Energy providers

Participants: BKK, Eviny Termo, (BIR)

Theme 1: The energy system of the future

Context:

Society's energy needs are increasing, and a steadily increasing demand for renewable/emission-free energy production is expected in the future. In parallel with meeting challenges related to meeting an increasing energy demand using various forms of renewable energy, efforts are also being made to find solutions that can increase energy efficiency and flexibility in the energy system. Sector coupling is an opportunity to decarbonize certain sectors such as transport and heating. By integrating various renewable energy carriers such as hydropower, wind power, district heating and solar power into a common energy system, one can extract unredeemed flexibility in connection with supply and demand of electricity and reduce peak demands, resulting in lower investment costs and lower energy prices.

Question:

What does an ideal smart (flexible and integrated) energy system look like in your industry?

Participant A (BKK) explains that their grid needs to become smarter. This means they need better monitoring and control, as well as more insight into what is happening in the grid and the ability to control production. In this regard, they have some specific needs that she highlights. Firstly, there is a need to maintain delivery reliability. This involves minimizing downtime for customers and implementing more automation to handle network faults. It may not necessarily require artificial intelligence (AI) for automation, as rule-based systems can be sufficient. Regarding delivery quality and voltage quality, there is also a need for more sensors and insight into the state. One way to improve voltage quality could be to implement more storage batteries in the system. She explains voltage quality as a measure of the stability and accuracy of the voltage delivered in an electrical grid. It includes criteria such as the nominal voltage (230V or 400V in this case) and an accepted deviation of plus minus 10%. Voltage quality can be influenced by various factors, including generation units that can cause increased voltages, as well as the presence of consumption units that can generate noise and disrupt the voltage in the grid. With an increase in variable production, such as from renewable energy sources like solar and wind and demands involving high and/or variable power consumption, maintaining voltage quality can become more challenging.

Participant B (BKK) adds to what Participant A (BKK) said and explains that it's about flexibility to both deliver and receive. One needs to consider both aspects.

Participant A (BKK) also highlights the importance of grid capacity, which includes investments and the physical limitations of the grid. To utilize the capacity and avoid building excessive new infrastructure, BKK wants better access to flexible loads that can be disconnected or adjusted as needed. Furthermore, achieving synergy with other energy sources, such as district heating or solar energy production, either through electrical self-production or heating from the sun, is important. Additionally, there is a possibility that customers have energy storage systems on their own properties, and the interaction with, for example, electric vehicle charging can provide support and flexibility to the grid. Participant A mentions the need for sufficient insight and tools to manage challenges in the future energy system, as well as the need for a standardized interface with other actors. They emphasize the importance of as much standardization as possible to avoid different actors requesting custom solutions.

Participant B (BKK) adds that everyone contributing to the energy system should communicate on the same platform to enable better coordination.

Participant C (Eviny Termo) starts from the perspective of thermal energy for heating and cooling when answering the question. Consumption depends on three factors: building characteristics and construction, building activity, and weather conditions throughout the year. This means that the picture is not the same every day, and this is one of the challenges of the heating and cooling solution. In an integrated system, tools are needed to optimize energy consumption in the short term by moving consumption in time. In the longer term, energy storage can help manage seasonal variations. To handle consumption peaks (peak loads), multiple parameters need to be managed. Data systems are needed to forecast future needs in the building stock so energy producers can adjust their production in a timely manner. Building energy demand must also be more controllable. This may mean that the building needs to start heating at night when energy is available. In an integrated system, more control is required than in the current system, and one needs to take responsibility for a larger part of both energy consumption and delivery. Participant C mentions "Energy as a Service" as an interesting concept. Participant C points out that a local thermal energy system is not very different from the general energy system in the Nordic countries. There are producers, some who distribute, and some who consume. To optimize the system, all three layers must work together. In Scandinavia and the Nordic countries, interconnectors are seen as a way of increasing energy security. One can choose to be independent and stand alone, or one can connect with neighbouring countries to improve security. The principle (and challenges) of Dokken is the same, only on a smaller scale. One can choose to be self-sufficient with energy for 90 percent of the year, but for the remaining 10 percent, one must rely on others for delivery. The smaller the percentage one is dependent on others, the more expensive it becomes for what remains, because the supplier also wants to make a profit.

Participant D (Eviny Termo) believes that we must be able to deliver energy using multiple sources simultaneously in an ideal energy system, especially if we want to use electricity for creating more jobs and stimulating increased industry. To achieve this, we need flexibility in low-value energy consumption, such as heating of buildings and low-value processes. One solution is to use water-borne energy to a large extent and electricity for the most necessary. This may include electrification of the transport sector and industry. However, Participant D believes we must move away from the idea that electricity alone should solve everything. An important part of the solution is to think on a system level and implement other solutions, like water-borne energy. This will free up energy in the power system and provide opportunities for optimization. In the future, the temperature level in water-borne energy may change for better optimization, such as lowering it from today's 120 degrees Celsius to perhaps 40-60 degrees Celsius in 50 years. However, this requires that consumers are ready to adapt to new solutions and technologies.

Theme 2: New business models in the future energy market

Context:

The energy system of the future means that we must rethink market solutions and business models that are able to exploit the flexibility of the energy system. The new energy system also requires the preparation of energy exchange agreements between several actors across sectors and vectors (energy carriers), and to find solutions for how flexibility is to be priced and financed. With many different actors in the equation, new business models are needed that promote cooperation and earning opportunities for both small and large actors.

Imagine that we are going to develop a new business model for energy systems and solutions for the future actors to join in on Dokken.

Questions:

- **When creating new business models that the various actors on Dokken will join, what needs to be done to secure the interests of you as an infrastructure owner/energy provider?**
- **What needs, advantages and disadvantages, opportunities and barriers do you think will affect the process of developing new/necessary business models?**

Participant A (BKK) highlights key principles that are important to their business in relation to future business models. They aim to be a neutral party, so they cannot assess or favour specific business activities. As a monopolist, their goal is to ensure equal treatment of all actors in the industry. Participant A also mentions sensitive information according to the "regulation on security and emergency preparedness in the power system" and emphasizes that they have certain limitations when it comes to sharing information with other parties. As the party responsible for operating the network with area licenses, they cannot give others control over their own network. Therefore, it is important to avoid creating "Dokken-specific" solutions. Instead, we must adapt what we develop to what is developed outside the project, for example flexibility market solutions, she concludes.

The moderator follows up with a question about what factors they believe determine the acceptance of a future flexible and integrated energy system in their industry.

Participant B (BKK) emphasizes that the company is very positive towards smart energy systems. They acknowledge that in the future, they will have to deal with a lot more than they have in the past, and that this is the way forward. He points out that there is little resistance in the industry when it comes to adapting and working with smart energy systems.

Participant A (BKK) explains that in the dialogue with new actors, BKK is keen on ensuring that they meet regulatory requirements. They emphasize the importance of delivering according to specific requirements and may be more meticulous and aware of this than new actors who are not fully aware of the role and responsibilities that come with it.

Participant A (BKK) agrees with Participant B (BKK). It is more about having certain conditions or prerequisites in place, such as clear and distinct interfaces and clarification of expectations. In their dialogue with new actors, BKK notices that they are often more focused on ensuring compliance with regulatory requirements and that everything functions properly. BKK is committed to delivering according to specific requirements and might be more conscious of this than new actors who may not fully grasp the role and responsibilities that come with it.

Participant B (BKK) adds that BKK often sees problems that the new actors may not, for better or for worse. To achieve innovation, there must be some who are willing to take risks and stumble along the way. BKK, on the other hand, tends to hold back and try to solve problems before they arise. For them, it is important that the solution is 100% resolved before they are willing to implement it. By joining the Dokken pilot project, BKK demonstrates that they are an actor willing to take a little more risk.

Participant C (Eviny Termo) mentions cooperative models as a possible business model for the future energy system. He highlights a project in Bjørnafjorden (a neighbouring municipality) where Eviny has established a jointly owned company between the developer, energy actor, and land buyers, with the latter holding B-shares in the company. The idea is to encourage adoption of these solutions and alleviate concerns that the sole motive is financial gain at the users' expense. To succeed at Dokken, Participant C believes that we need to move more towards collective solutions, as is done in Denmark[1]. If everyone building a building has complete individual freedom, it will not be possible to have a common system. Those who invest in the energy system run the risk of investing too much compared to what can be sold afterwards, in addition to uncertainty regarding operating costs. On the other hand, those who are going to use the system live with uncertainty regarding energy prices. Therefore, it is important to take a collective approach to mitigate this uncertainty.

Participant D (Eviny Termo) points out that building developers often prioritize maximizing profits by taking shortcuts and choosing the cheapest alternatives available within the given framework. This can pose a challenge when it comes to selecting energy solutions, as the best solutions may be expensive and may not align with the development plans. Participant D asserts that these mechanisms are critical and become increasingly important as you move up the system hierarchy. Therefore, NVE (The Norwegian Water Resources and Energy Directorate) and flexible agreements, such as fixed prices or tunnel prices, are crucial for achieving success for both producers and consumers. Participant D highlights the significance of reaching a consensus on the overarching goals in the collaboration process. Otherwise, complex solutions may disrupt the lower levels. For example, some actors may choose technical solutions that do not align with the larger context. To prevent this, Participant D believes it is essential to consider a more technically focused business model while remaining attentive to potential factors that could derail the overarching plans and vision for Dokken.

Participant C (Eviny Termo) suggests that Eviny should have a role as a facilitator in the new energy system at Dokken. Their role as a facilitator would entail ensuring the seamless operation of the system, including proper energy flow, timely delivery of energy, and backup solutions to guarantee constant access to energy. As energy is integral to the sustainability of the Dokken neighbourhood, Participant C believes the facilitator role that the energy company assumes is critical. He also considers ownership and operation of the energy system as part of the business model.

Theme 3: A sustainable energy system

Context:

In order to achieve national climate targets and local ambitions for a zero-emission society, the entire energy system (infrastructure, production, distribution, storage and consumption) must become sustainable. This means that all these parts of the energy system must become "cleaner" and more efficient in the future. Many now see local smart (flexible and integrated) energy systems as a way to go to achieve zero-emission societies. In such an energy system, we need renewable energy such as solar energy, hydropower, bioenergy, and thermal energy. In the energy system of the future, it will also be possible for new actors to enter the market on the production side, for example by capturing/producing surplus energy that is sold into the market.

Questions:

- **What opportunities and limitations will this give the business you represent as a future actor at Dokken?**
- **How do sustainability considerations affect choices related to design and energy solutions in your business?**

Participant A (BKK) explains that BKK's perspective is that their involvement in the ELEXIA project can provide valuable experiences that can be applied to the rest of the system. She highlights several issues discussed in the Dokken pilot that are also relevant to their operations when making sustainable choices. Throughout the process, they have been challenged on various issues, such as whether it is more sustainable to expand the network to increase capacity or to find alternative solutions. One challenge is that if they utilize the capacity better, they experience increased network losses[2], which represents BKK's largest CO_2 footprint. So, what is more important? Participant A clarifies that the company has precise calculations about network losses since it is an expense that they are required to cover. Moreover, she highlights that they must compensate for the losses with

CO_2 allowances, in addition to paying for them, resulting in a double financial penalty. Participant A shares that they have discussed several sustainability dilemmas during the project. By examining various scenarios, Participant A believes they can discover optimal solutions for addressing future energy system challenges. Regarding BKK's approach to sustainability goals in infrastructure and investment decisions, she highlights two focus areas. One is related to greenhouse gas emissions (including SF6), and the other is related to land use. Looking ahead, they have also set a vision of zero emissions. In the coming months, they plan to conduct a sustainability pilot where they will analyse the greenhouse gas footprint in a specific development project and assess the effects of various measures.

Participant B (BKK) has an additional comment on network losses and says it is possible to calculate the cost of producing those kilowatt-hours since they must produce them even if they end up losing them. Therefore, there are both economic and climate consequences to consider. Participant B believes that it is crucial to invest time in exploring the optimal utilization of renewable energy production during the early stages. For instance, by optimizing the location of solar panels to exploit both morning and evening sun, as well as low winter sun. Furthermore, he emphasizes the significance of storage technology in this context.

Finally, a conversation arises between the moderator, Participant A (BKK), and Participant B (BKK), where multiple proposals for sustainable solutions (zero-emission solutions) are put forward. For instance, suggestions are made on how to utilize energy losses for societal benefits (e.g., semi-climatized social zones), how to better utilize transformer capacity, and whether there are opportunities to harness waste heat at Dokken, such as from the Institute of Marine Research.

Participant D (Eviny Termo) reflects on the potential opportunities that a sustainable energy system can offer for their business. He believes that one of their significant prospects lies in acting as a facilitator to ensure the system is sustainable enough. According to Participant D, all these energy sources need a facilitator or a platform to integrate them into the system. He prefers to view district heating (i.e., water-borne pipe system) as a necessary platform to develop energy from excess energy and meet future needs at Dokken. They have already allocated 20 MW of district cooling to Dokken in their infrastructure. Eviny Termo is eager to contribute as a vital actor in the energy system at Dokken. When it comes to limitations, he highlights regulatory frameworks. If they intend to establish a flexible and integrated energy system at Dokken, it is essential to examine regulatory frameworks. For instance, it is possible to consider the requirements of the technical regulations and potentially be more ambitious than what they currently entail. Participant D suggests looking into the energy labelling scheme and its revision, with a focus on buildings' energy efficiency in terms of consumption and cost. He emphasizes the importance of considering how much energy the building purchases, not how much it uses. For example, if you install a heat pump in one building and supply heat to an identical building, the building will receive different energy ratings because one building consumes more energy than the other. With the current regulations, buildings may risk being penalized with a lower energy rating if the developer/contractor chooses to join a larger project or a larger (energy) system, similar to what is being planned for Dokken. This is suboptimal. Participant D concludes by mentioning concrete sustainability measures their business is working on. They are working on CCS in connection with district heating, mapping environmental profiles/environmental impacts on products and services (EDP environmental declaration), they are ISO14001 certified, and they follow the EU Taxonomy screening. Additionally, Eviny introduced the goal of emissions-free energy production in 2017, and they do not invest in companies that use fossil oil as an energy source.

Participant C (Eviny Termo) highlights the challenges with the current BREEAM certification system (Norway's leading environmental certification system for buildings). If a developer use BREEAM certification, they might get penalized for it. Today, it is better to have solar panels on your own roof rather than buying solar power from a neighbour, he explains. In response to the second question, Participant C identifies CO_2 emissions and environmental impact as two major drivers that guide Eviny

Termo. However, the parent company is committed to delivering on several sustainability goals beyond these. Participant C notes that Eviny incorporates the type of requirements outlined in the UN Sustainable Development Goals in all their procurement processes.

Theme 4: Regulation

Context:

In order for us to succeed in developing smart (integrated and flexible) energy systems that are also sustainable, it is essential that existing legislation can be adapted to the new reality. This may entail new environmental requirements, labelling, regulations, and tariffs on the part of the authorities that make it easier to make environmentally friendly choices.

Questions:

- **What barriers and challenges hinder the delivery of smart energy systems for the business you work in?**
- **What measures (political or otherwise) are needed for your business to become a part of a flexible and integrated energy system?**

Participant B (BKK) believes that the regulation as it stands today expects the distribution grid companies to deliver in a competitive market. These companies are primarily responsible for delivering monopoly aspects and defining the interfaces. However, several distribution grid actors have started taken on an energy coordinator role, going beyond this expectation. These actors see it as crucial that distribution grid companies take a more active role in this area. This is also something that BKK wants to explore.

Participant A (BKK) adds that several distribution grid companies, including Lnet in the Stavanger region, Tensio in Trøndelag, and Elvia in Oslo, Viken, and Innlandet, have proactively assumed the responsibility of making decisions regarding the energy system. These companies assert that their in-depth knowledge of the energy system, and the fact that they have access to data that they cannot share with others, makes them potentially best suited to take on this role in certain cases. However, Participant A acknowledges that, at present, distribution grid companies lack the expertise to make decisions about alternative energy options, such as solar energy or heating system choices. Their expertise is primarily focused on the distribution grid. This could be a barrier for distribution grid companies to take on this role. Participant A also mentions another potential regulatory barrier in the future energy system. There are very different requirements for traditional energy producers and plus customers[3] (prosumers). It could pose challenges if a prosumer feeds more power than the allowed limit (maximum of 100 kW) into the grid, as they would then have to meet the much stricter requirements for producers.

Participant B (BKK) explains that there have been some recent regulatory changes regarding the sharing of production across actors, which may also affect them. The updated regulations states that sharing of production is possible if participants are on the same property.[4] If joint-stock companies own or have shares in a project, they can also be involved in this sharing arrangement. This means that the interface between participants and the company could shift. Instead of the grid company being in contact with each individual actor, participants may now have a common interface towards the company. Participant B highlights that several of the regulatory changes are significant for the development of Dokken. Specifically, these changes include the requirement for each costumer/consumer/entity to have their own meters instead of relying on collectively measured installations, ensuring that everyone has access to their own meters, and granting each individual the freedom to choose their electricity supplier.

The moderator relates the regulatory changes to what we have learned from conversations with real estate actors (User group). The regulatory changes also affect the energy labeling of buildings. She explains that although a developer may develop a block of buildings, the properties will be divided into separate buildings. These buildings may be sold as individual units or rented, for example, in a corporate structure, and they may have their own financial system. The moderator points out that the energy regulations do not allow for heat pumps to be placed in the basement of one building to supply heat to the rest of the block of buildings (as discussed with Entra). This creates a suboptimal situation both in terms of energy regulations and the energy labelling of the buildings. It results in one building possibly having an incorrect energy account and being placed in the wrong category compared to the other buildings. This is not an ideal solution, she concludes.

Participant A (BKK) shares that there are multiple examples of "Energy Communities" abroad. It could be interesting to explore the related regulations that they adhere to, as there may be potential learnings for us in the ELEXIA project.

The moderator also highlights the other two pilots where the regulatory context may be completely different. There may be valuable insights to be gained from those as well.

Participant C (Eviny Termo) has already discussed some of the barriers and challenges towards implementing a smart energy system in Theme 1-3. However, he adds that the current energy system is very government-driven towards individual solutions, with a focus on each building using the least amount of energy possible. Participant C believes we need to move on to the next phase and demand more from the area. The government has currently approved the sharing of electricity between buildings on the same farms and usage number. He thinks it's only a matter of time before it becomes allowed within the same development area as well. The authorities need to be willing to consider more collective solutions and circular value chains. He emphasizes that this would promote what we are doing in Dokken. For instance, the authorities may allow heat recovery by supplying heat from the waste incineration plant in Rådal to areas in the Bergen city centre. This is positive as it avoids the use of electricity to produce the same amount of heat in urban areas. The subject of waste incineration can be disputed, he adds, but it is a political decision the city of Bergen has made. Participant C also highlights net fee models as a possible obstacle to a flexible and integrated energy system in Dokken. As a solution, he proposes dynamic pricing models that motivate buyers and consumers to adapt to the society's capacity to deliver.

