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Innovation ecosystems and financial risk mitigation

A case study in the energy sector

Master's thesis in Management and Economics of Innovation

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Cover:
An energy production facility of Vattenfall

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Abstract

Large-scale energy and infrastructure projects for increased electrification of society will most likely necessitate increased collaboration. Investments on such a large scale presents financial risks that shared resources and experiences could help to mitigate. While existing literature has looked at the role of innovation ecosystems in the sustainable transition towards renewable energy, there remains a gap in how this relates to financial risk. Additionally, flexibility and energy storages are becoming increasingly important for the energy system.

This master's thesis investigates the energy innovation ecosystem surrounding a potential project that Vattenfall are considering, The Storage Project. The study was conducted as a qualitative single case study, involving interviews and document analysis. The study explored how innovation ecosystems can help to generate and capture value for actors while aiding in mitigating financial risks. To achieve this, the study identifies key barriers for collaboration and potential risk mitigation mechanisms that can help overcoming the barriers and risk mitigation.

The study's findings outline four types of barriers that hinder collaborations. These barriers include Regulatory and policy barriers, Financial barriers, Internal governance barriers, and Inter-organizational barriers. In addition to these four barriers, the thesis also presents five types of risk mitigation mechanisms to help lower the financial risk of projects. These mechanisms are: Structuring mechanisms, Operational mechanisms, Engagement mechanisms, Communication mechanisms, and Intra-organizational mechanisms. These barriers and mechanisms can have direct or indirect impact on a business case's net present value calculation – in particular how they might influence discount rates, initial investments and future revenues.

These findings contribute with insights on how collaboration and innovation ecosystems can be helpful in mitigating risk. The finding also provides practical implications for managers in the energy sector about how to achieve successful collaborations and for policy makers about how they can help to facilitate a better functioning energy system.

Keywords: innovation ecosystem, financial risk, risk mitigation, business case, energy sector, energy storage, ecosystem risks

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1. Introduction

Innovation is the act of creating novel and valuable solutions or products. The understanding of innovation as a key concept in economics related to firm performance, economic growth, and competitive advantage was first stated by Schumpeter (1934). Schumpeter believed that innovation was necessary as the key driver for the "gale of creative destruction" which in itself was a key driver for economic growth and progress. Innovation drives the economic engine of society by creating new value and changing the economic landscape by creating opportunities for new firms to prosper.

An evolution of the research into innovation is the concept of innovation ecosystems. Innovation ecosystems shift the focus from an individual firm that is innovating to an ecosystem of actors collaborating and partnering to innovate. Adner (2006) states that innovation ecosystems are collaborative agreements between firms to create a better and more coherent offering to customers. Granstrand and Holgersson (2020) expands on this and presents a more actor-centric definition of the ecosystem: "An innovation ecosystem is the evolving set of actors, activities, and artifacts, and the institutions and relations, including complementary and substitute relations, that are important for the innovative performance of an actor or a population of actors". The innovation ecosystem unit focuses on the actors, their links, and activities in the ecosystem. Using this perspective for analysis allows researchers to better understand the connections and relationships around a company or value proposition. Actors in an ecosystem are often able to create products and systems whose value is greater than the sum of their parts – this "complementary surplus" is then captured by the members of the ecosystem (Baldwin et al., 2024). Value creation is defined as deploying resources where the benefits outweigh the sacrifices and value capture is defined as the process of capturing the generated value from value creation (Chesbrough et al., 2018).

The energy sector creates substantial value for society, enabling many of the critical functions of the modern world. It is also able to capture the value from the creation. The past few decades have been characterized by intense activity in the energy sector, fueled by the need to combat sustainability concerns through innovations (Sivaram & Norris, 2016). Innovations like solar and wind power have been paramount in transitioning from fossil-based energy sources to renewable energy sources and deployment has happened at large scales (Mitali et al., 2022). In Sweden, the energy mix has previously mainly been constituted by energy sources like hydro, nuclear, and fossil fuels (Zhong et al., 2021). However, a shift is occurring where more and more of the energy mix is constituted by renewable energy sources. Although the increasing renewable energy production brings a lot of benefits, they are not as flexible as other energy sources, as one cannot steer how much sun there will be for solar PVs, nor can one influence how much the wind will blow for wind turbines (Mitali et al., 2022). This variable output of electricity is referred to as intermittency and is growing ever more prevalent.

From a societal perspective, this can be challenging as energy consumption often does not match the intermittent nature of the renewable energy production. From a financial perspective, this is challenging too, since when there is a lot of electricity production, prices drop and can even go below zero (Halbrügge et al., 2024). Lower energy prices make it difficult to justify

new renewable energy projects and can lead to projects not being undertaken. Moreover, renewable energy sources present new types of challenges for the electrical grid that plannable energy sources did not (Suberu et al., 2014). It can be more difficult to maintain the correct frequency for the grid and there is a larger need to actively control voltages. Further, if electricity is not being produced at all times, there is a need for reserves. This has increased the importance of having markets for ancillary services connected to the electricity grid, which often are offered by the transmission system operator (TSO) in many countries to ensure that the grid is functioning correctly (Kryonidis et al., 2021). However, the increased efforts to stabilize the grid can often be passed on to customers who are faced with a higher electrical bill.

In addition to new energy sources in Sweden, the national energy systems are becoming more connected with each other as well. With globalization and increased technological development, the world of business has become more complex than ever before. Supply chains have become global and today few companies are able to produce products or services without the involvement of other actors. In the energy sector, actors are often bound to each other through the grid or other physical infrastructure and this presents many forced collaborations (D'haeseleer et al., 2017). Adding to that is the fact that there are often many types of actors involved in energy innovation ecosystems – ranging from electricity producers, transmitters/distributors, consumers, regulating, and enabling actors. Electricity producers refer to those actors who produce energy, consumers are those who use the energy, and between them are transmitters/distributors who transports energy through the energy grid (Svenska Kraftnät, 2023). Other agents such as regulators and potentially other enabling actors can play an important role in innovation ecosystems (Gomes et al., 2018). In this case, regulating actors include authorities, governments, and international agencies. Enabling actors refers to municipalities, academia, research institutes, and funding agencies who through their involvement could further enables energy solutions.

The energy sector is also characterized by large-scale infrastructure projects with long lifetimes and large investments (Steffen, 2020). Furthermore, it can often take many years until the net present value of an investment reaches zero and starts becoming profit-generating. In today's economy, solid high-yielding business cases can be seen as a necessity for projects to be undertaken. The possibility of not obtaining desired proftiability or even losing money can be defined as financial risk (Hayes, 2024). However, partnering with other actors in the ecosystem can remove or mitigate uncertainties that present financial risks in projects and allow for improved financial metrics on potential investment decisions. These partnerships can be a way to both reduce stakeholder risk by spreading out investment cost over multiple parties, securing future revenue streams, and lower the discount rate. In doing so, a better business case could be obtained and result in new energy solutions being constructed.

Vattenfall is one of Europe's largest energy companies and operates in multiple European markets across different energy types. They are fully owned by the Swedish state and are looking at the prospects of developing a novel energy storage project, henceforth referred to as "The Storage Project" with potential to be helpful for the green energy transition. A necessity for The Storage Project to be undertaken is that it has to have a solid business case with

sufficient financial returns. However, with large projects there is always large amounts of uncertainty, especially in regards to financial risks due to high initial investment costs and cash-generating revenue streams being far into the future. The risk of an unfavorable business case can however get mitigated by involving and collaborating with other actors connected to the potential energy project. These connections could prove to be very fruitful in lowering Vattenfall's financial burden of solely funding The Storage Project as well as securing the future revenue streams by entering into long-term arrangements. Yet, other ecosystem actors might be hesitant to enter such collaboration despite the value they stand to obtain. It is thus important for Vattenfall to understand how an innovation ecosystem can be facilitated and leveraged to enable increased value creation and value capture for ecosystem actors.

The study is designed as a case study about Vattenfall and the ecosystem in regards to their potential energy storage project – The Storage Project. Since Vattenfall is both the initiator and would-be operator of The Storage Project, which formed the basis for the case study, they are the central actor of this study. Vattenfall could take on a role to orchestrate collaborations in the ecosystem – therefore the choice was made to study the innovation ecosystem around The Storage Project and the potential value from the perspective of Vattenfall as the central firm. The word potential is used regarding The Storage Project since it is still in its planning and assessment phase, meaning that it has not been built yet. Previous innovation ecosystem research in the energy sector has mainly focused on digital technologies and digitalization (Almpanopoulou et al., 2019; Kolloch & Dellermann, 2018), renewable energy production (Alam & Ansari, 2020), and smart grids (Kotilainen et al., 2016). There have also been case studies focused on energy ecosystems in different geographies such as the Russian energy system (Yakovlev & Volkova, 2018) and the US biofuel market (Weil et al., 2014). The case study for this thesis is centered in Sweden, in particular the south of Sweden – an area where not a lot of research has been done in regards to innovation ecosystem in the energy sector. The thesis aims to study this gap in research and the potential for improved risk mitigation and improved business cases through collaboration connected to energy storages. This energy project is related to the renewable energy sector, better functioning energy grids, and energy storage – all highly relevant for climate challenges and sustainability. Furthermore, there is also the matter of societal value which the study encompasses. An inferior energy system leads to inefficiencies among electricity producers and grid operators – resulting in higher costs of electricity for customers. It could therefore be in many actors' interest to see a more future proof energy system.

The purpose of the study is to assess how Vattenfall can enhance value adding-collaboration and thus mitigate financial risk in energy projects. Naturally, there are many ways an actor can mitigate financial risk – however this study focuses on risk mitigation mechanisms that addresses collaboration with ecosystem actors or operational behavior. By mitigating the financial risks, Vattenfall could enjoy a more profitable business case which increases the chances of the energy project actually being undertaken. The types of mitigation mechanisms either directly or indirectly impacts the discount rate, initial investment or future revenue streams of The Storage Project. The revenue stream becomes realized when the energy project starts to operate. When this happens, value can also be added for other innovation ecosystems actors who in turn reap the benefits that are created jointly with Vattenfall. Despite the benefits

within reach for the other ecosystem actors, there could be reasons as to why they choose not to enter the depth of collaboration needed within the ecosystem. It is thus important to understand what potential barriers there are for ecosystem actors to undertake deeper collaboration. The purpose of the study is to answer the following research questions:

- What are the barriers for increased collaboration and added value in an energy innovation ecosystem?
- What mechanisms are there to mitigate financial risks and overcome the barriers?

The study contributes with theoretical knowledge about value creation from innovation ecosystems and increased value capture for ecosystem actors for academics. It also deepens the understanding of how innovation ecosystems and financial mitigation are interrelated. Furthermore, the thesis equips practitioners with insights that can be incorporated elsewhere in the energy sector in the undertaking of new projects.

The study's findings identified four types of barriers for collaboration between ecosystem actors. The barriers are the following: Regulatory and policy barriers, Financial barriers, Internal governance barriers, and Inter-organizational barriers. Apart from these four barriers, the thesis has also identified five risk mitigation mechanisms to help lower the financial risk of projects. These mechanisms are: Structuring mechanisms, Operational mechanisms, Engagement mechanisms, Communication mechanisms, and Intra-organizational mechanisms. The findings of the thesis contribute with insights on how collaboration and innovation ecosystems can be helpful in mitigating risk in large-scale projects. The findings also provide practical implications for practitioners in the energy sector on how to have better chances of achieving successful collaborations. Furthermore, the thesis also informs policy makers about how they can help to facilitate a better functioning energy system.

The remainder of this thesis report is structured as follows: Chapter 2 gives a theoretical background on innovation ecosystems along with risk mitigation, and ecosystem risks. The theoretical background is followed by Chapter 3 where the methodology of the report is described, highlighting the research design and methods used. Chapter 4 then provides an in-depth description of the case in the study. Afterwards, chapter 5 outlines the findings from the data collection and analysis. These findings are then further discussed in chapter 6, the discussion section. The thesis then closes by providing conclusions, including theoretical and practical implications along with suggestions for future research.