Theme 5: Flexibility

Context:

A flexible energy system can be crucial for the transition to a zero-emission society. Utilizing the flexibility of the energy system can be a more profitable and efficient way of dealing with power peaks in the infrastructure instead of developing new infrastructure[5] (Enova). Flexibility can be achieved through interaction between energy forms and actors, but also through the development of new technological solutions that make it possible to exploit consumption and storage flexibility in the energy system. The ELEXIA project aims to exploit the opportunity for better interaction between energy forms and new digital solutions aimed at achieving smart, safe, resilient, and cyber-secure energy systems.

Part I: We start by taking a closer look at the interaction between different forms of energy and actors

Context:

At Dokken, the goal is to develop an integrated and flexible energy system right from the start of the development phase. Here it will be possible for more players to not only consume energy, but also become producers of energy by installing, for example, solar cells on their own roof. Any surplus energy can be sold into the market or stored locally.

Imagine that your business will become an active part of an integrated and flexible energy system where you both produce and consume energy according to your needs and ability.

The case was presented to Eviny Termo in the following way during the interview: Imagine that your business needs to facilitate an integrated and flexible energy system and contribute to that picture with several producers or prosumers.

Questions:

- **What will this entail in terms of advantages and disadvantages for your business?**
- **What limitations or barriers do you see as an infrastructure owner/energy provider?**

Participant A (BKK) believes the advantage is that it can increase the flexibility in the system, e.g., in relation to the flexibility market where BKK can purchase flexibility. This will help optimize the utilization of the grid and avoid significant investments. The downside is that it can increase operational complexity, which requires new tools and services to be acquired and involves dealing with multiple actors. The customers of BKK pay for the grid and grid services through the tariff. Certain customers have reduced tariffs (typically those with electric boilers for heating such as UiB, or alternative power sources such as shore power (Plug)) in exchange for being flexible when needed. In a market context, BKK does not have the ability to compensate through tariffs. Participant A explains that in the current market, there may be larger actors or aggregators who submit bids on behalf of multiple smaller actors. An example of this is Tibber (an electricity company), which can submit bids on behalf of all their customers with electric vehicle chargers. Tibber can then control and disconnect the charging of electric vehicles because they have bought back the capacity. This means that Tibber can manage and control the variation in power consumption on behalf of their customers. For BKK, this means they need to have anticipated the need to purchase this capacity, so accurate prediction becomes important for them.

Participant C (Eviny Termo) explains that if we looked at Dokken as a closed area, the area could have its own backup solutions and feed into the common collective system (which can be useful in case of power outages or other unforeseen events). However, technical challenges must be solved to feed into the district heating network, as their waste heat is low temperature while the district heating network operates at high temperature. Raising the waste heat to the district heating network temperature would be costly. On a local network within Dokken, however, they could operate at very different temperatures, which technically makes it much easier to achieve. A limitation or barrier they see as an infrastructure owner and energy supplier is finding payment models that ensure they receive energy on time and are compensated if the energy is not delivered as agreed. Participant C believes that integrated and efficient solutions are fully achievable, for example, by using solar collectors that are more effective than solar cells on hot days. Regarding cooling, Participant C does not believe that it will become relevant for actors in Dokken to produce their own cooling. There are already 20 megawatts of cooling available right under the bridge (installed by Eviny Termo).

Participant D (Eviny Termo) points out that one of the advantages for their business is their ability to optimize production and the interaction between different energy sources, which Eviny Termo regards as their competitive advantage. They have used technologies such as machine learning, artificial intelligence, and Big Data to achieve optimization. Participant B believes that the key to success is having competent actors who understand the construction and operation of the integrated and flexible energy system. He also emphasizes the importance of long-term operating capability, as it entails building and operating the system for 50 years or more. Lastly, he emphasizes a scenario that is considered very unfavourable, where each quarter or building in Dokken would replicate the same infrastructure. For instance, if every entity decides to independently lay pipes into the fjord for cooling water extraction. On a system level, such an approach is utterly impractical.

Part 2: We go further and look at flexibility in the sense of developing digital solutions that exploit the flexibility of the energy system

Context:

In the ELEXIA project, three different systems for planning and operation of the future energy system will be developed. These consist of a "System Planning Toolbox" to support efficient sector coupling in three selected pilots, an "Energy Management System" for flexible, cost-optimized operation of sector-connected pilots, and a "Digital Service Platform" to facilitate energy management and planning.

Questions:

- **Will this type of system have an impact on the business you represent? If so, how?**
- **What opportunities do you see in using these types of tools/systems?**
- **What considerations do you think are important in the development of these digital solutions to ensure that your business gets the most out of such solutions?**
- **What do you think are the biggest challenges/barriers for the systems not working optimally, not delivering the desired results, or not being adopted?**

Participant A or B (BKK) expresses scepticism about having a centralized control system and believes that BKK should have the ability to control their own system. The limitation lies primarily in the information they can share with others. He/she suggests alternative mechanisms for coordination and collaboration rather than a system on top of the systems. He / She believes that it may be difficult, especially for monopolies, to be part of a common control system, and that challenges can be solved in alternative ways. Participant A/B also expresses the need to be able to see the connections between different systems in the planning process.

Participant C (Eviny Termo) believes that the biggest obstacle for the integrated energy system to function optimally is the integration with the buildings' control systems. Each building has its own control systems for ventilation, doors, windows, alarms, etc. Achieving integration with these systems is actually the most complex part of the process, according to Participant C. It's about obtaining permission and the ability to control these aspects of the building from the outside, in a way that is optimized for the integrated energy system. He believes there is a lot of potential to be gained if we manage to do this in a good way. This is where the need for a facilitator in the middle comes into picture.

The moderator adds that property developer (real estate actors) at the building level usually do not want the large systems to have too much control at this level. The buildings are already planned and optimized according to their specific needs. There are some challenges that need to be solved here.

Participant C (Eviny Termo) reflects on how he envisions a well-functioning integrated energy system at Dokken. Firstly, he would not necessarily refer to it as three separate systems (referring to the context). Furthermore, he emphasizes the importance of being able to model the entire system and having a system that can plan for the future, so that necessary actions can be taken today for optimal results tomorrow. If we are to offer charging for recreational boats and cars Dokken, this also needs to be incorporated into the system, as there will be fewer gasoline-powered outboard motors on recreational boats in the future. Participant C believes that integrating users into the system can become complex, and highlights cybersecurity as a crucial topic that requires careful consideration. As a district heating company, Eviny Termo is subject to emergency regulations, and they have complied with these regulations in their operations. However, a new energy company at Dokken will not be subject to the same legislation unless specific requirements and regulations are imposed.

Theme 6: Technology development and cooperation

Context:

The ELEXIA project, pilot Dokken, involves collaboration between research actors, public actors (mainly municipalities) and private energy and technology actors who contribute their expertise and perspectives to the development process.

Questions:

- **What advantages and disadvantages do you see in a tripartite collaboration between academia, the public and private sectors for the development of new energy systems?**
- **To what extent and in what way does your business want to be involved in development processes like this?**

Participant A (BKK) acknowledges the value of collaboration but also expresses concerns about the scale of the project. She believes that there is limited access to knowledge and insights from previous research, specifically regarding energy communities and solar cell production in districts like Dokken. In this project, research partners are more focused on developing tools that will contribute to the project, and less focused on communicating previous research and experiences. Participant A questions the current structure of the project, where the pilot partners are expected to have all the answers.

We came to the project to get answers, and now we have to provide the answers ourselves.
Participant A.

Participant C (Eviny Termo) explains that basic research is not something they engage in or finance in Eviny Termo. However, they can act as a testing and implementation partner for new technologies. They often receive inquiries from entities looking to delve deep into theoretical aspects, but this is outside the scope of Eviny Termo's business model. The triggering factor for Eviny Termo participate in a project is when they encounter actors with a specific need that they can address; in other words, projects that can serve as marketplaces to connect with other private sector entities. When it comes to the public sector, it can be more challenging, as there are different procurement frameworks in place. Participant C adds that they need to have the time to engage in these projects, or else there will be no value in their involvement. They do not have the capacity to sit down and read research reports and extract the essence from them. In response to a follow-up question about the role of the end-users, Participant C emphasizes the importance of considering the input of end-users when developing and establishing regulations for the new Dokken area. He stresses the need for end-users to feel like active participants in the process, rather than simply bearing the burdens afterwards. Participant C highlights “Akvariet” and the “Institute of Marine Research” as examples of end-users (at the building owner level) who should be included in the collective effort. By involving these large-scale users in shaping the system, it could ultimately make it easier for smaller end-users who comes later, he concludes.

Theme 7: Open-ended question

- **Anything you would like to add, comment on, etc.?**

Participant C (Eviny Termo) reiterates that we should consider Eviny Termo not only as a district heating operator but also as an energy actor that can play the role of an internal facilitator. He predicts that BKK (Bergen Kommunale Kraftselskap) may have a different perspective and primarily prefer to operate from an external position. He recommends adopting this mindset when communicating with other stakeholders involved in the project.

Appendix 4: Interview Outline – Pilot Dokken – Influencers

Stakeholder Subgroups: Media, Academia, and the Non-Profit Sector

Actor: CET

Theme 1: The energy system of the future

Context:

Society's energy needs are increasing, and a steadily increasing demand for renewable/emission-free energy production is expected in the future. In parallel with meeting challenges related to meeting an increasing energy demand using various forms of renewable energy, efforts are also being made to find solutions that can increase energy efficiency and flexibility in the energy system. Sector coupling is an opportunity to decarbonize certain sectors such as transport and heating. By integrating various renewable energy carriers such as hydropower, wind power, district heating and solar power into a common energy system, one can extract unredeemed flexibility in connection with supply and demand of electricity and reduce peak demands, resulting in lower investment costs and lower energy prices.

Questions:

- **What do you think an ideal smart (flexible and integrated) energy system could look like?**
- **How do you think communication surrounding transition projects, in this case, a smart energy system, affects acceptance in society? What role do you play in this regard?**

Participant A believes that there is a lot to gain from an ideal, flexible, and integrated energy system. He has been inspired by several presentations on smart cities, where engineers outline various solutions like connecting different sectors and making energy consumption more transparent to consumers. He is intrigued by the possibilities these ideas offer but questions why they have not been realized yet. Participant A is concerned about barriers such as silo systems, slow-moving institutions, outdated laws, cumbersome regulations, and the inadequate communication between different sectors and institutions, preventing progress. He also argues that there is an idealized view of consumers as purely rational actors that maximize their utility and will make use of technology and pricing mechanisms to reduce energy consumption. However, he believes that this assumption is not necessarily accurate, as consumers are influenced by a range of factors beyond cost, such as habits and lifestyle. Despite this, Participant A thinks that there is a lot of potential for achieving a sustainable energy system, transitioning to renewables, and reducing consumption. He suggests that effective communication strategies and solutions that engage consumers in the energy transition are needed to facilitate progress towards sustainable energy consumption, rather than solely relying on pricing and technological solutions.

Theme 2: New business models in the future energy market

Context:

The energy system of the future means that we must rethink market solutions and business models that are able to exploit the flexibility of the energy system. The new energy system also requires the preparation of energy exchange agreements between several actors across sectors and vectors (energy carriers), and to find solutions for how flexibility is to be priced and financed. With many different actors in the equation, new business models are needed that promote cooperation and earning opportunities for both small and large actors. It is assumed that there will be a need for new business models in the energy sector when planning, constructing, and operating the infrastructure in Dokken in accordance with sustainability considerations (climate/environment, economy, social factors).

Questions:

- **Based on zero-emissions and new business models in the energy market, what do you think is essential for various stakeholders, such as experts, technologists, residents, and decision-makers?**
- **What do you think will influence the public discourse and policy development on this topic?**

Participant A is discussing the importance of clear and defined goals in driving technological development and investment towards sustainable solutions. When it comes to Dokken, the Municipality of Bergen has been very clear that zero emission is the guiding principle. This has served as a clear signal for experts, technologists, and investors to align their efforts. This clarity provides legitimacy for investment in certain technologies and creates a sense of direction. Participant A highlights the importance of this clear signaling in projects like Dokken, where the local government has set a goal of zero emissions. This signaling effect influences people's decision-making, as they begin to see the chosen path as the one they should follow. If politicians start to back down on those clear signals, it will have a very negative effect. Participant A argues that while it is essential to listen to people's concerns, the clarity of goals is crucial for maintaining momentum and achieving progress. He also acknowledges that there are different segments of the population with varying degrees of engagement in environmental issues but emphasizes that clarity in goals is key for driving action.

Theme 3: A sustainable energy system

Context:

To achieve national climate goals and local ambitions of a zero-emission society, the entire energy system (infrastructure, production, distribution, storage, and consumption) must be economically, environmentally, and socially sustainable. This means that all parts of the energy system must become "cleaner" and more efficient in the future, but decisions and solutions also affect the social dimension of sustainable community development. Previously, climate was the main driver of energy transition. Nowadays, geopolitics, the need for affordable energy, and energy supply and security have perhaps become equally important in driving the energy transition forward (CICERO).

Question:

- **Has the climate crisis become less important in the context of energy transition?**
- **If so, what are the consequences of this?**

Participant A express that there has been a shift towards a greener energy system I recent years, but recent events such as power crises in Norway and Ukraine have complicated matters. The *Beyond Oil* conference in October discussed the conflicting opinions of experts regarding the future of the energy system, and whether more investment in fossil or renewable energy will be more beneficial. It is unclear what the consequences of increased investment in energy will be, but there is an argument to prioritize innovation in renewable and smart energy systems. Participant A argues that a zero-emission goal has many arguments in its favour, and even climate sceptics can agree that innovation in renewable and local energy systems is positive.

Theme 4: Regulation

Context:

In order for us to succeed in developing smart (integrated and flexible) energy systems that are also sustainable, it is essential that existing legislation can be adapted to the new reality. This may entail new environmental requirements, labelling, regulations, and tariffs on the part of the authorities that make it easier to make environmentally friendly choices.

Questions:

- **What barriers and challenges do you think are hindering the necessary change in the energy market to address the climate and energy crisis?**
- **What political measures do you think are needed to establish smart energy systems in transformation areas like Dokken?**

Participant A mentions the concept of local energy systems or *energy communities*, where people come together to create energy solutions. However, it seems that Norway has legal barriers that make it difficult to implement such solutions compared to other countries. A believes that these solutions can not only provide sustainable energy, but also create a sense of community around energy production. A suggests that if implemented in Norway, it could create a cultural shift around how people view and use energy, making it a more social and cultural phenomenon. Currently, people in Norway are used to cheap and readily available electricity, without much thought about their energy consumption. Making energy a more social and cultural phenomenon could lead to a more conscious use of energy, as well as the creation of a community around it.

The moderator brings up an interesting example we learned through interviews, which is the case of Lyseparken. In Lyseparken, they have formed a local energy company in the form of a corporation, where those who invest in buildings become shareholders. This model is not necessarily social, as it operates within a market-based framework, but it does offer different incentives and ownership in the energy sector. The moderator finds it particularly interesting because it explores the distribution and motivation for individuals to be more mindful of their energy consumption, as they can gain a benefit by delivering excess energy back to the market. It is worth noting that there are Norwegian models that are not cooperative but operate under an equity model, which can still function based on the same principles.

Participant A finds it fascinating and sees potential in how energy consumption can promote more awareness and mindfulness among Norwegians who has been accustomed to low electricity prices, resulting in lack of consciousness around energy usage. He mentions that recent events such as the energy crises have prompted people to become more aware and mindful of their consumption. Participant A suggests that legal barriers need to be addressed to enable the creation of energy cooperatives and other innovative solutions, but he is not familiar enough with the laws and regulations in this area to suggest any specific political measures that are needed.

Theme 5: Flexibility

Context:

Energy will become a scarcer resource. A flexible energy system may be crucial for the transition to a zero-emissions society. Utilizing the flexibility in the energy system can be a more profitable and efficient way of managing peak loads in infrastructure, rather than building new infrastructure (Enova). Flexibility can be achieved through interaction between energy forms and actors, but also through the development of new technological solutions that exploit consumption and storage flexibility in the energy system. The goal of the ELEXIA project is to exploit the opportunity for better interaction between energy forms and new digital solutions aimed at achieving smart, safe, resilient, and cyber-secure energy systems. In Dokken, the plan is to build an integrated and flexible energy system right from the start of the development phase. There will be the opportunity for several actors not only to consume energy but also to become energy producers by installing, for example, solar cells/solar thermal systems on their rooftops. Any surplus energy can be sold to the market or stored on-site.

Questions:

- **What role do you believe flexibility will play in future energy systems?**
- **Who stands to gain or lose in the development of new flexibility markets?**
- **Do you foresee any obvious dilemmas concerning requirements, regulations, and potentially top-down development of flexible energy systems?**

Participant A highlights the benefits of flexibility in an ideal renewable energy system as discussed in Theme 1, including the ability to reduce peak demand and allocate resources to other areas. He believes that flexibility will play a crucial role in the energy system, but it remains to be seen how it can be achieved and what role individuals will play in it. In terms of top-down development of flexible energy systems Participant A expresses concern about excluding end-users from the discussions. He points out that policymakers often make assumptions about user behavior, which may not accurately reflect the expectations and preferences of end-users. In this regard, he believes it is important to gain a better understanding of the behavior and expectations that end-users have.

Continuing the conversation, Participant A and the moderator discuss the challenges and trade-offs of reducing energy consumption to achieve sustainability goals. They highlight the dilemma of people potentially using the saved money from reduced energy consumption for other activities that produce carbon emissions, such as traveling by airplane. This illustrates the complexity of motivating behavior change towards environmental sustainability. Additionally, they address the conflicting goals of reducing consumption to invest in infrastructure versus reducing consumption to mitigate climate change. This highlights the need to strike a balance between economic growth and sustainability initiatives.

Theme 6: Technology development and cooperation

Context:

The ELEXIA project, pilot Dokken, involves collaboration between research actors, public actors (mainly municipalities) and private energy and technology actors who contribute their expertise and perspectives to the development process.

Questions:

- **What advantages and disadvantages do you see in a tripartite collaboration between academia, public sector, and private sector for the development of new energy systems?**
- **To what extent and in what way does your organization wish to be involved in such collaboration?**

Participant A mentions that the CET center works more closely with the public sector than the private sector. When collaborating with other stakeholders, he believes it is important to establish a shared understanding of the problem from the very beginning of the project. He thinks there is a lot to learn from collaboration with different kind of actors, and he believes such experiences enhance research and education and provide their students with insights on real-world situations.

Theme 7: Open-ended question

- **Anything you would like to add, comment on, etc.?**

Participant C (Eviny Termo) reiterates that we should consider Eviny Termo not only as a district heating operator but also as an energy actor that can play the role of an internal facilitator. He predicts that BKK (Bergen Kommunale Kraftselskap) may have a different perspective and primarily prefer to operate from an external position. He recommends adopting this mindset when communicating with other stakeholders involved in the project.

Appendix 5: Interview Outline – Pilot Dokken – Governance

Stakeholder Subgroup: Local and Regional Government Authorities

Participants: The Municipality of Bergen v/ Bergen Water Agency (Bergen Vann), The Planning and Building Agency (Plan- og bygningsetaten), Department in the Environment (Bymiljøetaten), and The Climate Agency (Klimaetaten)

Participant A: Director of Bergen Water Agency (Bergen Vann)

Participant B: Director of Planning and Building Agency (Plan- og Bygningsetaten)

Participant C: Chief Executive Officer, Head of the Implementation Department in the Environment Agency (Bymiljøetaten)

Participant D: Mobility Advisor for the City of Bergen. Working on electrification and leadership solutions.

Participant E: Director of the Climate Agency (Klimaetaten) (Participating digitally)

All the participants work in bodies/agencies that are subordinate to the Municipality of Bergen and have decision-making authority in their respective organizations.

Theme 1: The energy system of the future

Context:

Society's energy needs are increasing, and a steadily increasing demand for renewable/emission-free energy production is expected in the future. In parallel with meeting challenges related to meeting an increasing energy demand using various forms of renewable energy, efforts are also being made to find solutions that can increase energy efficiency and flexibility in the energy system. Sector coupling is an opportunity to decarbonize certain sectors such as transport and heating. By integrating various renewable energy carriers such as hydropower, wind power, district heating and solar power into a common energy system, one can extract unredeemed flexibility in connection with supply and demand of electricity and reduce peak demands, resulting in lower investment costs and lower energy prices.

Questions:

- **What do you think an ideal smart (flexible and integrated) energy system could look like?**
- **What role do you believe the municipality can play in building an ideal energy system in Dokken?**

Participant D poses an initial question to the moderator, wondering whether they should consider a scenario for 2050. The moderator responds by affirming that they can consider 2050 or even look further ahead in time.

Participant D questions the premise of ever-increasing demand for renewable energy production in the future, which is the context being discussed. Instead, he believes that we are transitioning to electrification until 2050, and after that, we should not need any more increase if we are to achieve goals such as zero emissions. He states that by 2050 we should already be at zero emissions. Participant D emphasizes that this is a crucial premise that needs to be addressed.

Participant C states that they understand the need for energy in the area but emphasize the importance of constructing an area with significantly lower energy requirements compared to the existing areas today. He wonders if there are any measures that can be taken to ensure efficient utilization of the energy consumption in the area or even transform it into a surplus. Participant C believes that about 40 percent of the solution may only be discovered in 2040, indicating that some aspects cannot be fully addressed at present. In addition, he wonders if the newly established Dokken development company has a role in all of this, or why this company is not mentioned. He suggests that certain expectations and ambitions should be placed on the company to meet the set criteria.

Participant D adds that if the buildings constructed at Dokken are according to a standard that is further ahead than TEK17 today, they will not require much energy. They will require some exchange and maintenance but not much energy consumption. He believes that it is easy to forget this when companies like Eviny and others are joining the project, but perhaps we will not need a lot of new energy in the future, except for the transport sector where there will still be a need for energy consumption.

Participant B states that if the starting point is 2050, the premise is that we should not need more energy after that. We should talk more about energy exchange and efficiency instead.

Participant C still finds it important to clarify who should impose requirements on the Dokken development company. He assumes that the municipality will have a role in this regard.

The moderator follows up and says it might be the company that have to set some requirements because they will be responsible for the zero-emissions vision to a large extent. So, you can turn this around a bit in terms of who is making demands from whom.

Participant A talks about Bergen Vann's experiences in collaboration with the "underground" infrastructure partners, which includes Eviny, BKK, Bir, and themselves. He emphasizes the importance of coordinating infrastructure in the area, especially since there is a sea boundary, so access to seawater should be ensured. He notes that infrastructure for waste management should also be in place to facilitate maintenance and expansion potential for future energy needs. Moreover, he suggests that the area should be a plus area for more energy-efficient building structures. Finally, he brings up the potential for system efficiency in water and sewage management, including the possibility of recycling heat from the waste. This has been a crucial point for his involvement in the ELEXIA conversations.

Participant B adds to Participant A' comment above. He notes that we talk about two vastly different visions when it comes to energy consumption in the area. One is to have an area that uses minimal energy, which is perhaps the goal we should aim for. The other vision involves producing as much energy as possible. These two visions require entirely different plans, definitions of land use, and area use definitions. Should energy production be an area usage purpose? How should the buildings be designed to maximize energy production or minimize consumption? He thinks the partners involved in the project and what motivates them plays a crucial role in how the project is executed.

Participant D refers to the new report by the Climate Committee (Norwegian Official Reports) about the choices Norway faces to achieve the goal of becoming a low-emission society by 2050. He finds it genius that the report is based on the UFF principle (Unngå, Flytte, Forbedre) (Avoid, Shift, Improve), which aligns with goals at the Municipality. The idea is to avoid transportation and energy needs as much as possible and focus on shifting people to alternative modes of transportation or utilizing different energy solutions. This principle can also be applied to technology. How little can we manage with, and how can we produce this in the best possible way? Furthermore, he emphasizes the importance of defining the system boundaries. Should the focus be on creating a self-sustaining area at Dokken, or should we consider a broader perspective, such as including Bergen or even the entire country in terms of energy exchange. Participant D thinks it can be dangerous to confine the planning only to Dokken, as it may result in solutions that, although exciting on a small scale, are not optimal in the grand scheme of things. He expressed that if we were to consider a system that goes beyond Dokken, we would not choose to proceed in the same way.

The moderator highlights the advantage of having two additional pilots involved, as it allows for observation of different contexts in two other areas.

Participant E emphasizes the importance of considering the robustness of the energy system when planning for 2050 and beyond, as we can expect an increased diversity of extreme weather. The current energy system is not very resilient in the face of extreme weather, and we have to assume that future extreme weather will be different. Participant E suggests it is vital to question whether the energy system must be constantly connected to a larger system or if it is possible to establish a system that enables functioning entirely locally, in case of extreme events.

Theme 2: New business models in the future energy market

Context:

The energy system of the future means that we must rethink market solutions and business models that are able to exploit the flexibility of the energy system. The new energy system also requires the preparation of energy exchange agreements between several actors across sectors and vectors (energy carriers), and to find solutions for how flexibility is to be priced and financed. With many different actors in the equation, new business models are needed that promote cooperation and earning opportunities for both small and large actors.

Questions:

- **What needs, benefits and drawbacks, opportunities, and barriers do you believe will impact the process of developing new or necessary business models?**
- **What role do you believe government institutions at the national, regional, and local levels play in this context, and what role do you think your organization (agency or BGO in general) can and should play in this effort?**

Participant B reiterates the point made earlier about whether the energy system should solely be designed to produce electricity or to create a sustainable, energy-efficient future. It is about creating a (profitable) system that serves the interests of multiple stakeholders, such as individual apartment owners, infrastructure providers, and residential builders. He suggests a business model that could potentially reduce housing costs and enable individuals to operate their daily usage without any cost. This scenario would allow for social sustainability.

The moderator challenges the previous perspective by highlighting the diversity in urban spaces and building types within the area. Some buildings may be well-suited for solar power generation, while others could be suitable for hosting heat or cooling pumps and batteries. She argues that the individual and economic perspectives, focusing on low or no energy expenses, can be seen as a positive aspect for enabling affordable housing for all. However, she brings up the challenge of integrating these different energy solutions, as there are currently no effective actors that can connect the various energy elements. The goal is to establish connections between the production potential in one building and the flexibility provided by batteries in another building or underground urban spaces.

Participant B explains that if the ambition is to produce electricity, it requires a different approach to regulations, material choices, and development. He emphasizes that they frequently receive applications to cover houses in solar panels, fill basements with batteries, and make profits for sports clubs. However, he acknowledges that this poses multiple challenges, including the overall appearance, child safety, aesthetics, and the perceived environment. Participant B feels that numerous complex issues need to be addressed simultaneously in this context.

Participant D suggests a new approach towards finding solutions to the regulatory and technological barriers that obstruct efficient exchange of energy. He proposes the digital regulation of energy usage to be similar to the intelligent tracking of vehicles[1] already tested out in Bergen.

> *Over the past two years, we have gained experience regulating fleets of intelligent connected vehicles, around 4,500 in the city, digitally. By constantly providing updates on their status, location, and condition, among other things, we can monitor the number of vehicles in different zones and obtain all the data we need digitally to regulate them. Although we have regulations written on paper, we can change the digital regulation from day-to-day, continually adjusting measures such as speed limits, quantity limits, and bans. Participant D*

He wonders whether we can apply some of that mindset to this field as well. He suggests that we could implement digital regulations and charging for the use of public infrastructure such as the power grid, district heating networks, and streets. If we approach this smartly, the digital twin and ELEXIA projects could be incredibly valuable in showing how these elements can be simulated at a system level to see how to achieve city goals in terms of transportation and energy, he adds. Perhaps we could also use artificial intelligence down the line to enhance these tools. It would be fascinating to implement such a project since it is purely a planning exercise.

Participant C raises an important perspective regarding the focus on either increasing energy consumption or striving for zero energy usage, as mentioned earlier. He emphasizes the widely accepted notion in waste management, which prioritizes resource reuse, recycling, and waste reduction. This approach seems to be the opposite of how we currently approach energy usage. Participant C agrees with Participant B's reflection that there are two distinct approaches for designing Dokken and shaping the overall perspective. He highlights the complexity of the current landscape, with various companies engaged in different activities, each with their own protocols, routines, regulations, work methods, and decision-making processes. Consequently, establishing seven separate companies at Dokken, each focused on different forms of energy, would not be the solution. Instead, Participant C suggests a more authoritative approach, where a single entity assumes overall responsibility for energy supply at Dokken, determining how to connect and leverage all available resources. Participant C believes that adopting this kind of approach is key to achieving success.

Participant A elaborates on the importance of considering social sustainability when designing Dokken as mentioned by Participant B. He cautions against creating a system that solely benefits business oriented “suits” who exploit smart technologies and regulations to maximize their gains, leaving the community unable to share in the benefits of becoming a low energy or surplus community. Regarding the current energy market, Participant A believes it is unpredictable, with prices fluctuating dramatically based on energy demand. He expresses concerns about the regulatory framework governing energy production and distribution, stating that it is immature and impractical in practice.

Or overripe, the moderator, interrupts.

Participant A notes that no one seems to be capable of solving the issues at hand. While one can acknowledge that it's not good, EU regulations prevent the necessary actions from being taken as the idea of “free flow” is a must. He believes that businesses should focus on the old idea that the individuals using the power are the ones generating profits, and it should cycle back to them. To participate in the development, there must be an opportunity space (business opportunity) that piques the interest of actors, and the process should be controlled, as opposed to the unregulated approaches seen in recent years.

Participant E agrees with Participant A's point and brings up research that shows greater opposition towards large-scale renewable energy projects such as wind turbines if they are owned by external parties, meaning the money is leaving the region. However, if the project is locally owned, the opposition is significantly less. Participant E cites Germany as an example where this has been observed. He believes there are less complaints about wind turbine noise, for example, if the turbines are owned by a local cooperative, as opposed to when the money is being sent out of the country.

Participant B expands on the point made by Participant A and highlights the importance of ensuring that Dokken's residents do not become small capitalists. However, they propose that an infrastructure plan that considers both mature and immature forms of energy, integration, and possible future scenarios beyond 2050 could address these concerns. He suggests developing a region-wide plan that identifies public spaces, such as roofs, marketplaces, streetlights, and mobility points, which could produce energy while still being used by everyone. Although ownership stakes could be given to individuals, the primary goal of the plan would be to force integrations between various systems. This idea is not uncommon as an infrastructure plan could be formed to meet these goals.

Participant C brings up the topic of strategic control and notes the importance of public ownership over key strategic assets in society, particularly in the water and sewage sectors. He points out that this aspect has been completely missed when it comes to the electricity market. He thinks the most important action to take is for the public sector to own the necessary infrastructure for power generation. For example, a municipally owned energy company at Dokken. He emphasizes the need for public ownership and control over this infrastructure.

Theme 3: A sustainable energy system

Context:

In order to achieve national climate targets and local ambitions for a zero-emission society, the entire energy system (infrastructure, production, distribution, storage and consumption) must become sustainable. This means that all these parts of the energy system must become "cleaner" and more efficient in the future. Many now see local smart (flexible and integrated) energy systems as a way to go to achieve zero-emission societies. In such an energy system, we need renewable energy such as solar energy, hydropower, bioenergy, and thermal energy. In the energy system of the future, it will also be possible for new actors to enter the market on the production side, for example by capturing/producing surplus energy that is sold into the market.

Questions:

- **How does your agency prioritize sustainability goals in questions related to infrastructure, energy planning, and spatial planning?**
- **How do you believe the Municipality of Bergen can use its supervisory role to influence sustainable development within the energy sector?**

Participant B says the answer to the first question is probably 'less and less.' In response to the second question (how the agency prioritizes sustainability goals in infrastructure, energy planning, and land-use planning), the answer is that it is stated in the municipality plan, and we use sustainability goals as a guiding principle in everything they do. It is the only thing we talk about morning, noon, and night.

We use sustainability goals as a guiding principle in everything we do. It is the only thing we talk about morning, noon, and night. Participant B

Participant C says that zero emission is the overarching goal when they build various infrastructures, He notes that the progress made in just two years is significant compared to the initial ambition set by the city council.

The other participants agree.

Participant B adds that 80% of Bergen's development occurs within the framework of Bergen municipality's set goals. This is in line with Nordic thinking and provides people with locally accessible options in their daily lives.

Participant A explains that Bergen Vann systematically looks at their facilities' operations and processes when working on construction projects, particularly when it comes to their climate and energy action plan. They break down the entire supply chain and attempt to improve different elements to become more sustainable or lessen their carbon footprint. Additionally, they have two plants that generate energy. They are also exploring other potential systems that could be realized. In addition, they are considering wastewater energy recovery to produce power and achieve a positive impact.

Participant B, who is responsible for construction projects in the city of Bergen, believes that in the pursuit of combining business-like solutions with climate-friendly solutions, the social sustainability aspect may have been neglected not just here in Bergen, but in many other places. There has been an excessive densification with restrictions on development in private gardens that may be too strict, leading us to lose the support of the majority in the city. We are now in a situation where people no longer want this densification, limitations on land development, or restrictions on transportation. It is explicitly stated in the city government platform that they will facilitate the use of cars to assist the people of Bergen in their daily lives. Clearly, something has been forgotten in the discussions about sustainability, and it is evident that these so-called win-win-win solutions don't exist.

Participant D agrees with Participant B’s concerns and highlights the importance of a cultural shift in achieving the desired changes. While planning, infrastructure, and other factors play a role, ultimately it is about getting people on board. Participant D acknowledges the existence of a genuine counter-reaction against these changes, but it may be somewhat exaggerated (smaller than we think). Many individuals are actually supportive of the main direction of development, and it is essential to engage those who are not that vocal about their opinions. Participant D also expresses caution about potential misinterpretations and falls in the implementation of initiatives such as zero-emission zones. He emphasizes the need to be mindful of these effects and acknowledges the eventual end of private ownership of four-wheeled vehicles by individuals or households by 2050. He concludes that transitioning to fleet-based systems will offer more freedom to people but acknowledges the challenge of promoting this idea effectively.

Theme 4: Regulation

Context:

For us to succeed in developing smart (integrated and flexible) energy systems that are also sustainable, it is essential that existing legislation can be adapted to the new reality. This may entail new environmental requirements, labelling, regulations, and tariffs on the part of the authorities that make it easier to make environmentally friendly choices.

Questions:

- **What barriers and challenges hinder the development of flexible and integrated energy systems in transformation areas like Dokken?**
- **What do you believe are the barriers/obstacles for so-called prosumers or other actors to deliver surplus energy to the market?**

- **What kind of political measures do you think are needed to achieve the transition to a flexible and integrated energy system?**

Participant B acknowledges these challenges, considering that energy production is strategically significant in the public interest. Perhaps people should be allowed to produce energy and feed it into the grid, provided that the municipality owns the grid and infrastructure. However, the availability and development of materials for energy production are critical factors. He asks: "Can we just install a box on the balcony with some panels and generate electricity, or do we need to put ˈuglyˈ panels on the walls to produce electricity? Do we need wind turbines on rooftops? He adds that now is the time to address these issues.

Participant C agrees that timing is critical. In response to Participant B's (?) comment on a municipal energy company that owns the infrastructure at Dokken, Participant C emphasizes that the plan must be put into action soon for the energy company to start working towards sustainable development goals. He also suggests that the energy company would probably have opinions on proposed plans and that addressing these issues should not be postponed until the first building is constructed.

Participant D suggests that by implementing digital regulations and exploring the possibilities of this solution, it may be possible to achieve the desired outcomes. He also proposes allowing private actors on different scales to have some flexibility if the infrastructure has public ownership, and there is a fair pricing mechanism for usage and exchange. Participant D believes this approach aims to ensure social acceptance, sustainability, fairness, and other related aspects.

Participant B highlights an interesting problem regarding the production of energy on rooftops. If we decide to produce energy on all rooftops, it may become an argument against green roofs. What's the point of having green roofs when we can generate power on them?

The moderator interjects, stating that there is a premise underlying the discussion that at least 50% of rooftops should either be green or designated for public use. She notes that the ELEXIA project aims to examine the ideal system for sustainable development over a long-term horizon and evaluate environmental, economic, social, and other factors to determine the potential benefits and drawbacks. It is essential to understand the potential consequences and barriers to implementing such a system thoroughly. The moderator concludes by emphasizing the importance of creating a knowledge base that examines both the positive and negative implications of implementing such sustainable development initiatives.

Participant B expresses agreement with Participant C's point about the exchange of infrastructure being fundamental. No one can predict how energy will be produced in 2050. It could be anything.