2. Theoretical Background

As the research questions is concerned with several topics from literature, a thorough review of literature in regards to relevant theory has been conducted. This chapter is divided into three sections, each covering one of the main concepts that the study is built around: Innovation ecosystems, Risk mitigation, and Ecosystem risks.

2.1 Innovation Ecosystems

That innovation is a key driver for economic growth and redistribution of wealth through the act of creative destruction was established by Schumpeter (1934) and is now well established in theory and research. As researchers were investigating the implications of Schumpeterian innovation studies, the locus of innovation began moving away from individual firms in single industries towards groups of firms and individuals from multiple industries (Baldwin et al., 2024). Baldwin et al. (2024) state that this has caused a shift amongst researchers, practitioners and policy makers to now view innovations as embedded in ecosystems.

According to Jacobides et al. (2018), there are three broad groups of ecosystems identified in research; business ecosystems which center around a single firm and its environment, innovation ecosystems that center around an innovation or value proposition – the latter refers to the attributes of offered service/goods (Winkler & Dosoudil, 2011). Finally, platform ecosystems that consider how actors organize around a platform. For this thesis, the two most relevant streams of research are business ecosystems and innovation ecosystems. The business ecosystem concept was the first one to be described in literature as used by Moore (1993) and would influence the emergence of the concept innovation ecosystems. According to Teece (2007), the business ecosystem is the environment that a firm must search and be aware of to react to as it can affect its dynamic capabilities and therefore the sustainable competitive advantage that a firm may try to build. The innovation ecosystem stream instead views an ecosystem as a "collaborative arrangement through which firms combine their individual offerings into a coherent, customer-facing solution" (Adner, 2006, p. 2). Here, the focus of the research is placed on understanding how interdependent actors interact to create value for the end-customer through innovation. An important part of an ecosystem is that the joint value creation creates a "complementary surplus" – the difference between the joint value creation and the sum of the parts, that the ecosystem actors are able to capture (Baldwin et al., 2024).

To identify what an ecosystem is, Baldwin et al. (2024) proposes a framework with three criteria: autonomy, complementarity, and modularity. Autonomy refers to whether actors in the system are autonomous organizations that have distributed governance and value capture. Secondly, complementarity refers to whether actors contribute with complementary resources for the value proposition to create a joint value creation which is larger than the sum of its parts. Lastly, modularity refers to if products and services in the ecosystem are modular within a larger technical architecture (Baldwin et al., 2024). To qualify as an ecosystem, a set of actors must satisfy all three criteria in the framework.

A big challenge in ecosystems can be coordination. Baldwin et al. (2024) states that it is important to differentiate between platform ecosystems which are coordinated by a central hub and non-platform ecosystems which are coordinated through other coordination mechanisms. Coordination mechanisms for non-platform ecosystems can include bilateral agreements, multilateral agreements arranged by "orchestrators", and temporary linkages arranged by "system integrators" (Kretschmer et al., 2022; Jacobides et al., 2024; Baldwin et al., 2024). Orchestration is a term researchers have applied to a form of weaker control (Reypens et al., 2021; Altman et al., 2022; Olk & West, 2023).

The orchestrator is often a focal firm with a lot of influence that ensures coordination and alignment between stakeholders (Pitelis & Teece, 2018). Another important part of the orchestrator's role is to ensure value creation, co-creation, and establishing a strategy for value capture (Pitelis & Teece, 2018). To do this, the orchestrator leverages soft power in the form of influence and relationships, as well as harder power in the form of contracts, partnerships, and joint ventures. Orchestrators play a large role in creating a sustainable ecosystem that allows actors to thrive and create valuable partnerships.

For innovations ecosystems to be successful, they require coordination and direction, and this is what orchestration refers to according to Hurmelinna-Laukkanen and Nätti (2018). Hurmelinna-Laukkanen and Nätti (2018) use the term innovation networks but their description is almost identical to innovation ecosystems, which is the term that is used in this study. The innovation ecosystem orchestrator is a focal firm that aims to orchestrate ecosystem actors to enable additional value creation and/or value extraction for the network and its members (Verhoeven & Maritz, 2012).

Innovation ecosystems are collaborative arrangements where actors come together to create a common value proposition (Adner, 2006). It is also a useful perspective to investigate how innovation is created within a sector or an industry as it helps to explain the interactions and relationships between actors. For the energy sector, this is highly relevant as firms are highly connected both through physical connections and in commercial relationships. In addition to this, the energy ecosystem in Sweden is currently undergoing a transition towards a larger share of unplannable and intermittent energy production in the form of renewable energy sources and this requires new innovative energy solutions (Svenska Kraftnät, 2024b). For this reason, it is highly relevant and valuable to explore avenues to facilitate new innovative solutions. One key challenge in these large energy projects are the financial risks. According to Baldwin et al. (2024), collaboration in an ecosystem could create additional value surplus. This value surplus if captured could offer an opportunity to mitigate some of the financial risk for actors.

2.2 Risk Mitigation

Risk can be seen as an uncertain event or condition that has a positive or negative effect on one or more project objectives if it occurs (Ahmed, 2017). Project objectives can include things such as scope and schedule but also costs or internal rate of return (IRR). In projects, there are different types of risks, one of which is business risk or financial risk, where firms' projects

must adapt against negative events. Projects face risk invariably of their type or size, but risks can be even more prevalent for organizations working on an innovative project. The novelty aspects of innovative projects bring a lot of uncertainty and project failure occurs more often in those than for proven and established projects. The activities and processes undertaken by firms to manage risk is often referred to as risk mitigation strategies (Ahmed, 2017). Effective risk mitigation strategies must be managed efficiently, not least for innovative projects, to ensure sound decision-making and so that projects can be undertaken.

Risk mitigation involves plans designed to manage, eliminate, or reduce risk to acceptable levels and then to continual monitor and assess it. In literature, there are complementary views on what processes are involved in risk mitigation – Dorfman (1998) proposes a three-step method which includes: identifying risks, choosing the risk response strategy, and monitoring the outcomes. Dorfman (1998) additionally identifies four methods to respond to risks: risk avoidance, risk reduction, risk sharing/transfer, and risk retention. Sanchez et al. (2009) refers to this approach as a risk-based approach where the focus is on analysis and possible solutions of the identified risk. Avoidance refers to eliminating all possibilities of the risk occurring, reduction implies reducing the frequency or severity of the risk (Reim et al., 2016). The next method, risk transfer or sharing, involves shifting some of the risk to other parties. The last method, risk retention, is when one party carries all or certain risks but attempts to profit from it by pricing their offering with a premium to cover for the increased risk.

While risk reduction and risk transfer or sharing are proposed as two different methods in risk mitigation strategies, they could be treated as not mutually exclusive. If an actor transfers some of its risk to another party in a project, and if that project was to fail, the losses for the actor would not be as severe were they to solely take on the risk themselves. Reducing the severity of a failure is in accordance with Dorfman's (1998) description of risk reduction. Risk sharing in projects is much explored in the literature and can be applied in many ways, some of which are investment costs, revenue guarantees and transfer backs (Adkins & Paxson, 2017; Adler et al., 2016; Figueiredo et al., 2007; Fischer, 2013). However, risk sharing has not been deeply investigated when it comes to large-scale energy project and specifically energy storage. Furthermore, risk sharing can be done with different parties including but not limited to customers, suppliers, banks, and authorities. Reim et al. (2016) highlights that contracts can be used as a tool for risk transfer.

Risk-sharing arrangements might also bring certain complexities in terms of the different parties' risk appetite. It has also been shown that firms' appetite for risk differs, and that cultural values within firms can play a part in that (Li et al., 2013). Buttriss (2021) mentions that companies actively should see whether risk mitigation is in line with a firm's risk appetite. Joint liability in investments may increase the borrower's, or focal firm's willingness to undertake risky but high-yielding projects (Fischer, 2013). When such projects succeed, there might occur a situation where the borrower has "free-rode" on the counterparty's liability without compensating them with sufficient reward. This situation can potentially lead to other parties being unwilling to share the risk in risky project and instead focus on safer investments. Risk sharing is described as a complex business relationship and the anticipation, as well as

realization of deception, remains a critical challenge (Adler et al., 2016). The thesis will mainly investigate risk reduction and sharing due to its close connections with financial risk.

The idea of firms or individuals trying to maximize profits has long been established. Already in the 1700's, Smith (1937) put forward the notion that the prime objectives of firms should be profit maximization and that business decisions should be taken only if they eventually result in profits. Profits, or financial returns, refers to excess of sales over costs and can increase either by increasing sales or decreasing costs. Khan (2017) argues that profit maximization still is an important decision-making driver, but that there are risks associated with profits. Financial risk refers to added variability of net cash flows with respect to owners of equity and financing alternatives. In business situations, the investment decision and financing alternatives entails a complex interaction on risk components where balance must be struck between overall business and financial risk. Henceforth, financial risk will be considered as the probability of not reaching adequate returns on investments or losing money – which is in accordance with the definition provided by Hayes (2024).

A common approach to determine whether an investment is worth pursuing is by evaluating it through a net present value (NPV) calculation. NPV calculations incorporates a central concept in finance, valuation principle, and examines whether the cash value benefits of a decision today exceed the cash value today of its cost (Berk & DeMarzo, 2023). The NPV of a decisions, investment, or business case, is calculated by using the formula seen in figure 2.1:

$$NPV = \sum_{t=0}^{n} \frac{CF_n}{(1+r)^t} - Initial\ investement$$

Figure 2.1: NPV formula for calculating financial returns of an investment

Where *t* represents the year, CF_n represent cash flow in year *n*, and *r* represents the discount rate. The general rule of thumb is to reject projects that have an NPV less than zero while one should accept those projects that have NPV larger than zero. The formula gives insights on levers that can help getting the NPV positive, three of which are discount rates, revenues (in regard to cash flow), and initial investments (Gallo, 2014). Not obtaining sufficient revenues or having too large initial investments costs or discount rates can be considered as financial risks. To improve a business case, efforts can thus be put into decreasing the discount rate, revenue or investment risks.

Crucial for the NPV formula is the discount rate *r*, as it will have large impacts on how much future cash flows represents in today's value. The discount rate is set by the firm undertaking the investment and represent their perceived financial risk of the investment as well as cost of capital (Pierru & Feuillet-Midrier, 2002). A higher discount rate may be chosen for more risky projects and means that future cash flow will be less valuable in today's value, which will ultimately make it harder for the NPV to be positive (Fernando, 2024). This is consistent with the assumption used in finance where individuals or corporations will seek compensation for additional risk (Fischer, 2013). Closely associated with NPV and discount rate is internal rate of return (IRR) which represent the expected annual rate of return on an investment (Magni, 2010). Firms often use IRR to compare profitability of different investments, and if the IRR

exceeds the discount rate, the investment can be considered acceptable. Another metric commonly used in relation to investments is payback period. The metric represents the amount of the time it requires the investment to reach NPV equal to zero (Dai et al., 2022).

Risk mitigation is key in all commercial enterprises to create resilient businesses. Managing risk is not a distinct function in a business, it is a key part of successful general management (Culp, 2001). Financial risk is particularly relevant when evaluating investment decisions as it is often the determining factor if an investment is greenlit and for this reason it is highly valuable to attempt mitigation of financial risk. Large infrastructure projects and energy projects that require a lot of capital, often risk going over both budget and timeline (Housh et al., 2023). This makes it extra important to investigate ways to mitigate this type of risk in the energy sector. A lot of financial innovation has taken place in the energy sector to enable further developments such as power purchase agreements (PPAs) that allow renewable energy projects to be constructed with less risk (Averdal, 2021). Innovative solutions to mitigate risk will facilitate new solutions in the energy sector.