Theme 5: Flexibility

Context:

A flexible energy system can be crucial for the transition to a zero-emission society. Utilizing the flexibility of the energy system can be a more profitable and efficient way of dealing with power peaks in the infrastructure instead of developing new infrastructure[2] (Enova). Flexibility can be achieved through interaction between energy forms and actors, but also through the development of new technological solutions that make it possible to exploit consumption and storage flexibility in the energy system. The ELEXIA project aims to exploit the opportunity for better interaction between energy forms and new digital solutions aimed at achieving smart, safe, resilient, and cyber-secure energy systems.

Questions:

- **Will new collaboration models or technological developments have an impact on the role and exercise of authority of the Municipality of Bergen? If so, how?**
- **Do you think that new collaboration models across energy carriers, infrastructure, and systems are a realistic future scenario?**

Participant C starts by stating that technological development has an impact on the role of governmental authorities, so the answer to question one is yes. In response to question two, his answer is "Not without the municipality taking an active role". It may well resolve itself in a century-long perspective, but it will be resolved much faster if someone is actively driving it. And that brings us back to this infrastructure company, or whatever it is, ownership, that they will then have the drive to develop and make it work as efficiently as possible. But someone needs to take on that role, he concludes.

Participant E notes that implementing technology-driven collaboration models requires a stable society that acknowledges the legitimacy of such collaboration. When considering future scenarios based on socioeconomic models presented by the climate panel, some indicate potential conflict and societal tension. Flexibility is seen as a crucial aspect for the future, yet difficult to predict. Participant E emphasizes that a polarized society, at local, regional, or international levels, could hinder access to resources necessary for more flexible collaboration models. Ultimately, she believes the potential for collaboration depends on the extent of polarization and cooperation within society, particularly concerning technology partnerships.

Participant A points out the difficulties of finding business models that make it interesting for private actors to participate in developing technology and achieving controlled profit margins. It is challenging to determine where the potential lies, as everyone will seek to develop and invest in projects that they believe can generate future profits. This process is unlikely to work through public initiatives. Therefore, finding collaboration models that allow private technology and system companies to contribute their resources and expertise to a pilot program would be desirable. However, they would need to see some form of future profit, either in the short or long-term.

The moderator mentions the cooperative model presented by Eviny Termo, where an established limited liability company owns the area, and future developers and building owners have the opportunity to own shares in the company.

Participant A thinks this is an exciting concept and continues to explore the idea: One could create an infrastructure plan for an energy-producing area. The primary focus of this area would be energy production. The surplus energy generated can be used for heating the houses in the vicinity. Essentially, it would function as a dam or a gigantic wind turbine. Based on decision related to infrastructure, the infrastructure plan can be developed, allowing both residents and companies to become co-producers. Companies can own buildings, and there are opportunities for innovative ideas involving the vehicle fleet mentioned earlier. This concept opens up a realm of exciting possibilities.

Participant D suggests that there are lessons to be learned from electric scooter companies, where high expectations for profits have resulted in many regulations being put in place. Unfortunately, these regulations have limited the companies' profits and resulted in a decrease in applicants. This situation provides an opportunity to learn more about infrastructure ownership, pricing, and other requirements.

Theme 6: Technology development and cooperation

Context:

The ELEXIA project, pilot Dokken, involves collaboration between research actors, public actors (mainly municipalities) and private energy and technology actors who contribute their expertise and perspectives to the development process.

Questions:

- **What advantages and disadvantages do you see in a tripartite collaboration between academia, the public sector, and the private sector for the development of new energy systems?**
- **To what extent and in what way does your organization wish to be involved in development processes like this?**

Participant A believes that a tripartite technology collaboration provides a mutual increase in competence for all parties involved. Academia becomes more practically oriented, thinking about possibilities rather than just focusing on the past. On the other hand, the private sector gains a better understanding of our needs and can provide tailored solutions and adjustments. Overall, he thinks that this collaboration leads to effective development and improvement.

Participant B thinks there is a lot to learn for the Municipality of Bergen here. Bergen Vann has been good at managing this, but in comparison to Trondheim, which hires seven people at SINTEF to administer application processes, initiate connections, and develop ideas, they are lagging behind. The Municipality of Trondheim is far more advanced in this area.

Participant C proposes a general idea for Dokken, suggesting that a certain amount of money could be allocated and managed by a collaboration between academia, public, and private sectors. This collaboration could aim to achieve a common goal, and it would require a framework and financial resources. Participant C expresses strong belief in the approach mentioned by Participant A and others.

Participant B agrees with Particiant A's idea but adds that the whole intention behind the collaboration should be for all parties to learn and grow. The intention cannot solely be for companies to make lots of money, for the municipality to solve its problems, or for academia to publish in high-impact journals. There must be a different motivation for the collaboration to fall under research and development rather than potential profit realization. Participant B believes that getting large private companies on board with this idea could be quite challenging.

Participant A shares that their involvement in an EU project on climate adaptation and green solutions has helped their team implement more future-oriented and effective solutions. This project has contributed to a better understanding of how to practically address climate change, and the team has been able to disseminate this perspective throughout the entire municipal system. It has become the standard to think in terms of green solutions and state-of-the-art approaches to meet climate change. His conclusion is that these efforts have ultimately helped the city become more resilient to climate change.

Theme 7: Open-ended question

- **Anything you would like to add, comment on, etc.?**

Participant E joined the discussion digitally but experienced some connectivity issues. Consequently, she was mostly present in a passive capacity throughout the conversation. Her closing comment was a reminder for the project to consider the issue of sea-level rise in their future planning.

Participant A agrees with Participant E’s final comment.

Stakeholder Subgroup: National Authorities

Invited actors: NVE and NVE-RME

Participating actors: NVE (no response from NVE-RME)

Norwegian Water Resources and Energy Directorate (NVE) is a government agency responsible for administering Norway's water and energy resources. Its tasks include supervising the energy and water supply, regulating the market, and promoting the use of renewable energy sources.

The Norwegian Energy Regulatory Authority (NVE-RME) is the national regulator for the Norwegian electricity and downstream gas markets.

Theme 1: The energy system of the future

Context:

Society's energy needs are increasing, and a steadily increasing demand for renewable/emission-free energy production is expected in the future. In parallel with meeting challenges related to meeting an increasing energy demand using various forms of renewable energy, efforts are also being made to find solutions that can increase energy efficiency and flexibility in the energy system. Sector coupling is an opportunity to decarbonize certain sectors such as transport and heating. By integrating various renewable energy carriers such as hydropower, wind power, district heating and solar power into a common energy system, one can extract unredeemed flexibility in connection with supply and demand of electricity and reduce peak demands, resulting in lower investment costs and lower energy prices.

Question:

How do you envision an ideal smart (flexible and integrated) energy system?

Participant A believes that flexibility is an important concept on both the production and consumption sides of the energy sector. He understands that the ELEXIA project is primarily focused on the consumption side, which he believes is an exciting area where there is a lot of activity and development to come. With increasing demand for power and more supply of intermittent renewable energy from sources like wind and solar, the need for flexibility from both the production and consumption sides is becoming increasingly important. In the past, the power system had a high degree of flexibility in hydroelectric power and power regulation capacity, as well as a well-developed network. However, with changes to the power system and more supply of intermittent renewable energy, the need for flexibility will continue to increase. Participant A believes that ideal energy systems will include measures that can help address demand variations, such as shifting peaks, reducing demand, or increasing production. Any measures that can help manage these variations will ultimately be beneficial.

Theme 2: New business models in the future energy market

Context:

The energy system of the future means that we must rethink market solutions and business models that are able to exploit the flexibility of the energy system. The new energy system also requires the preparation of energy exchange agreements between several actors across sectors and vectors (energy carriers), and to find solutions for how flexibility is to be priced and financed. With many different players in the equation, new business models are needed that promote cooperation and earning opportunities for both small and large players.

Questions:

- **What needs, benefits, drawbacks, opportunities, and barriers do you believe will impact the process of developing new or necessary business models?**
- **What role do you believe government institutions play in this context, and what role do you think NVE should take in this effort?**

Participant A explains that the Norwegian Water Resources and Energy Directorate (NVE) has ambitions and desires to develop forward-looking regulations that incentivize the private sector to choose sustainable solutions. However, he points out a weakness in the system. No matter how good NVE may be, the bureaucrats and government officials in NVE may not be able to anticipate the opportunities created by new technologies and the market's needs in time to have everything in place for the early adopters. There is an innovation phase here that we must try to assist in other ways, he adds. Typically, research projects and development projects are helpful in that regard. He adds that NVE/RME is an expert in providing incentives to the grid companies and refining their revenue framework model. By optimizing incentives and developing regulations around them, NVE/RME can play a crucial role in promoting the transition to a more flexible energy system. He states that NVE has a role to play in this, and they are actively trying to fulfil that role.

Theme 3: A sustainable energy system

Context:

In order to achieve national climate targets and local ambitions for a zero-emission society, the entire energy system (infrastructure, production, distribution, storage and consumption) must become sustainable. This means that all these parts of the energy system must become "cleaner" and more efficient in the future. Many now see local smart (flexible and integrated) energy systems to achieve zero-emission societies. In such an energy system, we need renewable energy such as solar energy, hydropower, bioenergy, and thermal energy.

Imagine that you are going to build a building/own a building at Dokken that contributes to achieving the zero-emission vision.

Questions:

- **How does NVE prioritize the Sustainable Development Goals in their work, and how do you believe NVE should use its management role to influence sustainable development in the energy sector?**
- **In what ways do you think environmental and climate considerations should govern energy projects like Dokken? Additionally, what considerations do you believe can outweigh climate considerations in these types of projects?**
- **What do you believe are the (regulatory) barriers/obstacles for so-called prosumers or other actors to deliver surplus energy to the market?**

Participant A acknowledges the complex relationship between environmental considerations and the energy sector. He explains that the situation is somewhat unique in Norway due to the presence of renewable hydropower, although not without conflicts. However, on a broader scale, there is a connection between power in Norway and power in Europe. This connection leads to controversial discussions regarding questions such as where and how reducing energy consumption can effectively reduce climate and gas emissions. Participant A goes on to elaborate on the relationship between Norway and Europe. If Norwegian power is considered renewable, as most people do, then increased or decreased consumption would have little impact on climate and gas emissions. However, if there is a link to Europe, and one argues that there is an impact on the use of coal power in Europe, then actions in Norway can have significant effects. It is not wrong to have different opinions on this matter; there are just different ways of looking at it. However, in practice, it is challenging and controversial, and often it results in not evaluating measures regarding climate and gas emissions. Participant A refers that often emissions reduction and energy efficiency, or reduced energy consumption, are discussed as two separate goals to avoid the discussions on how closely they are related.

The moderator asks if NVE deals with district heating as an energy carrier and its production.

Participant A confirms that NVE is involved with district heating, but they have limited control over what goes into the district heating system. However, NVE grants licenses to large district heating plants, so the input into district heating is a relevant topic. Emissions from district heating must be managed according to an emissions permit from the Norwegian Environment Agency (Miljødirektoratet). Therefore, the emissions permit and any associated fees or quota obligations are decisive factors. Participant A brings up the topic om energy labelling scheme for buildings and recalls working on it during their early years at NVE. Currently, the government is considering changes to the scheme, with one of the goals being to promote district heating and provide better incentives for its use. NVE has recently submitted a proposal for weighting factors, also known as primary energy factors, which are factors included in the calculation to determine the energy performance of a building (measures A to G). Climate gas emissions are one of the criteria here, he adds.

The moderator asks Participant A about his reflections on barriers or obstacles for prosumers and other actors who can supply surplus energy (from heat or electricity) back to the market.

According to Participant A, one of the main limitations for both prosumers and surplus energy suppliers is the ability to receive and transport the energy further. He explains that solar power requires a power grid capable of accommodating the influx of new power, while surplus heat needs a suitable heating system. This dynamic poses challenges as weaker grids may struggle to handle such large inputs. The infrastructure required for these purposes can be quite costly, creating a significant barrier. Participant A notes that actors involved in solar energy often encounter resistance from network representatives, as solar energy surplus typically occurs in the summer, precisely when network owners experience the lowest demand. Similarly, the existing pipes in a district heating system have limited capacity, which affects the integration of surplus heat sources. Another barrier is the temperature requirements of district heating systems. Often, district heating networks operate at high temperatures, making it difficult to directly incorporate surplus heat sources with lower temperatures. Participant A suggests that if district heating systems could transition towards lower temperatures, it would facilitate the utilization of surplus heat sources. To conclude, Participant A emphasizes the need for a change in attitudes and highlights the significance of including smaller heat sources within the system, rather than relying solely on centralized structures. To sum up, the two main barriers for solar power are the capacity of the power grid and lack of profitability. Similarly, the two main barriers for district heating might be capacity of the district heating grid, and the temperature requirements. Participant A believes these barriers might affect a scenario with local production back into the market at Dokken.

Theme 4: Regulation

Context:

In order for us to succeed in developing smart (integrated and flexible) energy systems that are also sustainable, it is essential that existing legislation can be adapted to the new reality. This may entail new environmental requirements, labelling, regulations, and tariffs on the part of the authorities that make it easier to make environmentally friendly choices.

Questions:

- **What barriers and challenges stand in the way of the development of smart (flexible and integrated) energy systems in transformation areas like Dokken?**
- **What changes in rules and regulations can be expected to facilitate energy exchange among prosumers?**
- **What type of political measures do you believe will be necessary to achieve the transition to a flexible and integrated energy system?**

Participant A notes that there is most attention on, and it is easier to think about production flexibility rather than flexibility of energy use. The context of theme 4 also highlights a focus on solar cells, wind turbines, and thermal energy delivery, reflecting the emphasis on flexibility in production. A challenging thought (and barrier) is to have a greater emphasis on the flexibility of energy use. When it comes to flexibility on the user side, as of today, there are obviously much greater opportunities on the thermal side than on electricity. Batteries are very expensive, while hot water is much more readily available. Leveraging thermal energy and controlling power usage to produce hot water when energy is available and storing it until it is needed is a good idea, and there are mechanisms and business models that could be developed to achieve this. He mentions some experiments around the world on controlling hot water tanks so that they are heated when energy is cheap, and so on. In small scale, this can reduce the variation in demand for a building, and aggregators can combine this to give results also for the larger energy system.

The moderator brings up the issue of sharing energy between buildings, which the real estate actors mentioned several times in their interviews. The problem is that buildings are often divided into separate organizational numbers (and the same owner may have buildings covering more than one estate), which poses challenges for implementing energy sharing even between buildings owned and developed by the same company, whether it involves locally produced electricity from solar panels or solar heating systems.

Participant A acknowledges that this is a problem for solar power, and it is one of the barriers that the Parliament, the ministry, and his colleagues at RME have tried to address. Participant A emphasizes that there is a strong desire to establish better sharing arrangements. However, this desire is challenged by the fact that using the power grid incurs a cost. You are using a portion of the power grid's capacity, and then others must bear the cost. Therefore, it is always a trade-off between these considerations. However, he does not rule out the possibility that there will be a proposal for more extended sharing options for solar power in the near future. Participant A does not believe there are any similar regulatory barriers for solar heating. In terms of heating, there are no regulations that are particularly challenging to overcome, whether it is sharing heat generated through solar or heat pumps.

The moderator believes that this issue is primarily related to how the climate budget is calculated in certifications and similar factors, contributing to it being perceived as a barrier.

Participant A explains that one part of this discussion revolves around the background of the weighting factors in the energy labelling system discussed earlier. The focus of the ongoing regulatory changes is due to the dissatisfaction expressed by the district heating industry, which claimed to be discriminated against in the calculation method. While NVE argues there is no discrimination, it depends on what you want to use this calculation for. However, a proposal has been made where the district heating industry is given a slight advantage in the calculation, but they are still not satisfied. Participant A continues by emphasizing another important part of this picture that also pertains to the sharing of solar heat within a project like the one at Dokken. He highlights the strength of the district heat system in having multiple heat sources and significant flexibility in heat production. The district heating system has the capability to utilize the most cost-effective source at any given time and combine them into a hot water system. This flexibility surpasses that of building owners who maintained their individual heating systems. However, up until now, district heating has almost always been priced at a rate that is like electricity rates. The district heating company blends all of these sources and sells it at the same rate as electricity. Consequently, if building owners always must buy heat at the same rate as electricity, they have no real incentive to use district heating. Therefore we need some innovation and new thinking from district heating actors to encourage the proper use of their system, he concludes.

Theme 5: Flexibility

Context:

A flexible energy system can be crucial for the transition to a zero-emission society. Utilizing the flexibility of the energy system can be a more profitable and efficient way of dealing with power peaks in the infrastructure instead of developing new infrastructure (Enova). Flexibility can be achieved through interaction between energy forms and actors, but also through the development of new technological solutions that make it possible to exploit consumption and storage flexibility in the energy system. The ELEXIA project aims to exploit the opportunity for better interaction between energy forms and new digital solutions aimed at achieving smart, safe, resilient, and cyber-secure energy systems.

Questions:

- **Will new collaboration models or digital systems have an impact on NVE's role and exercise of authority? If so, how?**
- **Do you believe that new collaboration models across energy carriers, infrastructure, and systems are a realistic future scenario?**
- **Are changes in regulations, new guidelines, or regulations expected to force changes in the energy market and new collaboration solutions to avoid unnecessary energy waste, heat dumping, or lost optimization solutions at the area level?**

Participant A explains that it is typical for grid companies to base their system plans on the assumptions made by municipalities. They plan the necessary infrastructure according to the anticipated development and power requirements of a given number of homes and various industries. These figures are based on the obligation of grid companies to provide service (leveringsplikt). However, in large-scale projects like the one at Dokken, developers can demonstrate the potential for lower power requirements per resident or workplace by employing certain solutions. This can provide opportunities for negotiation, as grid companies can reduce their investments in transformers and grid capacity. Developers can propose measures to reduce grid strain during development in exchange for a share of the profits. Participant A hopes to see more of these negotiations in such large-scale developments. Regardless, he believes that single buildings cannot have much influence in this process.

Theme 6: Technology development and cooperation

Context:

The ELEXIA project, pilot Dokken, involves collaboration between research actors, public actors (mainly municipalities) and private energy and technology actors who contribute their expertise and perspectives to the development process.

Questions:

- **What advantages and disadvantages do you see in a tripartite collaboration between academia, the public and private sectors for the development of new energy systems?**
- **To what extent and in what way does your organization wish to be involved in development processes like this?**

Participant A sees numerous advantages in these kinds of projects. Projects of this nature are crucial because regulations often fail to sufficiently anticipate future requirements. Within large projects like this (ELEXIA), it should be feasible to involve both public entities, infrastructure providers, and private actors, he concludes, as this prospect is of great interest to multiple parties.