2.3 Ecosystem Risks

Participation in an ecosystem carries risks for an actor as responsibilities are spread out to other ecosystem actors whom the focal firm cannot have direct control over (Adner, 2006). Assessing risks in projects can help the focal firm to decide which of the risks that should be shouldered by other actors and which ones that should be borne internally. As project complexity and number of actors needed to bring the innovation to market increases, the situation becomes even more pressing. There is even greater risk in ecosystems of innovative character as it deals with even more technological and market uncertainties as opposed to other forms of partnerships (Fliaster & Dellermann, 2016).

Participating in an ecosystem induces several types of risks, some of which are competition within the ecosystem, changes in relationships between actors or rapid changes in the external environment (Smith, 2013). Fliaster and Dellermann (2016) suggested that ecosystems risk can be divided into two groups, relational and performance risk. Relational risks refer to "probability and consequence of not having satisfactory cooperation" while the latter is concerned with the risk of not succeeding due to a lack of capabilities. With relational risks, there are difficulties in managing the behavioral assumption that actors will act opportunistically and focus on individual goals instead of common ones. Furthermore, closer partnerships within ecosystem requires intellectual property management (Holgersson et al., 2022) – thus preventing the prevalent risk of ecosystem actors competing with one another (Fliaster & Dellermann, 2016). The risk of knowledge leakage is described where actors capture resources from other actor for individual interest. In regards to performance risk, challenges lie in codeveloping capabilities as the competitive advantage depends on the whole of the ecosystem.

Important for the success of a company is how well they assess ecosystem risks (Adner, 2006). Adner (2006) proposed a framework which states that firms should specify initiative risks,

interdependence risks, and integration risks. Initiative risk covers uncertainties of managing a project, interdependence risks relate to uncertainties of coordinating with complementary actors, and integration risks are uncertainties about adoption of the innovation or solution. A key to mitigating the ecosystem risks is to understand what risks exists and then formulate a strategy to handle the risks. Adner (2006) states that firms in ecosystems must ask themselves, where, when, and how to compete. Focusing on the how to compete, a firm in an ecosystem must decide on how ecosystem leadership should be handled and whether the firm wants to take an active or passive role in guiding the ecosystem.

Ecosystem leadership and orchestration is key in mitigating ecosystem risks which are risk for all participants in the ecosystem. Ecosystem risks bring together innovation ecosystems and risk mitigation to highlight an important area for study. In the case of the energy sector, this is highly relevant as it is a sector currently undergoing a large transition while at same time having many incumbent actors that may be trying to innovate and collaborate. Ecosystems introduces collaboration risk as actors attempt to effectively collaborate to create more value. The energy ecosystems are no different and also brings a societal importance as electricity is essential for most businesses and society to function (Svenska Kraftnät, 2024a). This makes it a complex ecosystem with many different actors that need to collaborate and coordinate to succeed. The relational and performance risks mentioned by Fliaster and Dellermann (2016) are key to understand for the energy ecosystem to enable successful partnerships and mitigate said risks.

3. Methodology

The master's thesis was conducted as a *qualitative* research study with an *inductive* approach, where the qualitative and inductive stance indicates that the research generated new theory (Bell et al., 2022). A qualitative approach was deemed suitable due to the *interpretivist* nature of the study where the researchers aimed to understand how individuals and firms interact in systems (Lin, 1998) – in this study, the ecosystem. Additionally the focus of the study was to through a case study help to generate new theory which was more aligned with qualitative compared to quantitative research. The study was carried out in accordance with the typical steps proposed in Bell et al. (2022): *General research questions, Selecting relevant site(s) and subjects, Collection of relevant data, Interpretation of data, Conceptual and theoretical work,* and *Writing up findings/conclusions*.

The research design chosen for the study was a *single* case study of Vattenfall's innovation ecosystem in regards to their potential The Storage Project. Bell et al. (2022) states that the chosen case should be interesting enough in its own rights, which the study's was deemed to be. Furthermore, one of the advantages of case studies is that they enable in-depth investigations (Tsang, 2014). The case chosen can be viewed as both an *intrinsic* and *instrumental* case as described by Bell et al. (2022). The former is concerned with gathering certain idiosyncrasies of a situation while the latter sees the case as a mean to generalize understandings from the case. Moreover, the case chosen can be seen as a *revelatory* one as the aim was to uncover that which have not been thoroughly studied previously. The selection of an extreme case provides rich, detailed insights but inherently impacts the applicability of the findings to broader contexts. The unique characteristics of the case may amplify specific dynamics that are not representative of other cases in the energy sector. As such, the findings should be interpreted cautiously when applied beyond the study's setting. The choice of doing a single case study in the energy sector can be considered to have some degree of impact on transferability of the study. While a multiple-case study of similar energy projects could have offered great opportunities for comparisons, robustness and further transferability (Yin, 2009), it was deemed impractical as the study prioritizes depth over breadth.

3.1 Data Collection

Within qualitative research, there are a couple of associated research methods to generate data. This study mostly relied on *qualitative interviewing* but also made use of *collection and qualitative analysis of texts and documents*.

Qualitative interviews were chosen as they offer a more flexible way to collect qualitative data than for instance structured interviews (Bell et al., 2022). It also allowed for in-depth data and nuances from interviewees otherwise difficult to be obtained (Qu & Dumay, 2011). Most interviews were conducted with employees of Vattenfall, but there were also interviews with people from other organizations connected to The Storage Project's innovation ecosystem. The reason why the majority was from Vattenfall was due to time constraints as it was challenging to get access to other individuals from other organizations. By having qualitative interviews

with other parties than just Vattenfall, more insights could be obtained about the holistic picture of the ecosystem – not just inside Vattenfall's organizational boundaries. The qualitative interviews were carried out in two sequences, first one unstructured exploratory phase and then a semi-structured refinement phase. Five exploratory interviews were conducted with six respondents and then eight semi-structured interviews with new respondents were conducted in the refining stage. All respondents were only interviewed once, meaning that those who were interviewed in the exploratory phase were not interviewed in the refining phase and vice versa. There was an instance of when there were multiple respondents present at a single interview session. For that instance, the respondents are referred to as the interview number X followed by the letter a or b. Table 3.1 contains information about the respondents that were interviewed for this study.

Table 3.1

List of respondents

Phase	Respondent	Organization	Role	Duration	Medium	Date
Exploratory	R1a	Vattenfall	Business Developer	40 min	On-site	23/9-2024
	R1b	Vattenfall	Business Developer			
	R2	Vattenfall	Innovation Manager	40 min	Teams	7/10-2024
	R3	Distribution System Operator (DSO)	Innovation Manager	40 min	Teams	7/10-2024
	R4	Vattenfall	Business Developer	40 min	Teams	8/10-2024
	R5	Chalmers	Industry Expert / Professor	30 min	On-site	10/10-2024
Refining	R6	Vattenfall	Business Developer	40 min	Teams	11/10-2024
	R7	Distribution System Operator (DSO)	Business Developer	40 min	Teams	16/10-2024
	R8	Industry Association	Program Manager	50 min	Teams	16/10-2024
	R9	Vattenfall	Market Analyst	40 min	Teams	17/10-2024
	R10	Vattenfall	R&D Manager	30 min	Teams	18/10-2024
	R11	Vattenfall	Market Operator	40 min	Teams	4/11-2024
	R12	Vattenfall	Innovation Manager	40 min	Teams	28/11-2024
	R13	Vattenfall	Business Developer	40 min	Teams	2/12-2024

The aim of the exploratory phase was to interview an initial sample of actors in order to generate new theoretical ideas for the study. The positives of having these exploratory interviews as unstructured was that they were very open and allowed interviewees to elaborate extensively and steer the conversation to unpredictable directions (Alsaawi, 2014). Further, these initial exploratory interviews helped to initiate snowball sampling where interviewees for the latter phase could be identified. This was an effective way of getting insightful interviews with individuals inside and outside of Vattenfall based on the conversations which were had during the interviews. In accordance with Bell et al. (2022), the unstructured interviews were conducted using a brief set of topics and questions that were compiled before the interviews.

The topics were identified beforehand and were derived from insights gained during initial the literature review. These can be found in the appendix. Information received from Vattenfall were also used to identify topics for the exploratory interviews. The authors crafted an initial map of the ecosystem actors and could subsequently identify potential interviewees with assistance from the Vattenfall supervisor. This process allowed for the first few interviews to be scheduled with suitable interviewees allowing for relevant interviews from the start.

The aim of the refining phase was to go even deeper in regards to answering the research questions through the semi-structured format. Similar to unstructured interviews, semi-structured ones make use of a topic list and allows for large degree of interactivity and exploration of unexpected topics (Busetto et al., 2020). Brinkmann (2014) distinguishes between semi-structured and unstructured interviews in that the former has more structure than the latter. Semi-structured interviews can incorporate an interview guide as a foundation that allows for occasional departures when further investigation in a topic is needed (Bell et al., 2022). The interview guide was derived from the literature review along with the exploratory interviews and can be found in the appendix. The interviews were mostly conducted via Microsoft teams while two of them were held on-site. All interviews were audio-recorded and transcribed manually with the consent of the interviewees. There were no recordings of the video nor did the authors analyze behavioral observations in relation to answers that were provided by interviewees. Key findings from the interviews were investigated further and led to formulation of improved and more specific questions meant to enable better answers to the research questions in this study. This iterative process of adding and adapting questions in the interview guide allowed for more specific questions in the interviews – allowing for more insights.

In addition to qualitative interviewing, the study also made use of text and document analysis. These types of data are often referred to as secondary data and allows in-depth knowledge of what is already known about a topic and can complement initial findings (Johnston, 2014). For this study, it included evaluation of economic and technical aspects of the energy project, public reports published by actors in the energy ecosystem, and other research papers. There were primarily three types of text documents used: *public documents*, *organizational documents*, and *media outputs*. Bell et al. (2022) states that text and documents have the advantage of being non-reactive, meaning that they have not been created for the purposes of the study and can thus increase the validity of the data. The use of complementary texts and documents in addition to qualitative interviews is an example of triangulation which uses multiple approaches to extract information and critically analyzing it (Bans-Akutey & Tiimub, 2021). Overall, triangulation further solidifies validity and credibility of research and was therefore utilized in this study. This allowed the researchers to both improve questions asked during the interviews and to put interview answers into context with the realities of the energy sector and previous literature on innovation ecosystems and financial risk mitigation.

3.2 Data Analysis

In dealing with qualitative data, there is a need for a well-considered analysis strategy to cope with the rapidly growing dataset and its complexity (Bell et al., 2022). As the inductive approach entails iterations of data collection and analysis, the analysis strategy must be able to facilitate that. *Grounded theory* is a widely used analysis strategy in qualitative studies and allows for discovery of theory from data (Dunne, 2011). It can also be used as a strategy to collect data – which is why the analysis in this study is inspired by it and incorporated some of its elements. One form of grounded theory methodology that especially inspired the data analysis in this study is the Gioia methodology that aims to bring rigor to qualitative research (Gioia et al., 2013).

In accordance with the description of grounded theory by Bell et al. (2022), the authors utilized *theoretical sampling*, *constant comparison*, and *coding*. Theoretical sampling was an ongoing process throughout the data collection, which refers to the discovery of concepts, and was done in parallel with analysis (Dunne, 2011). The concepts were then used to identify categories with connections to theory – something that constant comparisons encompasses. In the coding phase, the authors broke down data into components and continuously gave it names to make it more descriptive of the phenomena observed. Furthermore, the authors applied *theoretical saturation*, which, according to Bell et al. (2022), refers to the practice of coding the data until no further review is needed to fit the data into the categories. It also involves collecting enough data within that category until new data does not give additional insights. This was exemplified by the scheduling of interviews with respondents R12 and R13 in the later stages of the study.