Moderator adds that it is the infrastructure owners that have been the driving force behind getting involved in this project, so they own the concept themselves to a large extent. (Drivers: Energy flexibility can improve their systems and reduce costs).

Participant A underlines the complexity in the process that involves the interaction between municipal planning and developers. Getting the right sequence of decisions and aligning them correctly with the plans and investment decisions of grid companies and district heating providers is an intricate process that several stakeholders are involved in.

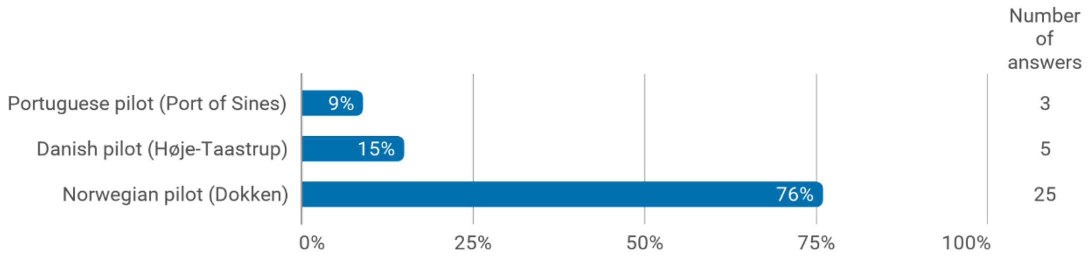
Theme 7: Open-ended question

- **Anything you would like to add, comment on, etc.?**

Participant A brings attention to the EU directives related to renewable and energy-efficient energy that offer incentives for local energy and renewable energy communities. These concepts have not been prevalent in the Norwegian energy supply system, where centralized systems have been preferred. However, there is now a greater demand for solutions on the user side, highlighting the need to involve and mobilize residents, owners, and all stakeholders. This approach represents a shift in energy policy, mobilizing multiple parties to tackle the significant challenges facing the sector.

Appendix 6: Survey Results

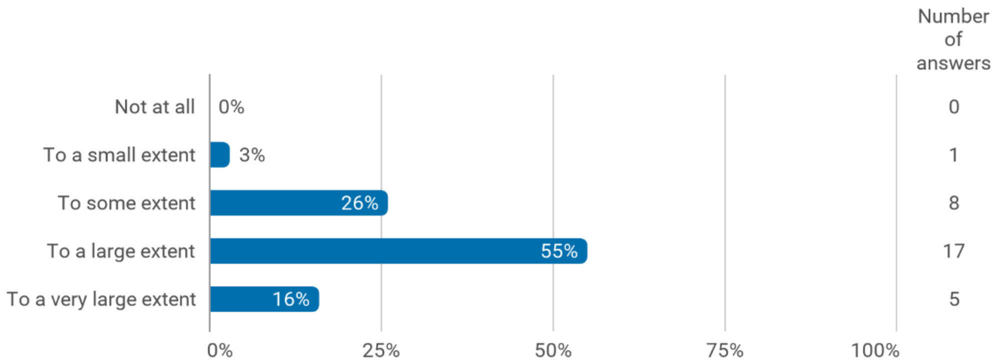
Norway had the most interviewees, 16 interviews and focus groups (with many more participants in each group); hence they were the largest group of respondents. In Denmark ten people were interviewed, half responded to the survey. In Portugal email interviews are not completed at the time of writing, but we can see that interviewed individuals also responded to the survey at this time.



Knowledge

The knowledge/awareness indicators measure the level of understanding and familiarity stakeholders have with the concept of a flexible and integrated energy system. It focuses on the extent to which stakeholders are aware of this innovation and comprehend its functioning. In our survey, this was measured using three questions, one of which was an open-ended question where participants could answer freely. The results of these are presented below.

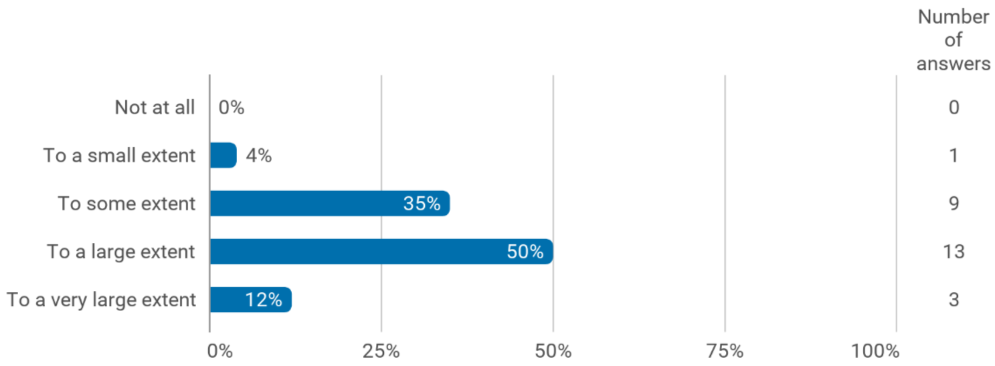
Generally, to what extent would you say that you understand what a flexible and integrated energy system is?



What comes to mind when you hear the words "flexible and integrated energy system"? (You can answer with either full sentences or just a few keywords if you prefer)
Future-oriented, sensible, but often technical and not very user-friendly
Flexibility on both production and user's side
Sharing, load control, energy market,
Waterborne heat
Use of flexibility functions in sector coupled energy systems
That the use and production of "whatever energy" is coordinated and work together. That no energy goes to waste
Systems that can produce and exchange energy between buildings, within a defined area In a flexible and integrated system, the energy is produced and distributed in an ideal way without technical, economic, and legal barriers

Small energy systems for a local area based on several flexible energy sources
Circular economy Sustainability Interaction New business models
Renewable energy sources, decentralized power generation, optimization, dynamic demand-response mechanisms.
Integration between systems as natural gas, district heating, power, waste, transport
An energy system that utilizes and manages local energy solutions / consumers in the most sustainable way possible
Environmental Benefits Cost Reduction for the user/owner.
Energy flow both ways. Different energy sources. Energy produced locally and centrally
Efficient sharing of renewable energy within a community
Effective, seamless, automatic, adjustable
Consumer, future, sustainability
A system consisting of energy sources and energy consumers that both have the required capacity and the means to balance, prioritize and restrict the power usage in a specific area.
A flexible and integrated energy system reflects a sophisticated and responsive infrastructure. It's akin to a well-coordinated network that manages diverse energy sources, namely solar, wind, and conventional power sources. Focusing on adapting to fluctuating demands, it ensures reliability and efficiency. The goal is to establish a highly integrated and dynamic energy system capable of matching energy load and demand.
Must integrate a wide variety of both consumers and producers of energy in an area in an intelligent way Has employed balancing mechanisms (pricing, algorithms, etc.) that maintains a steady supply and exchange with the wider grid. Manages different solutions for intermediate storing of electric energy in an optimal way (batteries, H2, etc.)
Future Energy saving Smart
Sharing energy - available when you need energy. Easy and safe solution/system Good for the environment

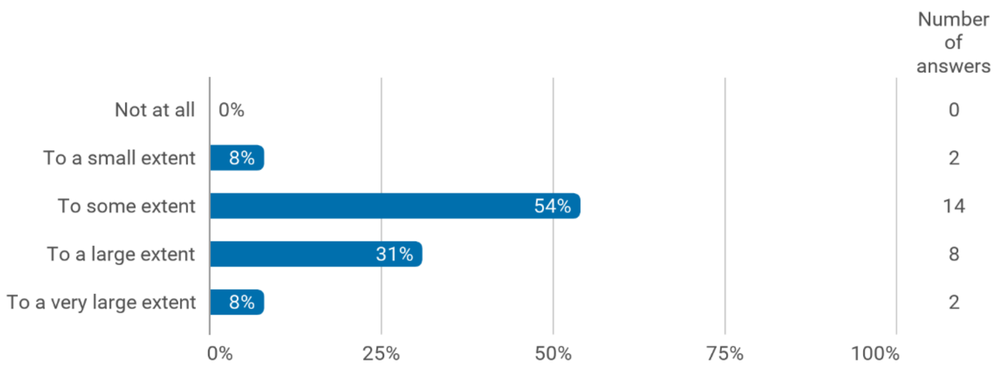
Generally, to what extent would you say that you understand what impacts such a system may have on emission reduction objectives, energy savings (energy efficiency), and reaching national and global climate goals?



Trust

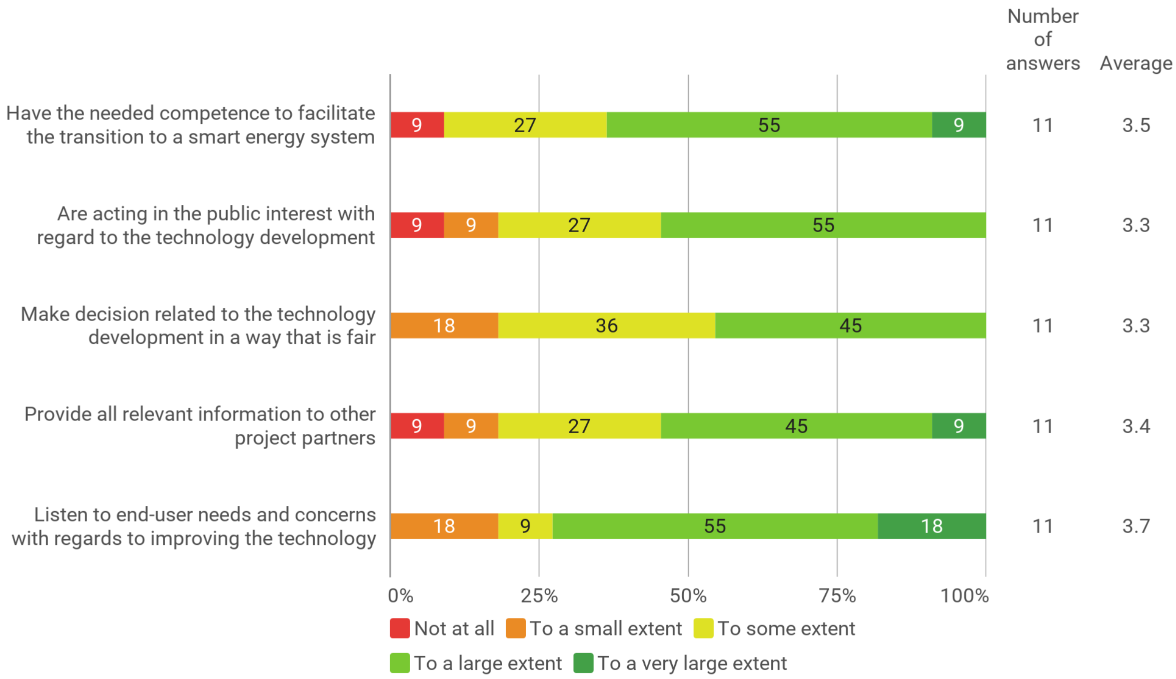
The trust indicators measure the level of trust that external stakeholders have in the project partners' (governance institutions/implementation institutions/research institutions) ability to achieve integrated energy sector innovation at the Pilot site.

Generally, to what extent do you trust the capacity of the consortium (project partners) to create a flexible and integrated energy system which is applicable in the future (at Dokken, Høje-Taastrup, and Port of Sines)?



Generally, to what extent do you trust that the local government:

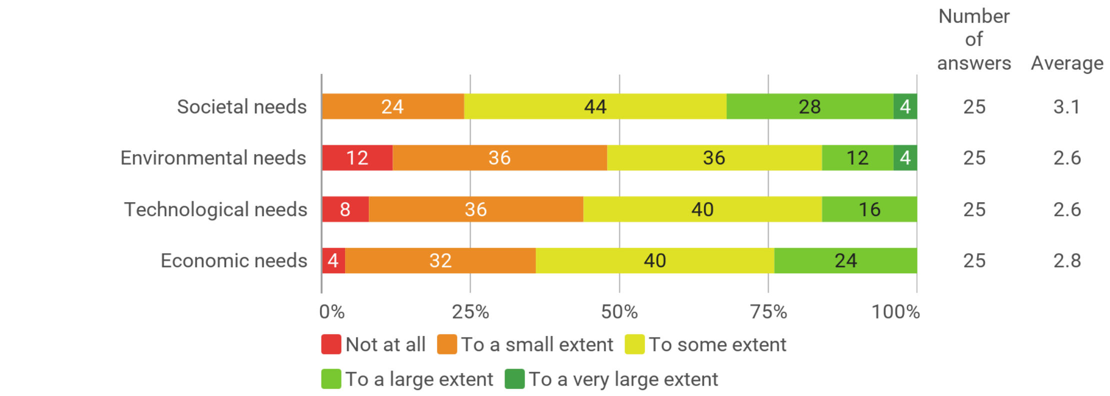
Generally, to what extent do you trust that the industry partners (energy providers, infrastructure providers, technology providers): (This question was only given to internal stakeholders)



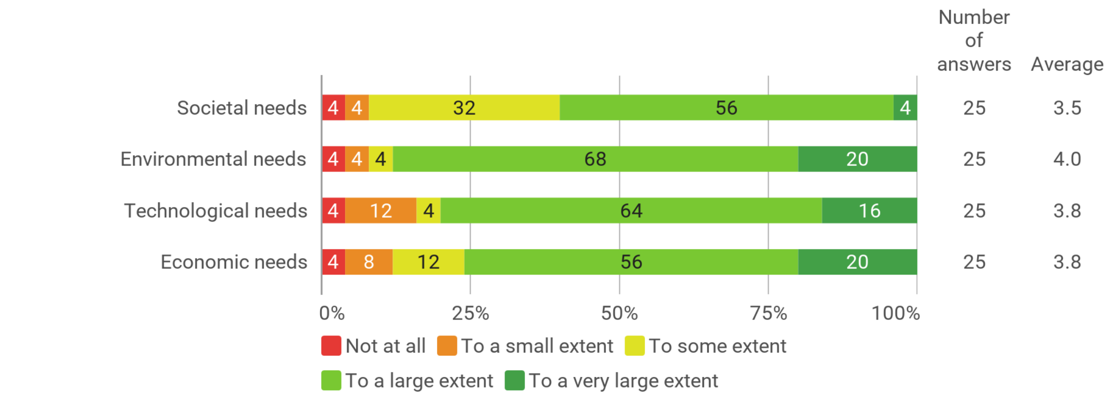
Satisfaction

The satisfaction indicators measure whether stakeholders are satisfied with the way the project objectives meet its (future) societal, economic, technological, and environmental expectations. Specifically, we have designed questions that provide us with a comparison between how the stakeholders believe that the current energy system, as opposed to a flexible and integrated energy system, is suitable for accommodating future social, economic, technological, and environmental needs.

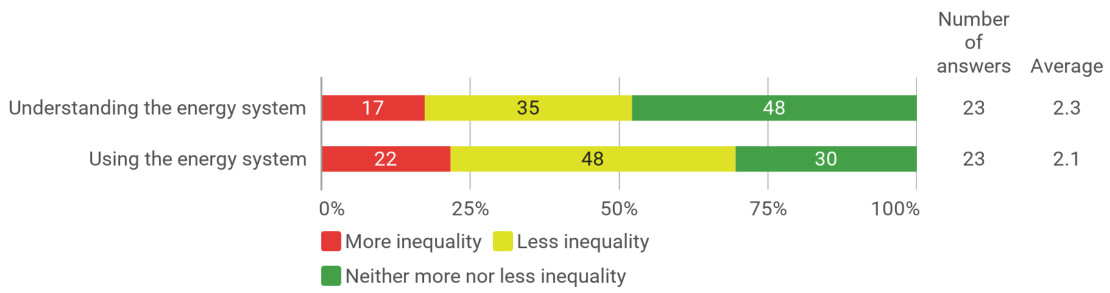
Generally, to what extent to you believe the current energy system is suitable for accommodating the following needs in the future:



Generally, to what extent do you believe that implementation of an integrated and flexible energy system will help accommodate the following needs in the future:



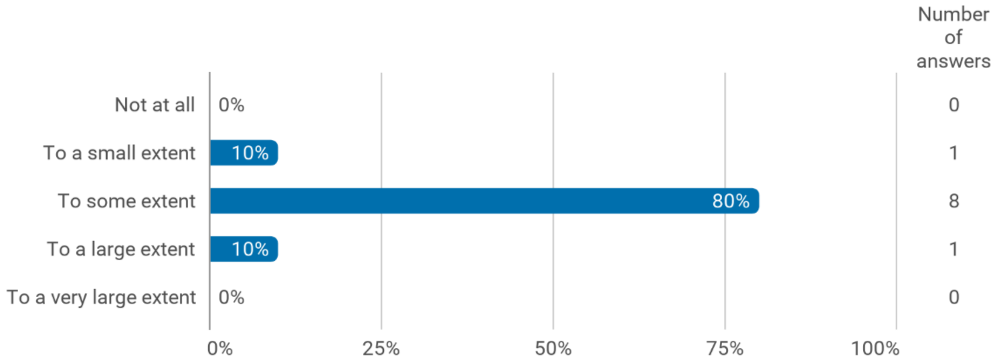
Do you think a flexible and integrated energy system will contribute to more or less social inequality in terms of:



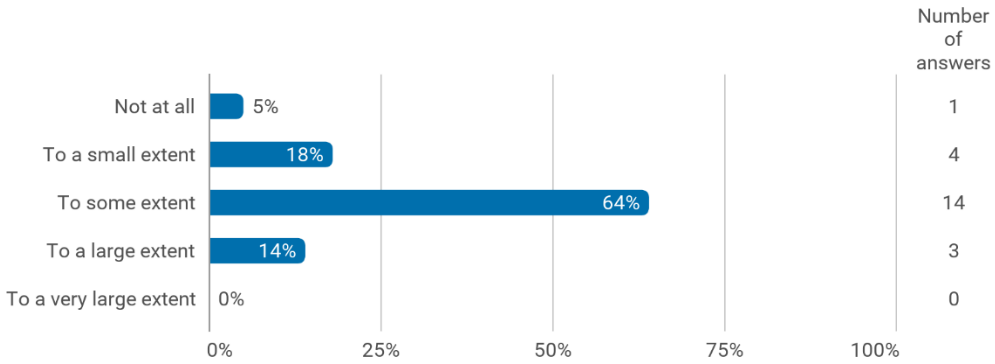
Communication

The communication indicators measure how stakeholders perceive the benefit and effectiveness of communication strategies in the ELEXIA project, how they would prefer to stay involved in future developments in the project, and how they perceive the benefit the exchange of information between project partners and future users of the project outputs (i.e., a flexible and integrated energy system).