Apart from the general descriptions of grounded theory, this study was inspired by the Gioia methodology. The initial interview data was coded to generate first order categories based on interviewees' responses. For the process of coding, one interviewer would begin to do a first coding and then a second researcher would review the coding to ensure that they agreed. If there were any differences, the researchers would discuss the matter and come to a mutual decision about how to code a specific passage. The first order categories were then grouped into second order themes illustrated on separate sides of the two-sided data structure, which can be seen in figure 3.1. On one side, barriers for collaboration were identified and on the other side risk mitigation mechanisms were identified. These two concepts also formed the aggregated dimension of the two respective sides. With the coding done and categories and aggregated dimensions identified, the data structure was created to represent the analytical work that had been done and to graphically represent the relationships between the data points. This is in accordance with what is suggested by Gioia et al. (2013). In line with the Gioia methodology, the study then continued to create a conceptual framework based on the data structure that could be used to provide a deeper analysis and discussion. The data structure obtained from the Gioia methodology used for this study can be seen in figure 3.1.

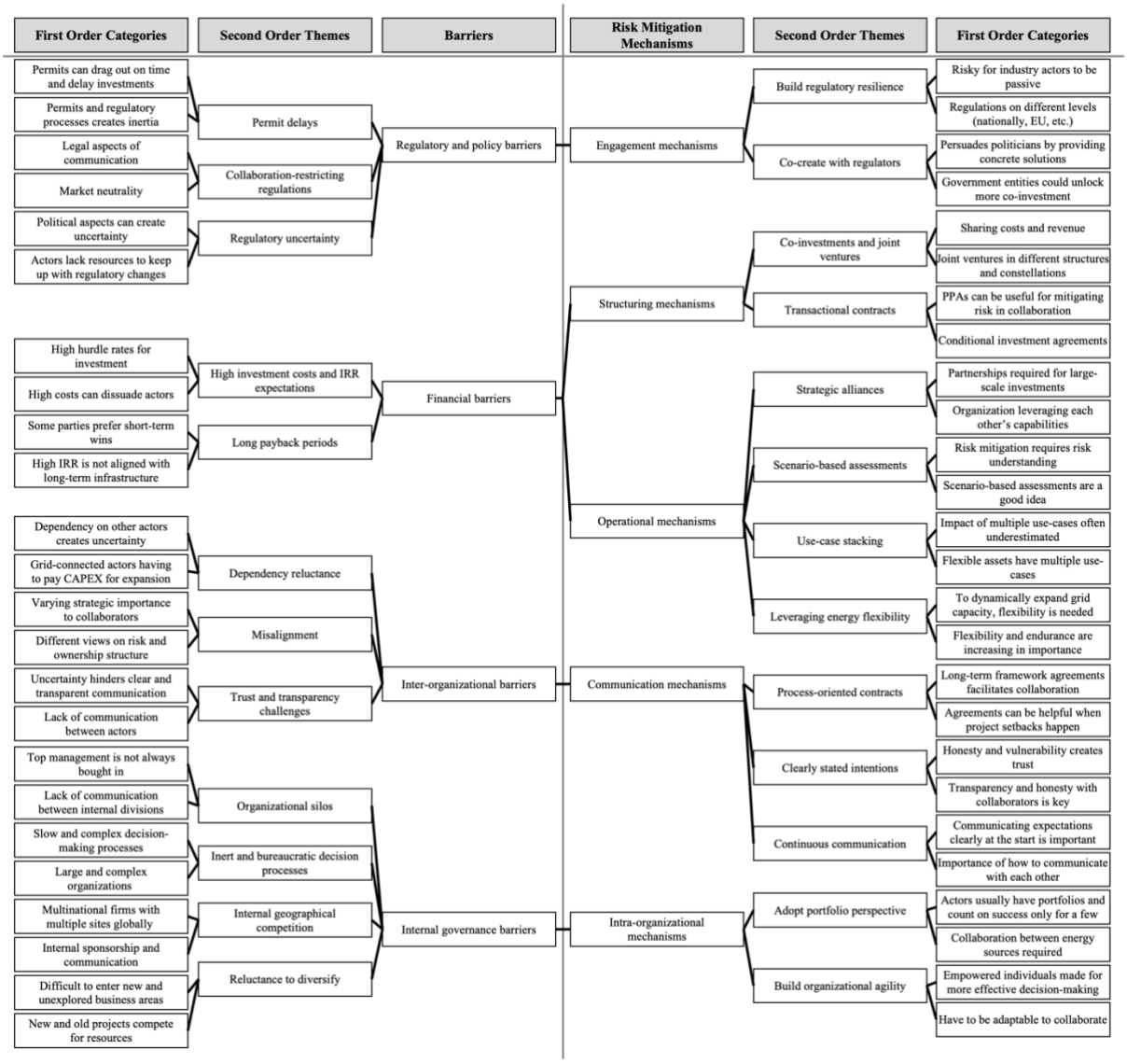

Figure 3.1: Data structure from Gioia methodology – used as a foundation for analysis in the thesis

3.3 Ethical Considerations

A key ethical consideration when conducting the study was integrity and personal data protection. To ensure that interviewees were treated respectfully and able to give informed consent, they were contacted before interviews to explain the purpose of the interviews and the content they would be asked about – as is suggested by Pope et al. (2007). The study was transparent with interviewees and allowed them to give informed consent after having received information about the research project in writing – as outlined in the principle for informed consent by Bell et al. (2022).

Interviewees were explicitly asked for consent if the interviews were to be recorded, and they had the option to remain anonymous in the final report. Anonymity was seen as central in ethical considerations for the research (Gajjar, 2013). This was to ensure that participants'

privacy was respected and not compromised in the study. In addition, the chance for interviewees to be anonymous might have enabled them to answer questions more freely in topics of more sensitive nature. Interviewees were also given an opportunity to review transcripts and data collected from their interviews. Giving interviewees the opportunity to review and validate the data is both ethical but can also provide additional context or generate unexpected insights (Goffin et al., 2019).

The study was compliant with General Data Protection Regulation (GDPR), as is suggested to achieve scientific integrity (Mondschein & Monda, 2019). Personal data that was gathered for the purpose of this thesis was stored securely and later deleted – in line with the regulations outlined in the GDPR. This was of importance not only to the authors of this study, but also for Vattenfall and Chalmers University of Technology.

3.4 Delimitations

The study was carried out under an 18-week time period, which meant practical considerations in regards to limiting the data collection period and sample size. As Vattenfall's operations and functions contain confidential information, there were agreements between the authors and Vattenfall about what could be disclosed. This meant that not all of the data gathered and insights obtained could be shared in this study, which could comprise transferability of the study. However, this limiting factor was mitigated as all information of true interest for the purpose of the study could be included in the report. The authors also decided to not include names of specific organizations, apart from Vattenfall. While this may have removed some practical insights into the case study, the authors consider this to have strengthened the understanding for non-Swedish readers as the terms used in this report are internationally established. Examples include name TSO and DSO, which are also the terms used elsewhere. Furthermore, neither of the authors have objectives or values that could compromise the confirmability of what is included in the report.

Further delimitations were made in order to effectively fulfill the essence of the study´s purpose. When considering the innovation ecosystem of the energy project, only actors that Vattenfall interact with directly or those that are particularly affected by or affect The Storage Project were considered. This meant that suppliers and similar actors deemed distant to nor have direct interests to The Storage Project were left out of this study. Neither were actor who might develop similar energy project solutions to Vattenfall elsewhere considered. Similarly, actors who could consume the electricity from The Storage Project but without relational or geographical proximity to it were also excluded.

4. Case-Description: The Storage Project's Energy Ecosystem

The basis of the case-study is Vattenfall's potential energy storage solution, The Storage Project, which the ecosystem evolves around. The section is outlined as follows: an introduction to the electrical system and energy storage, The Storage Project's business model, the ecosystem actors, and the ecosystem actor's potential value of The Storage Project.

4.1 The Electrical System and Energy Storage

In the electric system, the foundation is constituted by those who produce energy, those who consume it, and those who operate the grid. The grid transmits or distributes energy directly from where it is produced to where it is consumed. This occurs close to instantaneously, meaning that whenever energy is used in one's home for instance, that same energy was produced at almost the exact same time in an energy production facility elsewhere. Energy must be transferred from producers to consumers as the grid itself is not capable of storing energy. If energy is not consumed precisely when it is produced, it causes the grid to distribute it elsewhere to keep the grid from operating outside of its specification limits. This implies that production and consumption of energy needs to be synchronized and have equal volumes to not cause wear and tear on the electrical grid. To keep energy production and consumption synchronous, grid operators must be well informed about consumption behaviors as well as production capabilities to inform producers how much they need to produce. This applies minute-to-minute, day-to-day and even longer time periods. However, precisely balancing energy production and consumption is not always feasible.

More recently, the production of energy is becoming more and more unpredictable as plannable energy production from hydro or nuclear power is replaced with unplannable production sources such as wind or solar power. One cannot determine how much wind or sun there will be, which is a determining factor on how much energy wind or solar power can generate. This means that energy production from such sources will vary across time periods. In practice, this leads to it sometimes being lower and other times higher volumes of energy in the grid than needed. This phenomenon is referred to as intermittency, and can further accentuate the imbalance between energy production and consumption.

Energy storage solutions could help smoothen out the discrepancies between energy production and consumption. The reason for this is that these can take energy away from the grid when there is more than needed but then add the stored energy back into the grid when there is a higher demand. Energy storage solutions can come in many variants and are built around different principles – including but not limited to storing energy mechanically, thermally, and chemically. They also vary drastically in how much they can store and discharge – ranging from single digit watts of energy in small batteries to many megawatts in pumped hydro storages. Similarly, they differ in how quickly they can charge or discharge and for what durations.

4.2 The Business Model of The Storage Project

Vattenfall is considering developing a large-scale energy storage solution, The Storage Project, which would be capable of charging and discharging many megawatts of energy in an instant. It is planned to be developed at a site with plenty of already existing infrastructure, with proximity to a critical point of the grid, and which is next to energy intensive production facilities. The Storage Project would require large amounts of initial investments but can be made profitable from positive cash flows over its long technical lifetime. The foundation of its business model builds on buying and storing electricity from the grid when there is more energy in the grid than what is demanded – thus when prices are lower. The energy can then be sold and discharged when the demand for energy is higher than what is available in the grid at the moment. Prices would then be higher, which creates an arbitrage opportunity. There are several marketplaces for selling electricity, two of which are day-ahead and intra-day. The former refers to making bids that are determined the day before the electricity is sold and distributed. The latter works in a similar way, but bids and distribution of that electricity is done within the same day.

The stored energy could also be used for other opportunities, such as providing ancillary services for the grid. Ancillary services represent different services to improve the grid. It includes for instance service to stabilize the grid that arise from the discrepancies between production and consumption of energy. These can come in various forms, such as help regulating the frequency of the current in the grid – which is kept at 50 Hertz in Sweden. Some other ancillary services include voltage regulation, reactive power, inertia, and black start. Due to The Storage Project's proximity to energy intensive production facilities, there could also be potential to provide these actors with energy services otherwise unavailable for them.

4.3 Mapping of The Storage Project's Ecosystem Actors and Their Activities

Figure 4.1 illustrates the actors involved in the case study's ecosystem. The sharp arrows represent how electricity flows between actors and the rounded arrows represent market activities regarding trade of electricity. The actors can be divided into three categories: Electricity actors and consumers, Regulatory actors, and Enabling actors.