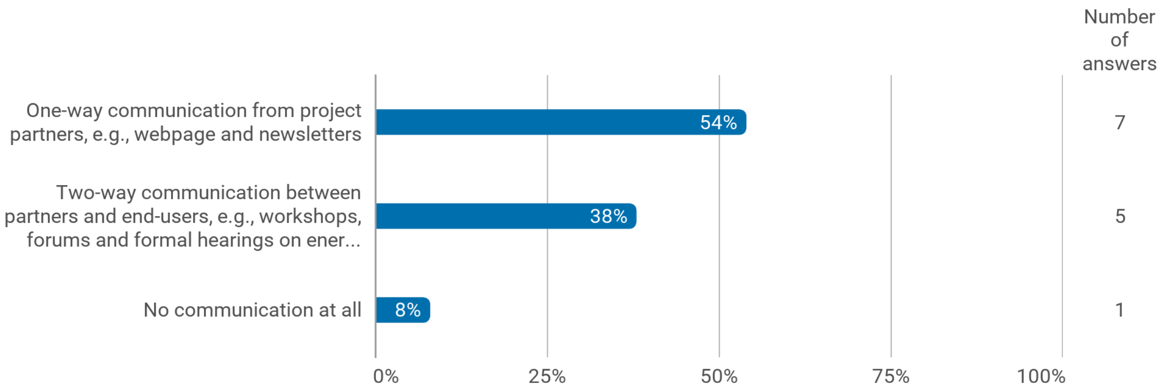
Generally, to what extent do you believe that the current communication channels in the ELEXIA project are beneficial for the exchange of information between project partners? (This question was only asked to internal stakeholders)



To what extent do you believe that the current communication channels in the ELEXIA project are beneficial for the exchange of information between project partners and future users of the flexible and integrated energy system?



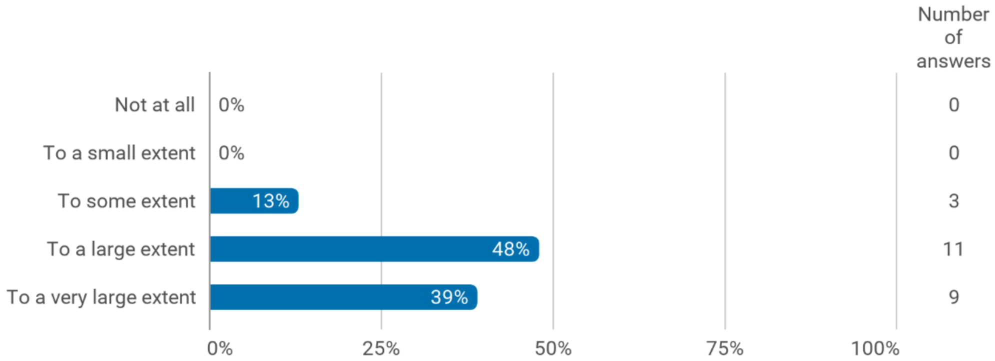
In the future, how would you prefer to stay involved in developments in the ELEXIA-project? (This question was only asked to external stakeholders)



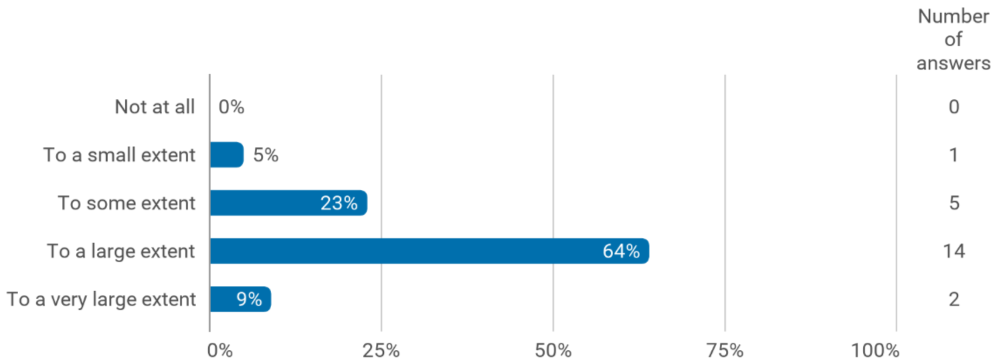
Technology Cooperation

Technology cooperation is understood as a two (or more)-way, ever-evolving interchange in which all participants play an active role in a dynamic manner (Mallet 2007). The technology cooperation indicators measure whether stakeholders are satisfied with the chosen form of technology cooperation in the project, which is involving the public, private and academic sector in addition to including the views and perspectives of end users.

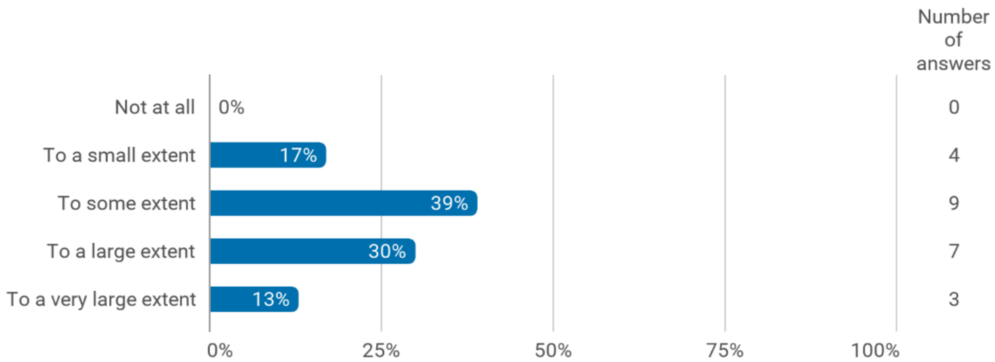
Generally, to what extent do you believe a tripartite collaboration between academia, the public sector, and the private sector is important for the development of an integrated and flexible energy system?



Generally, to what extent do you believe that the project partners (from academia, the public sector, and the private sector) are able to collaborate to create an integrated energy system which is applicable in the future (at Dokken, Høje-Taastrup, and Port of Sines)?



Generally, to what extent do you believe end-users of the future energy system should be involved and engaged in the early phases of the technology development process?



Appendix 7: Community and Stakeholder Engagement Guide

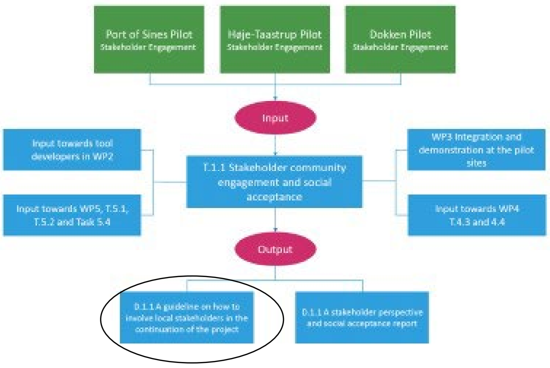
Contents

Forword

Sector coupling creates flexibility for the power system that can be crucial for the transition to zero-emission societies. At the same time, it opens for new societal issues that must be understood and overcome in order to be accepted and deployed by the local communities. Lack of feedback from stakeholders early in the process can lead to tools being developed that do not meet the expectations and needs of future energy system users, thus preventing acceptance by different actors in the community.

In the context of the ELEXIA project, we share two core beliefs 1) We should not directly influence social acceptance regarding acceptance objects, but we can help identifying barriers and give support in finding solutions to overcome these barriers (Leucht et al. 2010, p. 5); 2) Social acceptance needs to be subjected to public scrutiny. It should not be considered merely as an obstacle to overcome and as a necessary condition to support innovation (Casiraghi et al. 2021).

This guide is an integral component of the ELEXIA project's delivery for WP1, Task 1.1, intended to offer some guidelines for engaging local stakeholders in the forthcoming project period (2024-2026) at the three pilot locations Port of Sines (Portugal), Høje-Taastrup (Denmark), and Dokken (Norway).



Introduction

Within this guide, the social scientists involved in Task 1.1 provide three recommendations aimed at fostering social acceptance of a flexible and integrated energy system at Pilot Dokken. These recommendations are developed based on the examination of the five social acceptance indicators outlined in Deliverable 1.1, "Stakeholder perspectives and social acceptance," as well as the feedback acquired from participants in the initial survey. The results from the initial survey are presented in PART 2.

At the end of the project period, Task 1.1's social scientists plan to distribute the survey once more and conduct another evaluation to determine whether there have been any alterations in the level of social acceptance throughout the project duration.

Ultimately, it is up to the project and the pilots themselves to decide whether to implement one or more of the proposed recommendations as part of their stakeholder management approach within the ELEXIA project.

Terminology

Social acceptance

A bundle of processes of decision-making on issues concerning the promotion of or counteraction against a new phenomenon and new elements in the transformation of current energy systems (Würstenhagen et al., 2007)

Stakeholder

Any actor in society who can affect or be affected in one way or another by the launch of new products or new technology, even if they are not necessarily aware of it.

Stakeholder Mapping

Stakeholder Mapping is a technique for visually presenting stakeholders in a community and their unique roles and connections to each other in the project.

Stakeholder Engagement

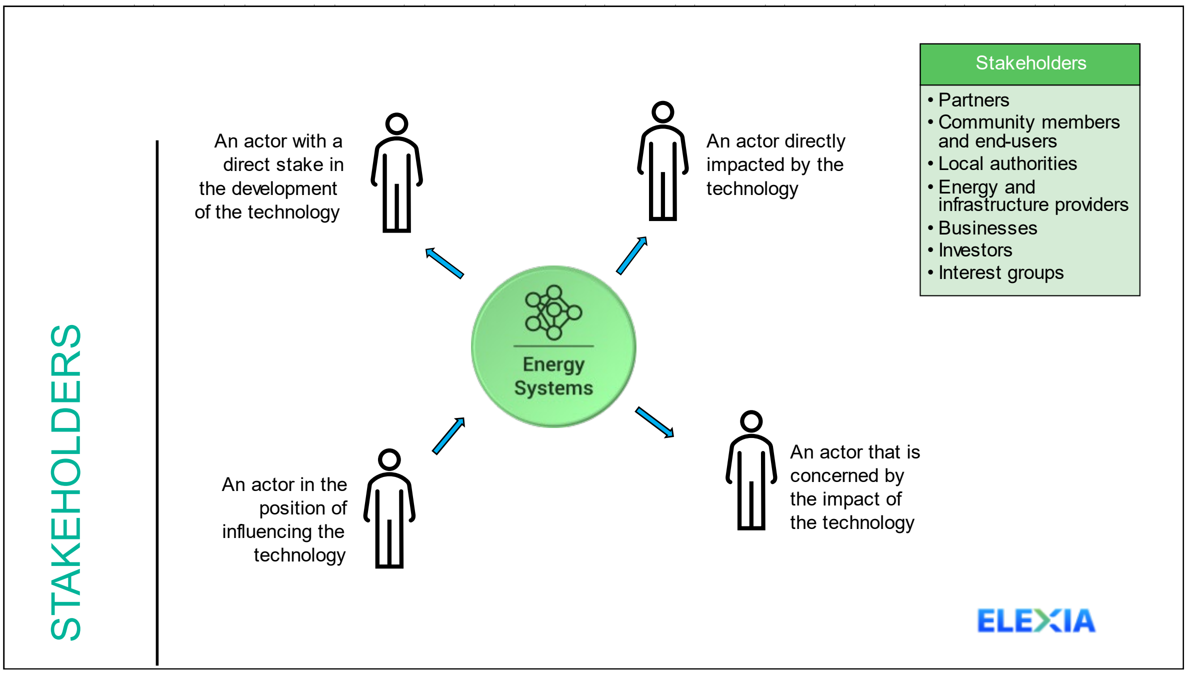
Involving stakeholders in project decision-making, communication, and other activities to build trust, increase support, and manage potential barriers that can prevent the development and implementation of a flexible and integrated energy system. (Look at what is written about "Ethical stakeholder engagement" in the notes.

ELEXIA

PART 1

Stakeholder Community Maps

ELEXIA



Stakeholder Community at Pilot Dokken

Table 1: Users of the future energy system – Pilot Dokken

Individual users	Public and private buildings as users	Large -scale users
Residents/ occupants	**Agency for Construction and Real Estate (Etat for bygg og eiendom)**	**BIR**
	Development Agency (Etat for utbygging)	Plug (shore power provider)
	GC Rieber/ Entra/OBOS /BOB/ **Sammen/UiB Eiendom /Bonova**	**Bybanen (Bergen light rail)**
	Statsbygg	**Eviny Termo (when they use their electric boiler for heating)**
		Mobility Hub

Table 2: Providers of the future energy system – Pilot Dokken

Infrastructure provider	Energy provider	Energy management provider
Eviny Termo (heating and cooling)	**Eviny Termo (heating and cooling)**	Climify
BKK (electricity)	Electricity company (e.g., Fjordkraft)	Energy technology company (e.g., Volte)
BIR (waste management)		
Plug (charging equipment)		
Bergen Vann (drainage)		

Table 3: Influencers of the future energy system – Pilot Dokken

Media	Knowledge institutions	Interest organizations
Bergens Tidende (local daily newspaper)	**Centre for Climate and Energy Transformation (CET)**	Friends of the earth Norway (Naturvernforbundet)
Bergensavisen (local daily newspaper)	The Bjerknes Centre for Climate Research	
Communication advisors in public and/or private organizations		
NRK (TV broadcasting)		
TV2 (TV broadcasting)		

Table 4: Governance actors within the local, regional, and national level with decision -making power towards the future energy system – Pilot Dokken

Local authorities*	Departments in the local municipality	Regional and national authorities
The Municipality of Bergen (BGO)	**Municipal agencies (e.g., The climate agency, The city environment agency, Agency for Construction and Real Estate, and the Development agency.**	**Norway's Directorate of Water Resources and Energy (NVE)**
		The Regulatory Authority for Energy (RME)

(Bold text indicates participation in focus groups or interviews fall 2023)

Stakeholder Community at Pilot Høje-Taastrup

Table 5: Users of the future energy system – Pilot Høje -Taastrup

Individual users	Public and private buildings as users	Large-scale users
Users of municipal buildings: **Townhall employees,** students, guests	Town hall	Datacentre
	Mølleholm Skolen	**HøjeTaastrup Fjernvarme**
	Borgerskolen	Transportcenteret
	Børne- og kulturhuset	Teknologisk Institut
	MindFuture	Nordic Harvest
	CEIS	Ikea
	Driftsbyen	Dansk Retursystem

Table 6: Providers of the future energy system – Pilot Høje -Taastrup

Infrastructure provider	Energy provider	Energy management provider
VEKS	**VEKS (DH transmission and distribution)**	**VEKS**
HøjeTaastrup Fjernvarme	**HøjeTaastrup Fjernvarme (DH distribution)**	**HøjeTaastrup Fjernvarme**
Albertslund Fjernvarme	Albertslund Fjernvarme(DH distribution)	Albertslund Fjernvarme
Energinet		Center Danmark
Radius		Climify
Varmelast		Varmelast
		DTU
		ENFOR

Table 7: Influencers of the future energy system – Pilot Høje -Taastrup

Media	Knowledge institutions	Interest organisations
The Municipality of Høje Taastrup (HTK)	Sjællandskenyheder	Dansk Fjernvarme
Board of directors VEKS	The Municipality of Høje Taastrup - communication department	("Energi på Tværs")
	Dansk Fjernvarmes nyhedskanal - Fjernvarmen	Fælleskabet for dynamisk data (F2D2)
	Ingeniøren	Danmarks Naturfredningsforening
	Energiforum Danmark	MEC (Miljø og Energicenteret)
	VEKS homepage, LinkedIn	
	Danish Board of District Heating (DBDH)- HOTCOOL	
	IEA DHC	
	Euroheat & Power	

Table 8: Governance actors within the local, regional, and national level with decision -making power towards the future energy system – Pilot Høje -Taastrup

Local authorities	Departments in the local municipality	Regional and national authorities
The Municipality of Høje Taastrup	BMC (By- og miljøcenteret (The City and Environment Centre)	Region Hovedstaden
(Danish Energy Agency)	SPC (School and Educational Psychology Centre)	Energistyrelsen
Board of Directors, VEKS		Udvikling og forenklingsstyrelsen

(Bold text indicates participation in focus groups or interviews fall 2023)

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Stakeholder Community at Pilot Port of Sines

Table 9: Users of the future energy system – Pilot Port of Sines

Individual users	Public and private buildings as users	Professional and large - scale users
Pilots (e.g., APS employees working at the port)	ZALSINES (logistic platform)	LNG Terminal
	AMERICOLD (cold warehouse located on ZALSINES)	

Table 10: Providers of the future energy system – Pilot Port of Sines

Infrastructure provider	Energy provider	Energy management provider
APS (port authority)	E-REDES (Public distribution grid company)	Tecnalia

Table 11: Influencers of the future energy system – Pilot Port of Sines

Media	Knowledge institutions	Interest organizations
Rádio Campanário (Radio)	Sines Tecnopolo	Quercus (national environmental NGO)
		CPLS (public and private entities association with mission is to promote development of the Port with balance of interests)

Table 12: Governance actors within the local, regional, and national level with decision - making power towards the future energy system – Pilot Port of Sines

Local authorities	Departments in the local municipality	Regional and national authorities
APS (port authority)	Câmara de Sines (municipality)	aicep Global Parques (Sines Industrial and Logistics Zone)

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PART 2

Social Acceptance Indicators

Social Acceptance Indicators

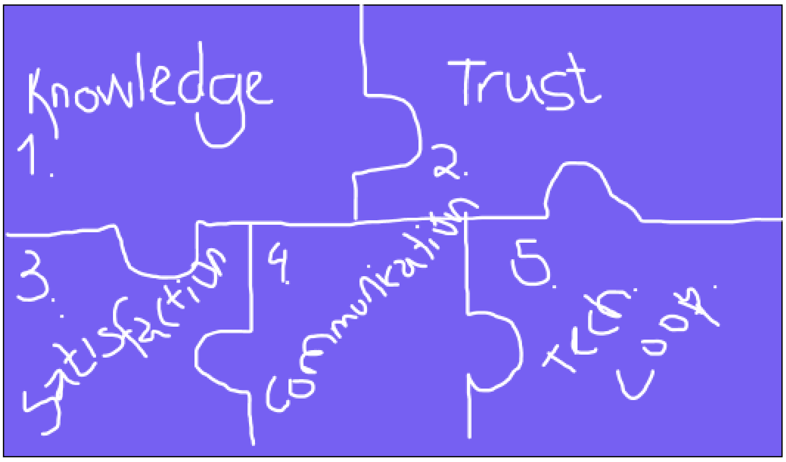
Knowledge
The knowledge indicator measures the level of understanding and familiarity internal and external stakeholders with the concept of a flexible and integrated energy system. It focuses on the extent to which stakeholders are aware of this innovation and comprehend its functioning. See survey results on pages x to x

Trust
The trust indicator measures the level of trust that internal and external stakeholders have in the project partners' (e.g., governance institutions/implementation institutions/research institutions) ability to achieve integrated energy sector innovation at the Pilot sites. See survey results on pages x to x

Satisfaction
The satisfaction indicator measures whether stakeholders are satisfied with the way the project objectives meet its (future) societal, economic, technological, and environmental expectations. Specifically, we have designed questions that provide us with a comparison between how stakeholders believe that the current energy system, as opposed to a flexible and integrated energy system, is suitable for accommodating future social, economic, technological, and environmental needs. See survey results on pages x to x

Communication
The communication indicator measures how stakeholders perceive the benefit and effectiveness of communication strategies in the ELEXIA project, how they would prefer to stay involved in future developments in the project, and how they perceive the benefit the exchange of information between project partners and future users of the project outputs (i.e., a flexible and integrated energy system). See survey results on pages x to x

Technology Cooperation
The technology cooperation indicator measures whether stakeholders are satisfied with the chosen form of technology cooperation in the project, which is involving the public, private and academic sector in addition to including the views and perspectives of end users. Technology cooperation is understood as a two (or more)-way, ever-evolving interchange in which all participants play an active role in a dynamic manner (Mallet 2007). See survey results on pages x to x

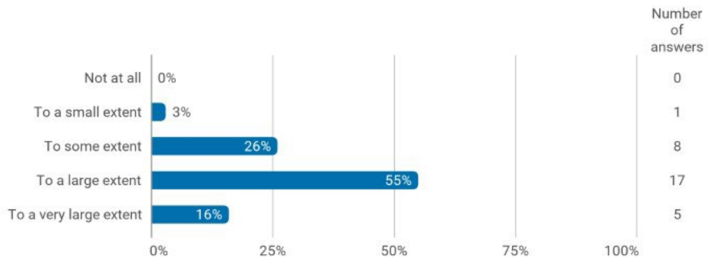


In fulfillment of Deliverable 1.1, multiple stakeholders identified within the Stakeholder map in PART 1 were invited to participate in focus groups and interviews. The purpose of these engagements was to gain insights and understanding regarding the diverse preferences and needs of the stakeholders involved. Furthermore, all participants were provided with a survey containing questions pertaining to the five social acceptance indicators.

Twenty-five individuals participated in the Norwegian focus groups and 1-to-1 interviews and submitted the post-interview survey. Among them, 28% were ELEXIA partners, while 72% were non-partners. Note that the graphs included in this guide do not distinguish between partners and non-partners when the same questions were posed to both internal and external stakeholders.

Knowledge

Generally, to what extent would you say that you understand what a flexible and integrated energy system is?

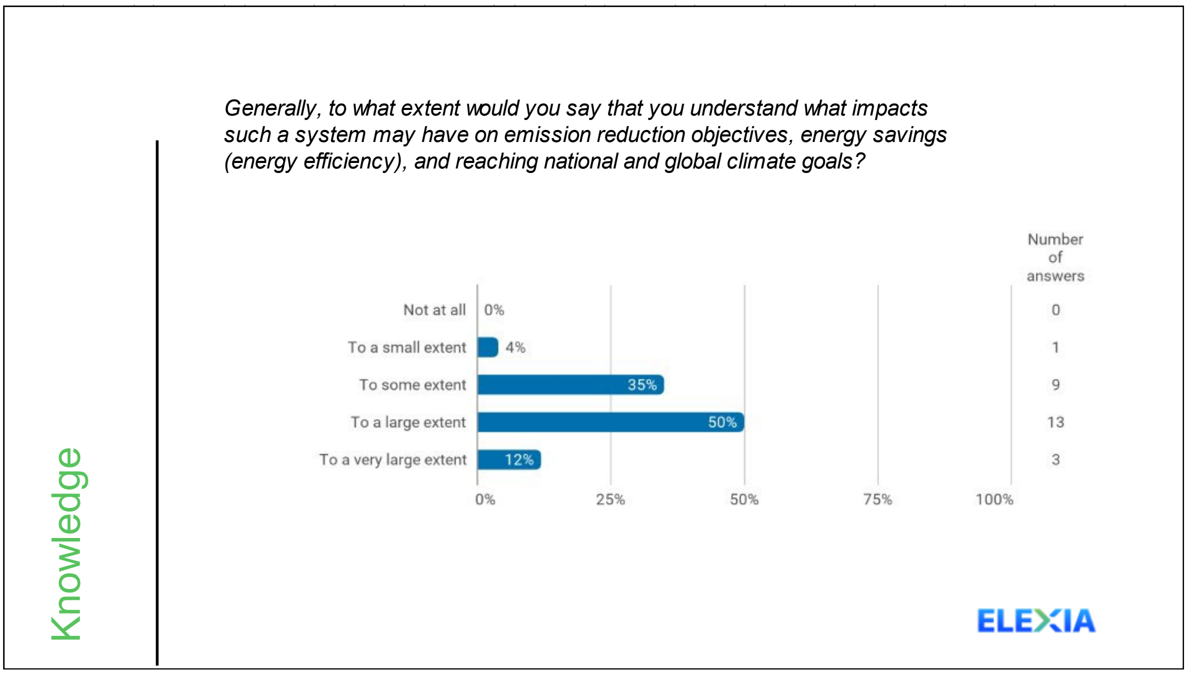


72% of the respondents are non-partners in the ELEXIA project, while 28% are ELEXIA partners.

Knowledge

What comes to mind …?

… when you hear the words "flexible and integrated energy system"?


Knowledge
Generally, to what extent would you say that you understand what impacts such a system may have on emission reduction objectives, energy savings (energy efficiency), and reaching national and global climate goals?
Number of answers
Not at all
0%
0
To a small extent
4%
1
To some extent
35%
9
To a large extent
50%
13
To a very large extent
12%
3
0%
25%
50%
75%
100%
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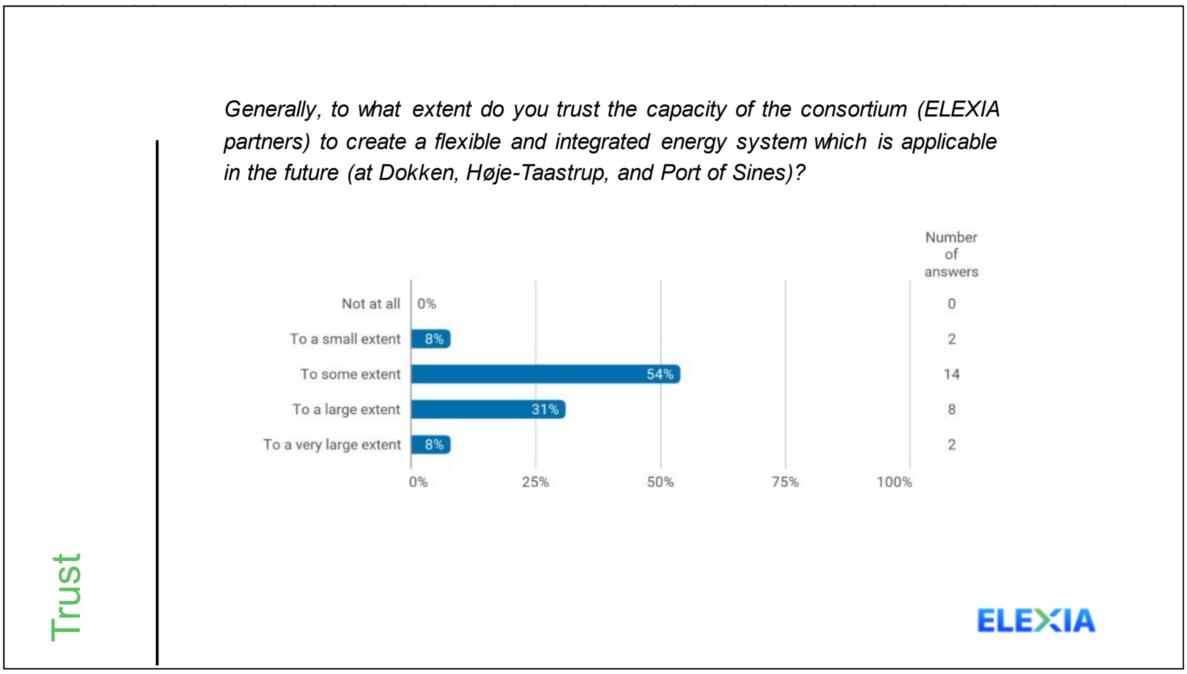
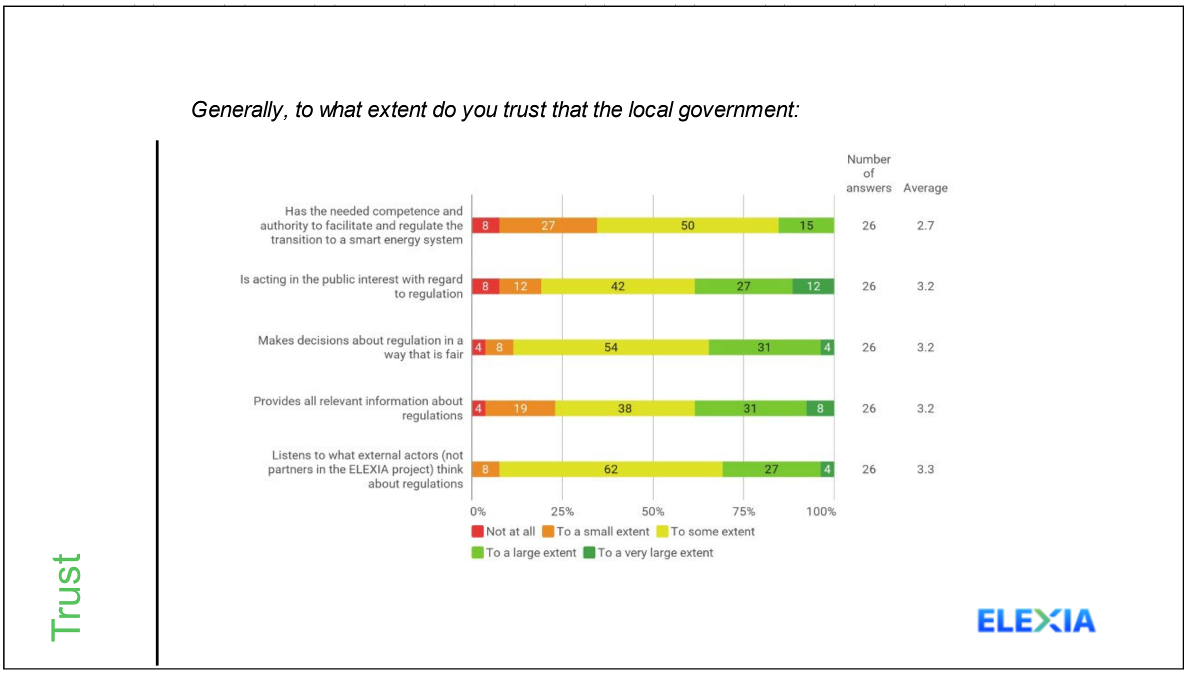
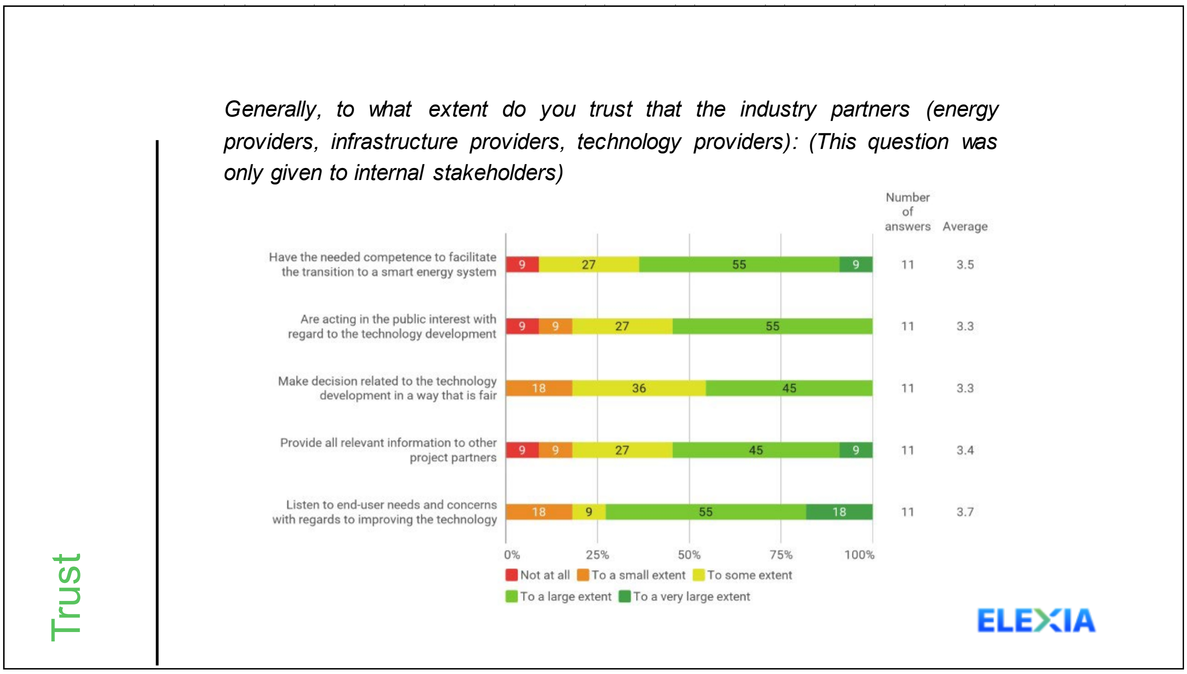
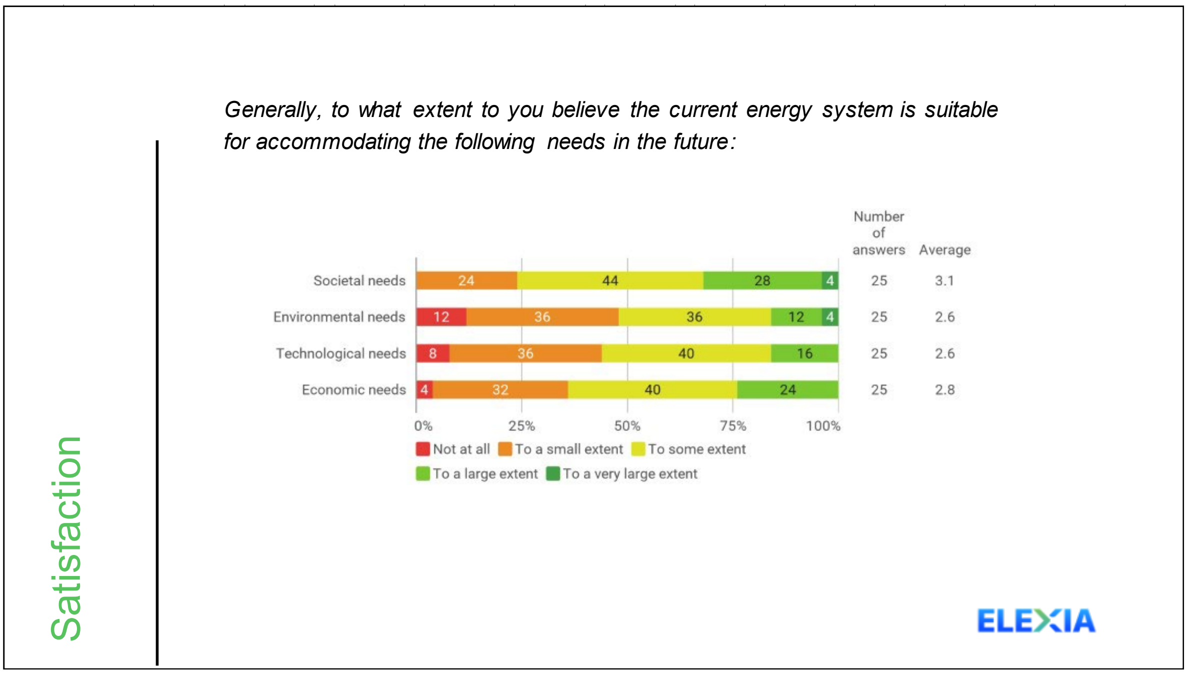
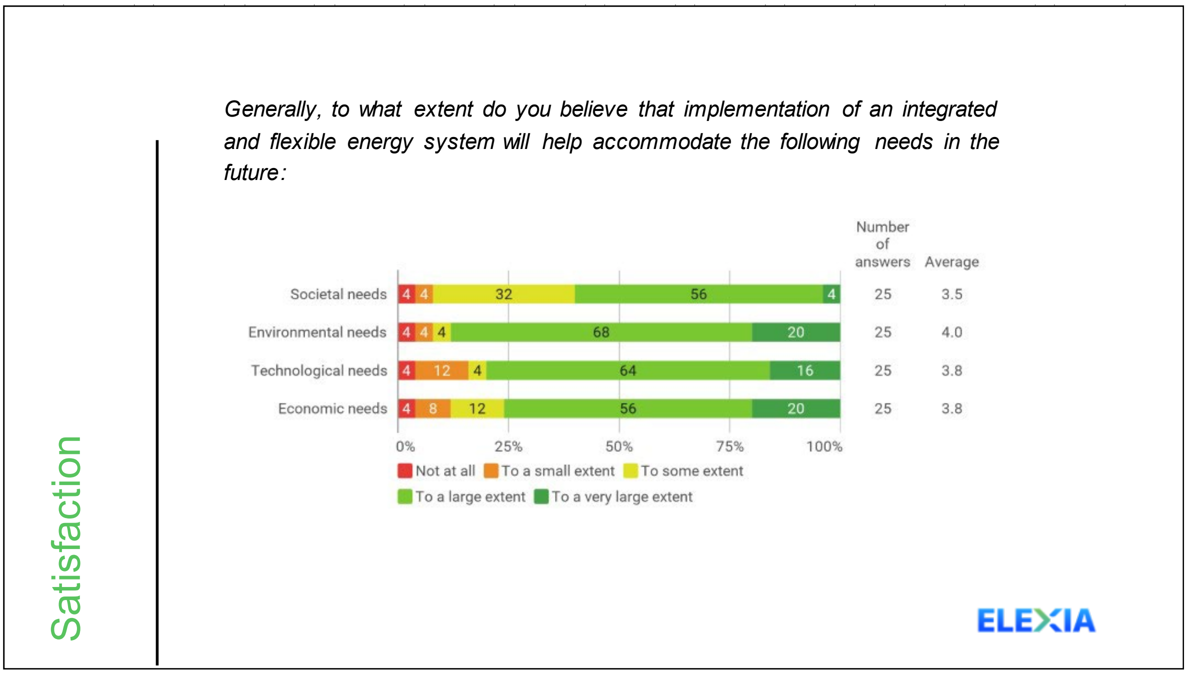