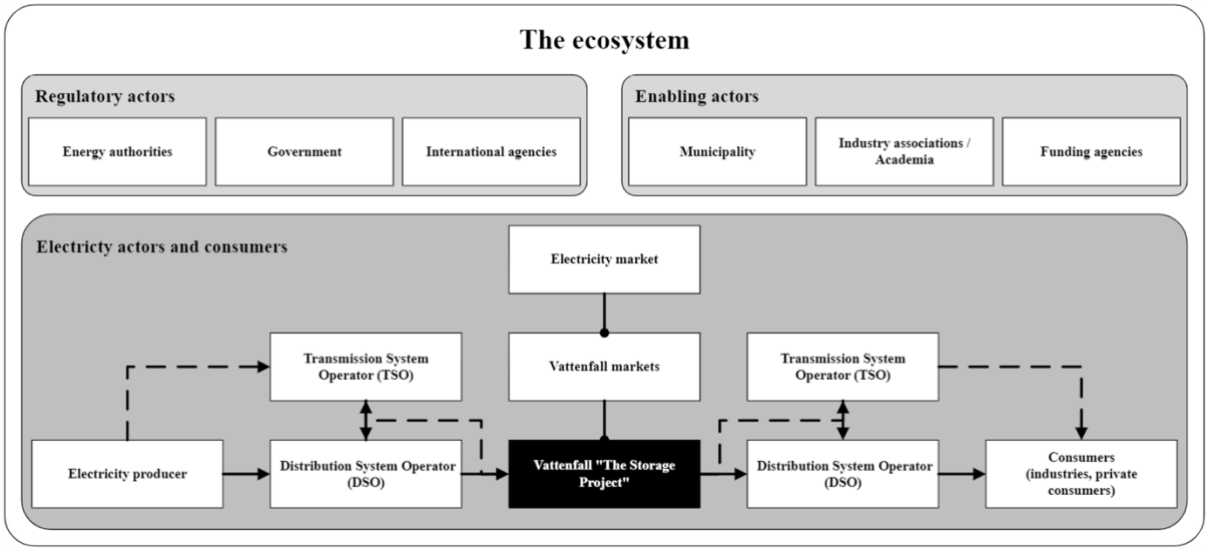

Figure 4.1: The energy innovation ecosystem of The Storage Project

Roles of electricity actors and consumers in the ecosystem

Production of electricity takes place at the electricity producer and can come from a variety of sources including but not limited to nuclear, hydro, wind or solar power. Once the electricity is produced, it enters the electrical grid in either the TSO's or the DSO's grid. The TSO manages transmission of electricity between regions where particularly large electricity producers or consumers sometimes are directly connected to the transmission grid. The TSO's exchange of electricity with large producer or consumers is represented through the dotted lines in the figure. DSOs manages regional and/or local grids and are most often those who distribute electricity to consumers.

Vattenfall's energy storage project requires the company to both buy and sell electricity, which is why they are placed at the center and have TSO/DSOs on both sides in Figure 4.1. To facilitate the buying and selling of electricity there needs to be a trading platform, which here is named as Electricity market. Vattenfall markets deals with trading based on market conditions and data from the Electricity market. They are the ones intended to operate the buying and selling activities of electricity for The Storage Project.

Roles of regulatory actors in the ecosystem

Within the ecosystem, there are regulatory actors that influences the other actors. These include Energy authorities who facilitates compliance, marketplaces, permissions, and consumer info to name a few. There is also the Government and International agencies who stipulates legislation and provides policies that impacts the electricity system.

Roles of enabling actors in the ecosystem

Enabling actors involves those who through their actions can help facilitating energy projects including The Storage Project. The Municipality governs certain permissions and could provide smaller infrastructure projects or components. Industry associations / Academia contributes with knowledge development and sharing that could improve collaborations, technology, and other things beneficial for The Storage Project. Lastly, there are Funding agencies who can enable the project to be undertaken through their funding.

4.4 Potential Value from The Storage Project for Ecosystem Actors

The Storage Project could present Vattenfall with a possible business opportunity and it can also enable value in different forms for other ecosystem actors.

Value possible for electricity actors and consumers

As the effects of intermittency in the energy system becomes more prevalent, it might possibly be needed to halt further deployment of intermittent renewable energy sources. However, with more energy storage solutions that can smoothen out the effects of intermittency, such as The Storage Project, it could further incentivize deployment of intermittent renewable energy sources. There may thus be interest for electricity producers, particularly those devoted to renewable energy, to see the realization of The Storage Project and similar ones in the future.

The electricity grid also stand to benefit from seeing The Storage Project and similar projects getting deployed. The discrepancy between energy production and consumption exerts a toll on the grid and the need of ancillary services increases at a similar rate to the deployment of intermittent energy. Currently, there are not a lot of large-scale storage solutions in the south of Sweden, that can both reduce and add energy to the grid like The Storage Project is expected to. An alternative solution would be for the TSO and DSO to expand the grid and make other improvements to increase its capabilities to manage energy production and consumption discrepancies. Such investments would however be lengthy and costly for the TSO and DSO, which would prevent them from allocating their resources in other productive areas. Therefore, it may potentially be preferable for them to see deployments of energy storages to larger extents which can complement grid investments.

Consumers of energy may also enjoy value from having The Storage Project deployed. The energy intensive industry actors located close to the planned location of The Storage Project need further energy to enable electrification of their production processes. Furthermore, for their future electrification processes, they may be in need of larger amounts of instantaneous energy than what is currently available. Also, to ensure operations without interruptions, they might want spare capacity for whenever there is a deficit or temporary shortage of energy in the grid. The Storage Project could help the industries regarding these concerns and it may also

help everyday consumer by preventing fluctuations in prices and lead to overall less spendings on energy bills.

Value possible for regulatory actors

Through the use The Storage Project and other similar future solutions, which could potentially enable more deployment of renewable energy, the government might easier reach its sustainability goals. With more renewable energy and less fossil-dependent sources in the energy system, the total amount of emissions could decrease. This also applies for international agencies that may pursue similar environmental agendas. Similarly, The Storage Project could enhance the image of Sweden as a technology leader and a front figure in enabling the green transition. Also, it could potentially lead to export of expertise and technology.

Value possible for enabling actors

The Storage Project could also provide value for the Enabling actors. For the municipality, The Storage Project could lead to a more competitive industry in the area and with more electrified and environmentally friendly processes. For the energy intensive actors in the area, having The Storage Project and its electricity may secure the needs for their operations, which in extensions means that they can remain in the area and tax revenues for the municipality. This would ensure employment for the ones already working at these industries, which could be of interest for the municipality but also industry associations. It may also provide traffic to the municipality where new industries and actors can get established. Academia may also benefit from The Storage Project as it is a novel technology solution. This could enable research opportunities and in extension lead to development and diffusion of knowledge.

5. Findings: Barriers for Collaboration and Risk Mitigation Mechanisms

Based on the data analysis, the findings are divided into different parts. The first parts explore what interviewees considered as barriers for increased collaboration between actors. This is then followed by mechanisms that could mitigate the barriers and create more favorable conditions for The Storage Project in the form of lower financial risk. By understanding the barriers and the risk mitigation mechanisms, a more successful business case could be fostered. The barriers and mechanisms can be found in table 5.1:

Table 5.1

Summary of barriers for collaboration and risk mitigation mechanisms

Dimension	Category	Type
Barriers	Regulatory and policy barriers	Permit delays
		Collaboration-restricting regulations
		Regulatory uncertainty
	Financial barriers	High investment costs and internal rate of return expectations
		Long payback periods
	Internal governance barriers	Organizational silos
		Inert and bureaucratic decision processes
		Internal geographical competition
		Reluctance to diversify
	Inter-organizational governance barriers	Dependency reluctance
		Misalignment
		Trust and transparency challenges
Mechanisms	Structuring mechanisms	Co-investments and joint ventures
		Transactional contracts
	Operational mechanisms	Strategic alliances
		Scenario-based assessments
		Use-case stacking
		Leveraging energy flexibility
	Engagements mechanisms	Build regulatory resilience
		Co-create with regulators
	Communication mechanisms	Process-oriented contracts
		Clearly stated intentions
		Continuous communication
	Intra-organizational mechanisms	Adopt portfolio perspective
		Build organizational agility

5.1 Barriers for Increased Collaboration and Added Value in the Ecosystem

Collaboration in an ecosystem can contribute to an increased joint value creation, creating a complementary surplus (Baldwin et al., 2024). There are however many barriers to increased

collaboration which need to be overcome to unlock value surplus in the ecosystem. This section will present findings on these barriers and what causes them. The barriers have been grouped into four categories: *Regulatory and policy barriers*, *Financial barriers*, *Internal governance barriers,* and lastly *Inter-organizational governance barriers*.

5.1.1 Regulatory and Policy Barriers

The first category of barriers is related to regulation and policy. In the energy sector, this is a category of barriers which is often present since many actors are heavily regulated. These actors include regulated monopolies or government agencies, other state-owned actors, and private companies. The presence of this diverse set of actors and their actions in the ecosystem can create barriers in the form of regulatory and policy constraints. The three constraints identified within regulatory and policy barriers are: *Permit delays*, *Collaboration-restricting regulations*, and *Regulatory uncertainty*.

Permit delays

One regulatory barrier that was mentioned in interviews was permit delays which have slowed down many projects. Slow permission processes are not only a barrier to collaborative projects, but to all infrastructure projects that require permits to move forward. Respondent R5 stated that permission processes and inertia in the Swedish system makes rapid transitions difficult. The timeline for permit processes can make it challenge to effectively plan and make good decisions for actors in the ecosystem. Respondent R8 added that industry actors are dependent on permission processes not taking too long to avoid delays in projects. This highlights the importance of a well-functioning permission process to not create further delays.

"Right now it is probably more about building permits, permit processes and the entire inert Swedish system that is not made for rapid changes" -R5

Collaboration-restricting regulations

A second regulatory barrier is collaboration-restricting regulations. One example of these regulations is market neutrality where actors in the ecosystem that are regulated monopolies are required to stay market neutral. The requirement to be market neutral for these actors can sometimes make it difficult for them to enter collaborations as it can be viewed as giving unfair advantages. Respondent R3 mentioned that collaborations for DSOs can be a little bit more challenging than for other actors due to regulations related to market neutrality. From the interviews, it became clear that this fact makes collaboration between energy producers and DSO/TSO actors challenging at times. Additionally, respondent R4 stated that it can be challenging to collaborate with public actors because of their limited freedom due to regulation.

"My experience is that public actors operate under regulations with limited freedom, where you have to adapt. There is a difficulty in having a strategic dialogue." -R4

Regulatory uncertainty

A third regulatory and policy barrier for collaboration is regulatory uncertainty. This is especially true in transition projects where industry or cross-industry collaborations are planned to enable transitions to more sustainable solutions. Respondent R5 raised the point that a current challenge for industry actors is that they lack the resources to keep up with regulations and regulatory change. This highlights a reason as to why actors may be hesitant to enter into projects or collaborations when it is unclear what the regulatory environment will look like in the future. It can be costly to make changes, and uncertainty increases the risk of such investments. Respondent R8 agreed that regulatory uncertainty can make investment decisions less predictable. However, the respondent also offered a slightly contrasting view regarding collaboration, stating that regulatory uncertainty does not necessarily lead to less willingness to collaborate. Respondent R1b brought up that the political perspective often can create uncertainty among actors in an ecosystem as it creates nervousness in management teams when making forward-leaning investments. R12 mentioned an instance where actors reverted from an initiative due to regulatory uncertainty. This highlights how the political nature of regulations can contribute to uncertainty in an industry or ecosystem.

"The challenge we see now is that when the rules change quickly and often you don't really have the resources to keep up." -R5

5.1.2 Financial Barriers

The second category of barriers is focused on financial barriers, as evident through interviews. There can be financial barriers for one or several actors that potentially could collaborate – sometimes making actors hesitant to collaborate with each other. The barriers of focus within this section are *High investment costs and internal rate of return expectations* and *Long payback periods*.