Trust
Generally, to what extent do you trust the capacity of the consortium (ELEXIA partners) to create a flexible and integrated energy system which is applicable in the future (at Dokken, Høje-Taastrup, and Port of Sines)?
Number of answers
Not at all
0%
0
To a small extent
8%
2
To some extent
54%
14
To a large extent
31%
8
To a very large extent
8%
2
0%
25%
50%
75%
100%
ELEXIA


Generally, to what extent do you trust that the local government:
Number of answers
Average
Has the needed competence and authority to facilitate and regulate the transition to a smart energy system
8 27 50 15 26 2.7
Is acting in the public interest with regard to regulation
8 12 42 27 12 26 3.2
Makes decisions about regulation in a way that is fair
4 8 54 31 4 26 3.2
Provides all relevant information about regulations
4 19 38 31 8 26 3.2
Listens to what external actors (not partners in the ELEXIA project) think about regulations
8 62 27 4 26 3.3
0% 25% 50% 75% 100%
Not at all
To a small extent
To some extent
To a large extent
To a very large extent
Trust
ELEXIA


Generally, to what extent do you trust that the industry partners (energy providers, infrastructure providers, technology providers): (This question was only given to internal stakeholders)
Number of answers
Average
Have the needed competence to facilitate the transition to a smart energy system
9 27 55 9 11 3.5
Are acting in the public interest with regard to the technology development
9 9 27 55 11 3.3
Make decision related to the technology development in a way that is fair
18 36 45 11 3.3
Provide all relevant information to other project partners
9 9 27 45 9 11 3.4
Listen to end-user needs and concerns with regards to improving the technology
18 9 55 18 11 3.7
0% 25% 50% 75% 100%
Not at all
To a small extent
To some extent
To a large extent
To a very large extent
Trust
ELEXIA


Satisfaction
Generally, to what extent to you believe the current energy system is suitable for accommodating the following needs in the future:
Number of answers
Average
Societal needs
24
44
28
4
25
3.1
Environmental needs
12
36
36
12
4
25
2.6
Technological needs
8
36
40
16
25
2.6
Economic needs
4
32
40
24
25
2.8
0%
25%
50%
75%
100%
Not at all
To a small extent
To some extent
To a large extent
To a very large extent
ELEXIA


Satisfaction
Generally, to what extent do you believe that implementation of an integrated and flexible energy system will help accommodate the following needs in the future:
Number of answers
Average
Societal needs
4
4
32
56
4
25
3.5
Environmental needs
4
4
4
68
20
25
4.0
Technological needs
4
12
4
64
16
25
3.8
Economic needs
4
8
12
56
20
25
3.8
0%
25%
50%
75%
100%
Not at all
To a small extent
To some extent
To a large extent
To a very large extent
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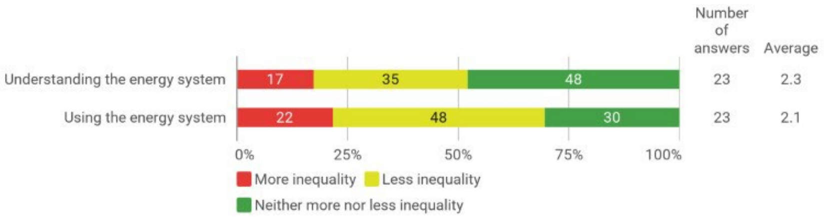
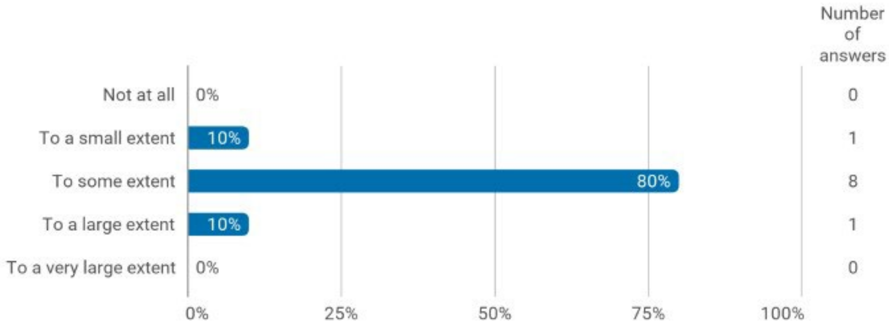
Satisfaction

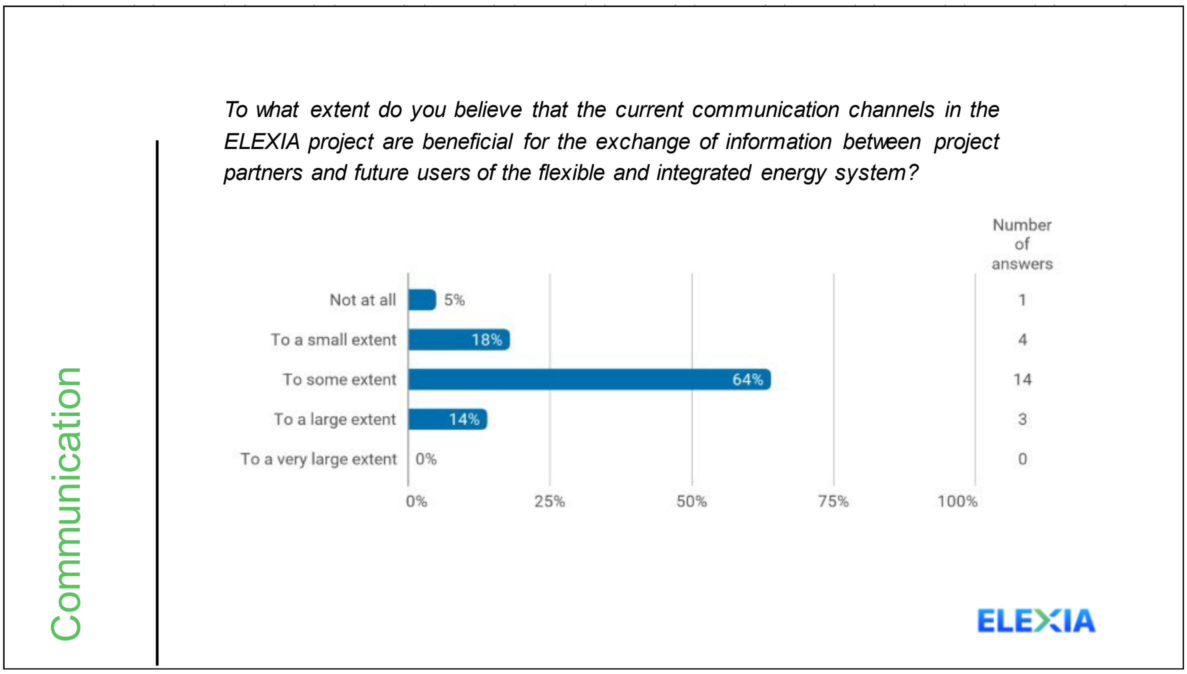
Do you think a flexible and integrated energy system will contribute to more or less social inequality in terms of:

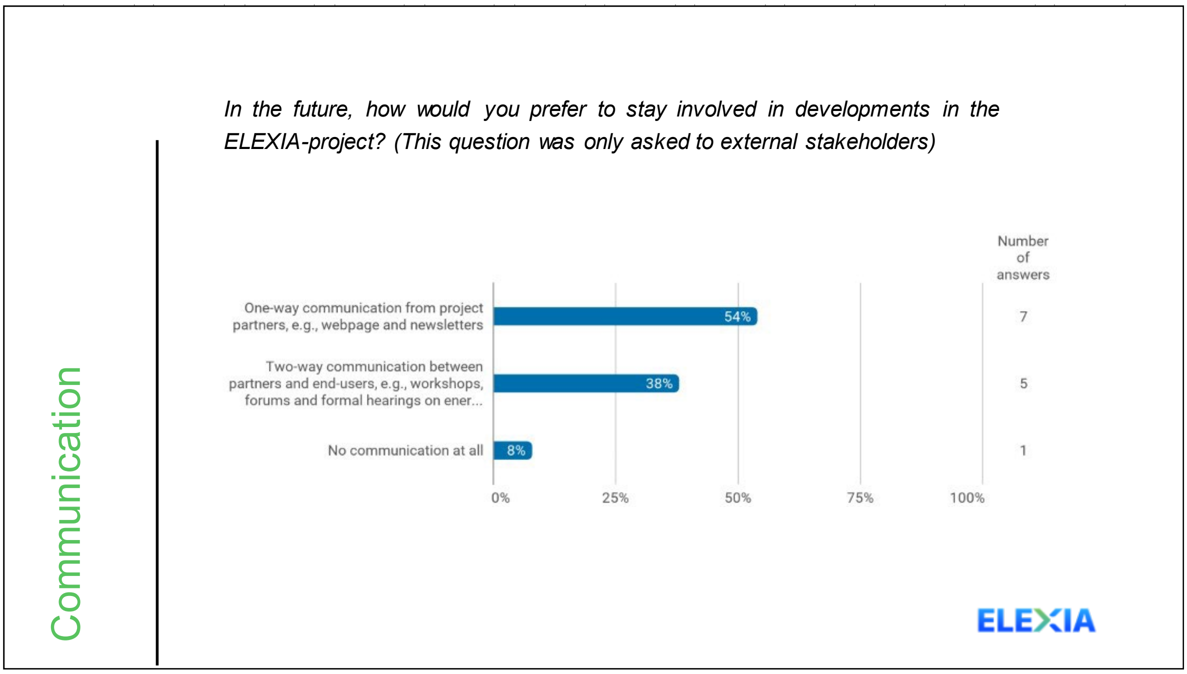


Communication

Generally, to what extent do you believe that the current communication channels in the ELEXIA project are beneficial for the exchange of information between project partners? (This question was only asked to internal stakeholders)




Communication
To what extent do you believe that the current communication channels in the ELEXIA project are beneficial for the exchange of information between project partners and future users of the flexible and integrated energy system?
Number of answers
Not at all 5% 1
To a small extent 18% 4
To some extent 64% 14
To a large extent 14% 3
To a very large extent 0% 0
0% 25% 50% 75% 100%
ELEXIA


Communication
In the future, how would you prefer to stay involved in developments in the ELEXIA-project? (This question was only asked to external stakeholders)
Number of answers
One-way communication from project partners, e.g., webpage and newsletters 54% 7
Two-way communication between partners and end-users, e.g., workshops, forums and formal hearings on ener... 38% 5
No communication at all 8% 1
0% 25% 50% 75% 100%
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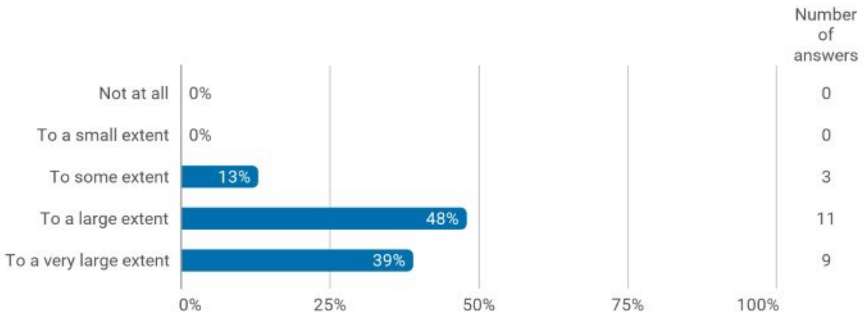
Technology Cooperation

Generally, to what extent do you believe a tripartite collaboration between academia, the public sector, and the private sector is important for the development of an integrated and flexible energy system?



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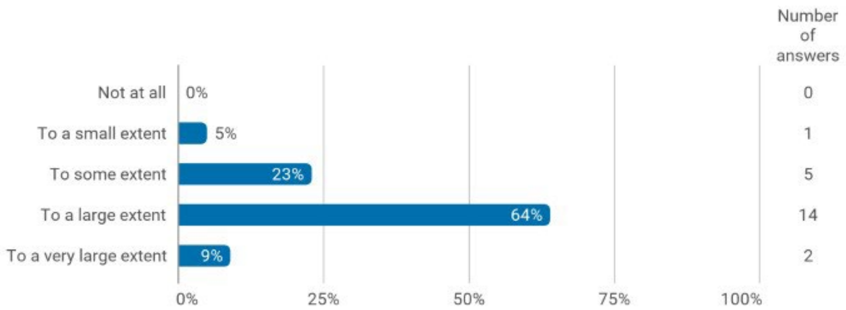
Technology Cooperation

Generally, to what extent do you believe that the project partners (from academia, the public sector, and the private sector) are able to collaborate to create an integrated energy system which is applicable in the future (at Dokken, Høje-Taastrup, and Port of Sines)?



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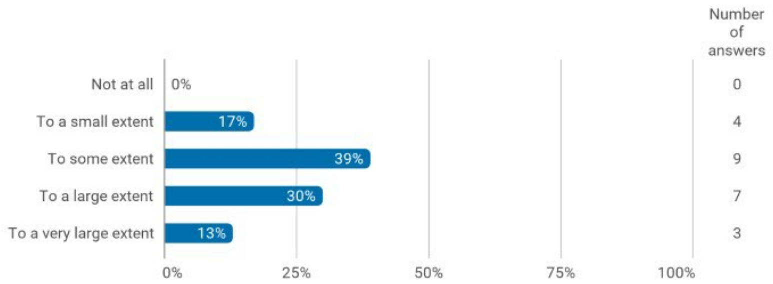
Technology Cooperation

Generally, to what extent do you believe end-users of the future energy system should be involved and engaged in the early phases of the technology development process?



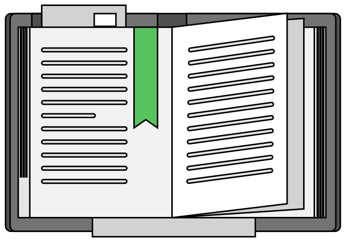
PART 3

Three Recommendations to Increase Social Acceptance

This chapter introduces the three recommendations for continued stakeholder engagement during the project period. The three recommendations are dividing in two levels; project level and pilot level.

All three recommendations address the five social acceptance indicators, aiming to improve knowledge , trust,satisfaction, communication and technology cooperation, based on feedback and observations outlined in D.1.1.

In order to make this a successful process, please see PART 4 on ethical considerations.



1. Facilitate knowledge exchange across the various stakeholders

1.A On project level, inviting partners and external stakeholders to attend regular talk series (e.g. every two months) with invited energy experts from, for example, social sciences and beyond, organized by the PMO team or the communiction and dissimination partners.

1.B On pilot level, conduct local initiatives that will enhance the level of knowledge among stakeholders, e.g. establishing a local energy forum for knowledge exchange or workshops.

2. Actively seek feedback, address concerns, and continue improving the technology based on stakeholder input

2.A On project level, continued and intensified engagement with advisory group. At the same time, continue regular workpackage and task meetings with a special focus on exchange, also between workpackages; the aim is to avoid silos.

2.B On pilot level, development of reciprocal mentorship where key internal or external stakeholders are asked to mentor the pilot team on, for example, a rotational basis, seeking active mentorship while reciprocating.

3. Decide on channels or platforms to communicate and interact with the stakeholder community

3.A On project level, establish an open forum (e.g. a Teams channel) where partners can ask eachother questions, which are answered by anybody who knows, from literature recommendations to practical concerns, as well as suggest topics of discussion, and themes they would like to see addressed in the ELEXIA talk series (see 1.A).

3.B On pilot level, pilot teams could do the same on pilot level with participants in activity 1.B.

PART 4

Research Ethics

Responsible Research and Innovation (RRI)

Source: https://rri-tools.eu/

In accordance with our commitment to Responsible Research and Innovation, as outlined in Task 1.1, the ELEXIA project pledge to prioritize societal needs and challenges throughout every stage of our research and innovation processes. This entails incorporating ethical standards and engaging with stakeholders in a transparent and inclusive manner

RRI principals

Ethics
Focuses on (1) research integrity: the prevention of unacceptable research and research practices; and (2) science and society: the ethical acceptability of scientific and technological developments.

Gender Equality
Gender equality in RRI is about promoting gender balanced teams, ensuring gender balance in decision -making bodies, and considering always the gender dimension in R&I to improve the quality and social relevance of the results.

Governance
To reach futures that are both acceptable and desirable, governance arrangements have to (1) be robust and sufficiently adaptable to the unpredictable development of research and innovation (de facto governance); (2) be familiar enough to align with existing practices in research and innovation; (3) share responsibility and accountability among a large variety of actors and provide governance instruments to actually foster this shared responsibility.

Open Access
Addresses issues of accessibility to and ownership of scientific information. Free and earlier access to scientific work might improve the quality of scientific research and facilitate fast innovation, constructive collaborations among peers and productive dialogue with civil society.

Public Engagement
The process of R&I is collaborative and multi actor: all societal actors (researchers, citizens, policymakers, industry, educators, etc.) work together during the whole research and innovation process in order to align its outcomes to the values, needs and expectations of European society.

Science Education
Focuses on (1) enhancing the current education process to better equip citizens with the necessary knowledge and skills so they can participate in research and innovation debates; and (2) increasing the number of researchers (promote scientific vocations).

Ethical Guidelines

Ethical issue	Definition
Voluntary participation	Your participants are free to opt in or out of the study at any point in time.
Informed consent	Participants know the purpose, benefits, risks, and funding behind the study before they agree or decline to join.
Data pseudonymization	Identifying information about participants are replaced with pseudonymous, or fake identifiers (e.g., Participant A).
Confidentiality	You know who the participants are, but you keep that information hidden from everyone else. You anonymize personally identifiable data so that it can't be linked to other data by anyone else.
Potential of harm	Physical, social, psychological and all other types of harm are kept to an absolute minimum.
Results communication	You ensure your work is free of plagiarism or research misconduct, and you accurately represent your results.

Adapted from: https://www.scribbr.com/methodology/research-ethics/

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the European Union