High investment costs and internal rate of return expectations

A barrier to collaboration can be high investment costs and IRR expectations. Many energy projects, particularly investments in energy or large-scale infrastructure, require significant upfront capital. If investment costs are high, it may put a strain on liquidity of the firm – thus making the investment less appealing. These costs can discourage potential partners from participating, particularly smaller organizations or those with limited liquidity. High investment requirements also amplify the financial risks associated with the project, as the potential downside becomes even larger. This can become extra challenging in a potential collaboration where both sides may have high requirements on IRR. Respondent R8 mentioned

that high investment cost and lower than hoped for IRR may be a deterrent for certain investments – leading to resources being placed elsewhere. An example of this was mentioned by R8 regarding a tender in which actors may not be willing to participate due to high costs making the opportunity unattractive. From the interviews it became clear that if both parties of a collaboration have high IRR expectations and at the same time are risk averse, it could be difficult to successfully establish collaborative projects. Respondent R6 mentioned that IRR expectations internally can differ between firms, and this combined with differing views on risk/reward can sometimes make collaborations challenging. R12 further mentioned how IRR high expectations can be troublesome when dealing in infrastructure projects. If one were to apply high discount rates, it leads to a situation where nearly all NPV gets generated during the first few years of a project. For a project with a lifetime of eight decades, the latter six decades might potentially only generate less than 5% of the NPV. This phenomenon thus further becomes a barrier as it leads to rejection of projects which otherwise might have been accepted.

"If you had tried to build hydro power today, if you hadn't had it before, which is our cash cow - then we wouldn't have built it. It had been considered too risky and difficult; we had set such high return requirements that it would not have been profitable." -R12

Long payback periods

It has been established that large-scale infrastructure or energy projects demand large upfront investments. Due to this, such investments usually require the project to generate revenues over long periods of times to become profitable, often exceeding decades. This leads to another problem which might deter actors from wanting to pursue an investment – namely long payback periods. Investing large amounts of capital into a project in combination with it taking many years for it to generate profits can have a toll on actors with less financial resilience and cash reserves. This dynamic amplifies the challenge of high investment costs and can be troublesome for stakeholders who prioritize faster returns despite upsides of a potential great IRR over a project's lifetime. According to R12, there had been a project initiated between two large actors related to when one of the parties got new directives – to prioritize short-term returns. One party shifted and wanted to prioritize quick returns over the long payback period entailed by the project through the collaboration. R12 further mentioned a paradox in regards to how actors within energy infrastructure thinks around finances. They tend to sometimes apply financial models that are more suitable for a venture capitalist but may not be best suited for long term investments – as is usually the case for infrastructure projects. This dynamic tends to dissuade actors in that space from pursuing new investments and instead rather focus on managing already existing ones. R13 added to that sentiment and mentioned that such projects may require an owner who can back the project and provide it with warranties and conditions to continue. It has also been highlighted that the culture of a firm can impact risk appetite and that firms will see different aspects of a project as something that requires risk mitigation. This underpins the importance of a firm reflecting on what kind of organization they are, how much risk that can be accepted and how much of risks that can be mitigated.

"I think [company] have ended up more focused on the economics of each quarter. I think that fewer and fewer companies are thinking long-term" -R12

5.1.3 Internal Governance Barriers

The third category of barriers is focused on internal governance barriers within actor's organizations, that hinder collaborations. Collaborations between different actors can often be challenging and two aspects that came up as challenging in the interviews was governance and effective decision-making processes. Establishing who is responsible for what and how decisions will be made for individual actors can be a challenge. Another internal governance challenge for actors is internal competition within a firm. Competition for resources within a firm is common and can lead to geographical locations competing. Finally, there can be a reluctance to enter new areas of business and a desire to stick to the core business within firms. The internal governance barriers identified are: *Organizational silos*, *Inert and bureaucratic decision processes*, *Internal geographical competition,* and *Reluctance to diversify*.

Organizational silos

The first internal governance barrier identified was organizational silos and a lack of communication within actors' organizations. Having siloed information might hinder key stakeholders from getting a full overview of a situation and could influence decision-making. Similarly, a lack of communication within a firm may hinder key insights from reaching the right people. One insight from the interviews is that in large and international firms, a lack of communication may lead to not all information reaching top management. Respondent R8 stated that it can be hard for local management at industry actors to sell local investment decisions internally to top management which are based elsewhere. This can create situations where local management and group management may disagree on what the right decision is, and top management may not see the benefits of collaboration. Another internal challenge related to siloed information was raised by respondent R1a who said that it can often be difficult to navigate internally and find the right direction before a common strategy is put in place when it comes to collaborations. R13 said that it is important to ensure transparency within an organization and to underline benefits of initiatives to have cohesions between an organization's different projects.

"That can sometimes be the biggest challenge, navigating internally, finding the right direction there before there is a stated strategy in place." -R1a

Inert and bureaucratic decision processes

The second barrier, inert and bureaucratic decision processes can be a barrier for development, not least in those that involve large organizations and multiple stakeholders. It can imply stringent protocols, layers of approval, and a lack of agility in responding to dynamic

requirements. Having slow decision-making processes can be detrimental within an individual organization, but it only worsens when expected to collaborate and make decisions together with a separate actor as well. This might end up in delay of critical decisions, resulting in missed opportunities, delays, and higher costs. During interview R6, it was mentioned that for a collaborative project, the two involved parties had different ways of working where one of the parties were more agile. The other party, however, was more dependent on steering committees and other approval process to advance with decisions. A similar situation was mentioned during interview R1a where initiatives were perceived differently throughout some organizations – thus making decisions more difficult. Inertia and bureaucratic processes can also lead to less mandates for individual employees to take the project forward in an agile manner. R6 highlighted this fact as something that could hinder individuals from taking initiatives and responsibilities to drive results.

"*It was also seen much more clearly that [employees in Company A] had a much greater mandate within its organization to make decisions themselves... [in Company B] every decision had to be brought up in a steering group*" -R6

Internal geographical competition

Another internal governance barrier that has come up in interviews is that there might exist intra-company geographical competition in large multinational firms. Geographical sites within the firm may be competing for the same resources and investments – which might create competition and friction. This may result in collaboration looking attractive to a local subsidiary while a management team based in another location may see collaboration as an unnecessary risk if they can invest their money in a different geographical location. Respondent R8 mentioned that there is an internal international competition within many of the multinational companies. Respondent R1b similarly raised that the geographical question of potential investments can create uncertainty internally among actors. This suggests that this internal competition can create more uncertainty in a potential collaboration, thus making collaboration between actors more difficult.

"The geographical perspective – should it be invested here or elsewhere? Every value chain has uncertainties that are characterized by disturbances that come in over time - which lead to uncertainty about whether to implement certain things or not." -R1b

Reluctance to diversify

The final barrier when it comes to internal governance is the occasional reluctance of actors to diversify into "non-core" areas of business. Stepping into non-core areas, such as co-investing or operating within unfamiliar businesses can be seen as dilution of focus and inadequate use of a firm's resources and capabilities. Furthermore, it might lead to an increase in risk exposure for the firm in regards to financial losses, operational inefficiencies, or reputational risks. Many organizations may thus prefer to focus on already established domains to enhance their current

value propositions. R4 exemplified a reluctance to enter a new business with the example of a fuel company perhaps being reluctant to enter into the electricity business or the other way around. Similarly, R5 highlighted that it may not always be in the interest of consumers of electricity to also produce it. The reluctance can limit innovation and cross-industry collaborations. Some large-scale investments – especially those concerning the green transition – may often require actors going outside their core-areas. The will for transitions was mentioned by R1a as one of the reasons as to why cross-industry collaborations takes place and why reluctance to stepping into non-core areas needs to be overcome.

"It becomes so big, for an industrial actor – to operate an electrical plant would be unthinkable… it is completely outside their core business, it is natural that whoever supplies electricity takes care of it." -R5

5.1.4 Inter-Organizational Governance Barriers

The category refers to barriers that may occur between different actors when they try to collaborate. This may include actors being reluctant to be dependent on other actors in the ecosystem, misalignment between collaboration parties, and trust challenges that can hamper the will to collaborate. These soft aspects have been mentioned as a challenging endeavor to overcome and reasons as to why collaborations were not undertaken or difficult to manage. There have been three barriers identified related to this: *Dependency reluctance*, *Misalignment*, and *Trust and transparency challenges*.

Dependency reluctance

The first barrier within this category relates to dependency which refers to the reluctance of being dependent on other actors, even if a potential collaboration could be mutually beneficial. This reluctance stems from concerns about losing control over key operations and becoming vulnerable to the decisions or performance of another actor. An example could be if one actor was heavily reliant on supplies from another party or if two actors have shared infrastructure where the other party's decisions impact the other. This reluctance could hinder the willingness to share resources, co-invest, or form alliances – all of which can be important for collaboration regarding large-scale projects. During interviews, examples were mentioned where dependency on another actor impacted the decision. R5 mentioned that some industry actors had projects that were not within their core business, and despites so, the projects were decided to be managed in-house rather than outsourced to withhold control. However, it has been mentioned that dependencies on other actors does not necessarily have to stop collaborations from happening according to R8.

"Some of the reasons were that you wanted to be sure that you get the resources when you need them. You are a little hesitant to make decisions like this as it puts you in a position of dependence on another party. It is a major obstacle when it comes to shared infrastructure." -R5

Misalignment

A second barrier to collaboration between different actors can be misalignment. Misalignments could arise in regards to goals, priorities, or strategies between the different actors – not least when it comes to risk-tolerance. This challenge can be prevalent in projects that involve multiple stakeholders with diverse backgrounds who needs to find common ground. The interviews highlighted that collaboration often occurs in new and sometimes untested ventures. These projects can often be seen as risky and it is important that all parties are aligned on what tolerable risks are. R8 mentioned that some actors may reject the same project that another actor accepts due to differences in regards to IRR requirements and risk-tolerance. Similarly, R4 highlighted the aspect of ecosystem actors having different perceptions of risks. From interviews, it became clear that misaligned risk tolerance can put a strain on collaborations as one party may want to pursue a riskier strategy or can perceive that they are taking additional risk as compared to other partners. R5 highlighted an instance where the collaborators on a project had different thoughts about risk-reward aspects of a project. Additionally, R1a stated that it is important for successful collaborations that actors align commercial expectations such as investment size and time horizon with each other. Interviewee R12 also mentioned that different parties may have different expectations on collaboration in regards to how much one controls. It was highlighted that some actors prefer to be a majority owner in collaborations and that they actively avoid situations where they would not be.

"What we call 'frontend loading' is very important, that you agree on the things from the beginning - what you want out of a collaboration" -R12

Trust and transparency challenges

A third barrier identified within the category was trust and transparency challenges between actors. When trust is at challenge, partners may withhold critical information, doubt each other's commitments, or act to protect their interests – leading to inefficiencies. Transparency is closely tied to trust, which may impact openness about goals, intentions, or risks which can worsen willingness to engage in deeper collaborations. Transparency is also related to the previous barrier of misalignment as transparency can help to avoid misalignment. Both trust and transparency concerns become prevalent in large-scale collaborations where there is a lot at stake. Trust and transparency challenges might arise due to past experiences, competitive pressures, or legal constraints, such as nondisclosure agreements that limit open communication. R13 mentioned that large actors might act in a protectionist manner to not give away business information, which ultimately leads to less initiatives being taken and less chances for partnerships. R8 mentioned that a lack of communication sometimes limits the opportunities for collaborative efforts. R1a also highlighted this aspect and shared experiences where poor communication led to concerns over expectations before decisions were made.

"There you easily get stuck in a 'catch 22'-situation, where no one takes the first step, and you become protectionist. That you don't want to reveal too much about your business." -R13

5.2 Risk Mitigation Mechanisms

Ecosystems surrounding an innovation entails risks that needs to be overcome. Henceforth, the definition of risk by Ahmed (2017) – uncertain events with an effect on project objectives – will be used, especially in relation to Hayes' (2024) definition of financial risk – the probability of not reaching adequate returns on investments. This section captures mechanisms that can mitigate risk related to Vattenfall or its interactions with ecosystem actors that may have a direct or indirect effect on project objectives. Five broad categories of risk mitigation mechanisms have been identified, and these are: *Structuring mechanisms*, *Operational mechanisms*, *Engagements mechanisms*, *Communication mechanisms*, and *Intra-organizational mechanisms*.

5.2.1 Structuring Mechanisms

Structuring mechanisms refers to various forms of agreements for resource allocation, risk-sharing, and operational coordination for two or more actors within an ecosystem. Using structuring mechanisms, actors can further enable joint value creation. The two mechanisms within this category are: *Co-investments and voint ventures* and *Transactional contracts*.

Co-investments and joint ventures

The first structuring mechanism, co-investment, entails multiple stakeholders placing some of their financial resources to support a project between actors. Co-investing can lead to lower financial exposure for each actor if the project was to fail and enables smaller actors with less liquidity to participate in the investment. Respondent R3 mentioned that partnerships are and will continue to be important to handle large investments in the energy sector. Co-investment can both lower the financial risk by spreading out the investment cost, but also technical risks as actors can often bring more diverse experiences and expertise to the project. Respondent R4 mentioned that large and complex projects often require resources from multiple actors to succeed. There have been examples mentioned throughout interviews where one actor successfully managed to get involvement and co-investment from another actor. The other actors had interests in the projects and were able to enjoy mutual benefits of co-investing. One instance of when mutual benefits could be obtained was, according R8, seen among the energy-intensive industry actors related to The Storage Projects ecosystem. The actors have contributed with investments into shared resources such as infrastructure, services, knowledge centers, and other technical investments.

Related to co-investing, joint ventures entail ecosystem actors creating a new separate entity that are jointly owned by the actors where the new entity is the one investing. This mechanism can simplify ownership questions as its predetermined how risks and rewards are shared among the owners. R6 described instances of actors creating joint ventures to provide new value

propositions. Furthermore, R9 and R11 mentioned energy projects that are jointly owned by different actors where the different parties contributed with investments. R13 mentioned that a joint venture could allow for a more collective view on development. The interviewee also mentioned that it might be beneficial for this joint venture to be somewhat independent from its owners to allow for it to closely consider particular situations in specific areas.

"Society is very dependent on electricity – the partnerships are coming and are crucial, but it's a little uncertain what they might look like." -R3

Transactional contracts

Transactional contracts are a mechanism that allow for structured and legally binding agreements regarding transactions related to projects. By using contracts, the actors can mitigate uncertainties that might negatively impact project outcomes, such as financial losses or operational setbacks. It also enables potential upsides as they can secure revenues for the future. Transactional contracts were said by interviewees to provide security in long-term project regarding uncertainties and volatility, for instance by locking in pricing terms and trading volumes. R9 and R11 highlighted instances where contracts helped ensure terms around services from one party to the other and R3 mentioned how contracts can help to determine certain operational terms around electricity. Moreover, R13 mentioned the importance of entering agreements for guaranteeing revenues to reduce overall risk. Transactional contracts can have many forms, but two prominent ones within the energy market are conditional investment agreements and Power Purchase Agreements (PPAs).

In the interviews it was mentioned that a conditional investment agreement could be leveraged to lower the risk and generate joint value. In this case one or more customers agrees to co-invest in a project and in return receives certain conditions, for example, a set price for electricity for a certain time frame. Respondent R2 suggested that Vattenfall could for instance offer a long-term price commitment to remove the price risk for a collaborator. This would help to both lower the initial investment cost and could provide more predictable cash flows for an investment in the future. It also allows a potential co-investor to have a guaranteed price point which could be lower than market rates and more predictable as it avoids market volatility. A solution using a conditional investment agreement could in this way benefit both parties.

PPAs are long term contracts between sellers of energy and potential buyers that have been used frequently when it comes to renewable energy. Commonly for PPAs, an energy producer builds and operates a facility which produces electricity and then another actor commits to be a long-term buyer of energy, often between 10-25 years. The buyer could be corporations, utilities or government entities for instance. This is an effective way to attract financing and securing loans for the seller of energy. It can also help to protect against volatility in energy prices and ensure better predictability for a buyer of energy. Respondents R2 and R6 both mentioned that PPAs potentially could be an interesting solution to lower risk for energy storage solutions, similar to how it has worked for the renewable energy sector. Respondent

R11 also mentioned that PPAs might be a good way to lock in future revenue for an asset. This highlights how PPAs could be mutually beneficial.

"You could also offer a long-term commitment to pricing and take price risk out of this because normally you would say these peak loads are very much focused on the industrial process. You need them at a certain moment because quite a lot of industrial processes are determined by time and not electricity price" -R2

5.2.2 Operational Mechanisms

The second category of mechanisms identified are operational mechanisms. These represent ways in which a project or collaborators around an energy storage solution can enjoy stronger operational performance and thus a stronger business case from the increase in value created and captured. Four forms of operational mechanisms have been identified: *Strategic alliances*, *Scenario-based assessments*, *Use-case stacking*, and *Leveraging energy flexibility*.

Strategic alliances

Strategic alliances allow for the ecosystem actors to share resources and expertise on a project where synergies can be obtained. These can be between actors within a similar line of business but also cross-industries, which became evident through examples mentioned in interviews. According to R3 and R7, collaborations and partnerships are becoming more prevalent – not least in regards to the electrical system. Combining resources and strengths enables mitigation of risks that an independent actor might not have been able to handle themselves. Spreading operational risks across multiple entities reduces the impact of adverse events, such as supply chain disruptions or market downturns. Interviewee R8 mentioned that industry actors have joined forces regarding topics that impacts each respective businesses. R4 highlighted other instances where actors from different industries have entered alliances where they combine efforts to co-create value.

"This means that all the actors jointly have the same challenge in transitioning. This also applies to the issue of the climate footprint. It therefore became natural to collaborate on these issues" -R8

Scenario-based assessments

Scenario-based assessments involve creating multiple hypothetical scenarios, each reflecting different combinations of variables such as regulatory changes, market prices, energy demand, and other factors. Using a scenario-based analysis of a project allows for better modelling of potential scenarios for stakeholders to anticipate how an asset can perform across a range of possible futures, ensuring that decision-making is robust. This helps to increase resilience in case of volatility or unexpected developments but also helps to identify opportunities that

otherwise might have been missed. Additionally, scenario-based assessments help manage risk by revealing potential downsides. For instance, a scenario that models regulatory delays or stricter policies might highlight vulnerabilities in certain operational strategies, prompting stakeholders to adapt their approach proactively. Furthermore, this approach also facilitates strategic alignment between partners by providing a shared framework for evaluating asset performance. When all stakeholders assess scenarios using the same data and assumptions, it reduces conflicts and fosters consensus on the best operational approach. Respondent R2 mentioned that the first step towards mitigating risk is to understand the risk and a good way to achieve this is through scenario-based assessments.

"Because to mitigate risk you need to understand risk." -R2

Use-case stacking

A third way to operationally mitigate risk and improve the business case is to conduct use-case stacking and optimization of the use-cases. As mentioned in the case description, The Storage Project and other energy storage solutions, have multiple use-cases and can generate revenue in different ways over time. For instance, The Storage Project could participate in energy markets both day-ahead and intra-day while also participating in ancillary services markets. Despite the opportunity to participate in multiple markets over time, The Storage Project will not be able to do so simultaneously. It therefore becomes an optimization question where Vattenfall should be active in the market that provides the most profit at the time.

According to respondent R11, one needs to optimize between different markets since it is not possible to trade in all markets at once. To improve the business case of an investment, it is important that the asset is being used for the most valuable use-cases at that time – since this will most likely shift over time. Respondent R2 mentioned that it is highly valuable to have the flexibility to shift between use-cases to enable risk mitigation. Use-case stacking is helpful both to maximize the value that is generated, but also to mitigate the risk of being too highly dependent on a single value stream. In the case of The Storage Project at Vattenfall, it was mentioned that different ancillary services can be valuable streams to add. Respondent R9 explained that to better understand the value of ancillary services, one should start with understanding what services an asset can offer and to what extent. R2 echoed this sentiment and stated that one should consider the specific capabilities of an asset. Having the capability to provide ancillary services will allow for use-case stacking and better optimization of the asset.

"If you say that you want to understand what ancillary services that might be added, you would have to understand the following: 1) what ancillary services can this storage solutions provide? … 2) how much of a certain ancillary service can be provided and at what time." -R9

Leveraging energy flexibility

Being able to provide flexibility from one's energy solution can be seen as a mechanism to operationally mitigate risks. According to respondent R7, flexible energy solutions will be more valuable and important as more intermittent energy sources are connected to the grid. With this information, it is highly valuable for new energy projects to keep flexibility in mind for their business cases. R11 additionally mentioned that flexibility will most likely become more valuable in the future. When the energy system and consumption looked like it did in the past, flexibility was believed to be an unnecessary luxury. However, in the modern energy system, it has becoming more of a necessity, and it will increase the value of these assets. Having a flexible asset like The Storage Project could also imply further revenues from TSOs and DSOs. In some markets, the owner of storage solution can receive payments as the solution mitigates investments that the TSO or DSO otherwise would have to make to improve the grid. Respondent R11 stated that they had not heard of such models gaining a foothold in Sweden, but that there are other opportunities to get compensated by providing value for the grid. R13 highlighted that it might be possible to obtain a lower discount rate if the overall operational risks of the project decreases.

"However, I do not see the potential upside of ancillary services as decisive for a business case. It is the flexibility itself that is what you get paid for." -R11

5.2.3 Engagement Mechanisms

Regulations and policy can play a major role in whether projects can be undertaken and whether certain actors may collaborate on that project. Based on information from interviews, navigating the regulatory environments is seen as challenging but necessary. To overcome such challenges, actors can resort to engagement mechanisms. These represent ways in which actors can engage with regulators and policymakers to get conditions in which the project and ecosystem can thrive. The engagement mechanisms around regulation and policy have been divided into two categories: *Build regulatory resilience* and *Co-create with regulators*.

Build regulatory resilience

Building regulatory resilience emphasizes strategies to manage regulatory risk through adaptation. It involves ongoing dialogues with regulatory bodies to stay informed about legislative directions and to remain adaptive. It has proven to be an effective approach in projects to ensure smoother navigation through regulatory landscapes according to interviewees. It has been highlighted that actors can perceive regulatory uncertainties as hindering, particularly when regulations around certain technologies are ever evolving, making it difficult to effectively shape business plans and projects. Involvement with regulators and policymakers has been described by interviewees to be important throughout the lifecycle of projects, not least in earlier phases when investment decisions are taken. It was brought up during interview R5 that energy-intensive industry actors are used to interacting with regulators and staying informed to navigate the uncertain landscape. R12 also mentioned that it is

impossible to make a profit by working against regulation, implying that one must adapt to regulation to succeed.

"In other words, it's all up to politics and regulations, that's the basic thesis. There's no one who can act against regulations and make a profit from it." -R12

Co-create with regulators

In contrast to the previous mechanism, co-create with regulators is more concerned with actually shaping the regulatory environment with regulators instead of simply adapting to it. It involves active participation in shaping regulations in favorable direction that address specific project needs – thus reducing the risk of future legal or compliance issues. Industry actors have also previously worked with government bodies to co-create regulatory structure that support innovation and the green transition while protecting public interests. An important action taken by actors has been to leverage case studies and data to advocate for changes that can accelerate innovation and stable investment conditions. Interviewees also described the need to provide regulatory bodies with understanding of practical implications of policies. Apart from enabling further innovation, this accelerates project approvals and ensures that regulations are crafted to facilitate, rather than hinder, the green transition. In this way, more supportive ecosystems can emerge and pave the way for long-term project successes.

Co-creation initiatives' have been described to lead to opportunities that can harmonize national and international regulations. This can be even more critical in projects that entails cross-border collaborations and compliance. R8 highlighted examples of actors coming together when communicating with politicians in the desire to help shape regulations. R1a emphasized that it is important to educate and demonstrate the value of solutions to other actors. This can include regulators and acts to form conditions in which projects can thrive. It was also mentioned in interviews how different actors regularly engage with municipalities with the ambition of co-creating value in the area. R12 also mentioned how actors actively engage with politicians to steer the regulatory development but acknowledges that there is only so much a single actor can achieve on its own in this regard.

"What we do in [our organization] is a lot of demonstrating what opportunities/challenges there are in transitioning the [industry] - also what we need help with. For example, what conditions do we need from politicians. How they can help us in the journey." -R8

5.2.4 Communication Mechanisms

The success of collaboration between ecosystem actors rests heavily on how well communication between the actors work. Interviewees have described both successful and unsuccessful instances of communication and transparency in previous collaborations. Three mechanisms were identified that might mitigate the risk of insufficient communication: *Process-oriented contracts, Clearly stated intentions* and *Continuous communication*.

Process-oriented contracts

Process-oriented contracts is a mechanism to mitigate uncertainties related to how a collaboration between two ecosystem actors should work in a project. These contracts outline clear protocols for regular communication, including schedules for meetings, reporting mechanisms, and platforms for information sharing – ensuring transparency and alignment across all parties. Through process-oriented contracts, the involved actors can rely on pre-determined agreements to resolve potential disputes and other things that might induce risks around the collaboration. Having a mechanism to foster transparency and trust, reducing ambiguity, and providing legal safeguards was described as beneficial in the work of achieving project objectives and to remain resilient and productive overall. R1a described a large project where the parties used contracts that facilitated communication aspects.

"What is written in the agreement is roughly that our strategic development executives – those responsible for strategic development – should have contact once every six months. And that within the framework of the agreement we can have development projects with structure around it. This has meant that you have regular contact with more or less frequency or intensity - and that we have a structure for starting things up." -R1a

Clearly stated intentions

The second communication mechanism, clearly stated intention, refers to the practice of establishing transparency early on to provide ecosystem actors clear understandings of one's goals, motivations, and expectations regarding a project. It involves articulating clear statements of what each party aims to achieve from the collaboration, including strategic objectives, risk tolerance, and desired outcomes. By being upfront about intentions and contributions, actors can prevent misunderstandings or indifferences that arise from mismatched expectations. Interviewees have highlighted instances of large-scale projects from the past where the initial clarity helped provide stability even when the project faced challenges. The upfront openness has also been described to have streamlined decision-making process and integration between the companies' workforces. Interviewee R13 mentioned that it is important to establishing fair and equal terms regarding efforts and rewards. The partnership might otherwise suffer and one of the parties might withdraw from the collaboration and attempt to conduct business on its own. Moreover, the mechanism has also been helpful in laying the groundwork for fair negotiations and mutually beneficial agreements, fostering the sense of shared success and commitment. Interview R2 highlighted the importance of being upfront early in projects to align the involved parties. In this way, roles and responsibilities throughout the value chain can be assigned effectively and in a value-enhancing manner. Similarly, R7 emphasized the importance of early alignment in large strategic projects.

"Talking about risks and opportunities, early in the project, is very important. You need to write it down in a way that you agree on how you look at things. That you see things in a similar way." -R13

Continuous communication

The third mechanism focuses on continuous communication and transparency between actors throughout the collaboration to build trust and reduce misunderstandings among project stakeholders. Interviewees have described it as helpful when actors who collaborate are sharing relevant information about project updates, risks, and path forward in a timely and accessible manner. Establishing transparency can be facilitated through a variety of forums including roundtable discussions, workshops, virtual meetings and more. One particularly prominent forum is an industry association which encompasses Vattenfall, industry actors, and the municipality where representatives from each actor meet on a regular basis to communicate strategic developments and directions. With all relevant parties having access to essential information, it minimizes the risk of potential challenges or changes in the project environment. Interviewees have stated that enhanced transparency between actors allows for joint problem-solving and collective decision-making – thus further creating a cohesive and cooperative ecosystem where successful project outcomes are more likely. R13 highlighted that understanding each other's business contributes to establishing sound partnerships. R8 mentioned that the industry actors connected to The Storage Project regularly communicate with each other to improve the transparency and also stated that it can be a barrier to collaboration if actors don't communicate very well. In a similar vein, R1a emphasized the importance of continually communicating one's stance, which becomes even more important in uncertain environments.

"Another factor could be that the communication between the companies does not work so well. It could also be that you don't know each other's common needs that well." -R8

5.2.5 Intra-Organizational Mechanisms

To mitigate financial risk in an ecosystem, a useful tool can be intra-organizational mechanisms. These are mechanisms that companies can leverage internally to more effectively mitigate risks. Two intra-organizational mechanisms have been identified: *Adopt portfolio perspective* and *Build organizational agility.*

Adopt portfolio perspective

The first intra-organizational mechanism is called adopt portfolio perspective and corresponds to enabling the creation of a project or investment portfolio for an organization. The idea is that having a portfolio perspective enables an actor to take more chances and diversify a project portfolio to mitigate specific project risk through reliance on multiple projects. This mechanism

would not help to lower the risk of a single investment but could be helpful from an actor perspective to make investments that may else have seemed too risky. R13 mentioned that an organization can apply different discount rates for different projects depending on the risk level, which can enable projects with less IRRs to be undertaken as well. Cultivating a portfolio perspective within actors' organizations could also be helpful in avoiding information silos and enabling more knowledge sharing across an organization. Risk mitigation capabilities is an important success factor for operating a project portfolio.

In the interview with R6 it was brought up that having a project portfolio for an actor allows it to take more bets on a project type. This allows for both a different risk tolerance and a more iterative process for experimental projects. Interviewee R12 mentioned that there are upsides of adopting portfolio perspectives. This could allow actors to segment projects in different ways to provide suitable management structures around them. For instance, an actor might have one portfolio for projects with growth potential and have another one where that the actor is looking to divest from it in the shorter term. R13 mentioned that organizations can take resources out of one asset type or projects and redistribute it to areas that the organization wants to invest further in.

"They had 12-13 ongoing projects, not exactly like this one but in the portfolio. They expect that between 2-4 will be realized. They start up tests, see what works or doesn't work. This is not working, and we can take this one a step further, and so on." -R6

Build organizational agility

The second intra-organizational mechanism which have been identified is called build organization agility. Organizational agility refers to organizations that are able to adopt the commonly used "agile project model", but also maintaining an agile mindset. Some characteristics of an agile organization is an ability to quickly adapt to changes, iterative processes, and empowered project teams which can take important decisions. These characteristics can in many ways indirectly lower the financial risk of a project, but also in some direct ways by increasing the efficiency of a project. Increasing organizational adaptability could also potentially facilitate collaboration as an actor is better able to adapt to a partner's needs or requirements, thus increasing the likelihood of a successful collaboration. R4 mentioned that public actors' actions and collaborations often are restricted by regulation, therefore potential collaborators must be adaptable. This could indicate that a more adaptable and agile organization might be able to more easily collaborate with these public actors.

In the interviews, the benefits of an agile organization have been highlighted for collaborative project work as it helps to empower individuals who are involved in projects. Respondent R6 mentioned in the interview that agile ways of working facilitated decision-making by project team members through a larger mandate to make decisions. This highlights the potential for agile organizations to have a more decentralized decision-making process without many layers of approval. In addition to that insight, R6 highlighted that it is important for individuals in an organization to have opportunities for agile training to realize the benefits of an agile

organization. This insight indicates that a structural shift in the organization may not be enough on its own, instead it should be accompanied with trainings and a culture shift. Another potential benefit of the agile organization is that it enables project team members to take more ownership. More individual ownership can be beneficial in collaborative projects with other actors as there tends to be more trust between members of a mutual project team as compared to members of a steering committee or a management team that do not regularly interact. R13 mentioned that parties might have to take initiatives and solve situations regarding a project on its own before getting other actors on board. If the market and asset is existing, one can then invite other parties to further add value for the parties and ensure better returns.

"We must create the conditions for projects to succeed… the agile way of working, I think is great." -R6

6. Discussion: Towards a Framework for Improving the Business Case

The discussion chapter focuses on synthesizing the findings and discussing it in connection to literature. Connections are drawn between the barriers for increased collaboration and added value in the ecosystem and the risk mitigation mechanisms. The chapter discusses in-depth how the risk mitigation mechanisms mitigate the barriers and how a certain mechanism connects to a certain barrier within the ecosystem. To do this, a conceptual framework with different levels of analysis has been constructed which explains whether a barrier or mechanism has a direct or indirect impact on The Storage Project's financial risk and business case. A core theme of this study was to investigate how collaborations within ecosystems can have an impact on financial risk and NPV calculations of a business case.

To visualize and structure the data collected through interviews, a two-sided data structure was created with barriers to collaboration on one side and risk mitigation mechanisms on the other. The data structure can be seen if figure 3.1. From the data structure it became clear that the barriers could be connected with the mechanisms as they were related. In the data structure, this is illustrated by where the two sides meet, for all but one barrier there is a single mechanism that maps towards it. The exception is financial barriers that maps to both structuring and operational mechanisms. This data structure was then used to help conceptualize a framework, which was then used as a tool for the analysis. The framework can be seen in figure 6.1.

	Direct impacts on the business case		Indirect impacts on the business case	
	Barriers	**Mechanisms**	**Barriers**	**Mechanisms**
Internal environment (Impacts within an organization in the ecosystem)	**Financial** *-High investment costs and IRR expectations* *-Long payback periods*	**Operational** *-Use-case stacking*	**Internal governance** *-Organizational silos* *-Inert and bureaucratic decision processes* *-Internal geographic competition* *-Reluctance to diversify*	**Intra-organizational** *-Adopt portfolio perspective* *-Build organizational agility* **Operational** *-Scenario-based assessments* *-Leveraging energy flexibility*
Inter-organizational environment (Impacts between organizations in the ecosystem)	**Financial** *-High investment costs and IRR expectations* *-Long payback periods*	**Structuring** *-Co-investments and joint ventures* *-Transactional contracts*	**Inter-organizational governance** *-Dependency reluctance* *-Misalignment* *-Trust and transparency challenges*	**Communication** *-Process-oriented contracts* *-Clearly stated intentions* *-Continuous communication* **Operational** *-Strategic alliances*
External environment (Impacts not exclusive to the ecosystem)	**Regulatory & policy** *-Regulatory uncertainty*		**Regulatory & policy** *-Permit delays* *-Collaboration-restricting regulations*	**Engagement** *-Build regulatory resilience* *-Co-create with regulators*

Figure 6.1: Framework for direct and indirect business case impacts from barriers and mechanisms

The levels of the framework were determined based on the focus of data collection and available theoretical frameworks for risk in an ecosystem. The framework contains three levels: *Internal environment*, *Inter-Organizational environment*, and *External Environment*. The first level, internal environment, focuses on barriers and mechanisms within an organization. The inter-organizational environment highlights barriers and mechanisms between actors and how these can influence the business case. The last level, external environment, outlines barriers and mechanisms which impacts will be on a larger scale, not exclusively within or between

ecosystem actors. Within these levels of analysis, a further division has been done to identify *Direct* and *Indirect Impact on the Business Case.*

Smith (2013) stated that there are multiple risks for an ecosystem including competition within the ecosystem, relationships changing or a changing external environment. The first two risks could be categorized as inter-organizational risks while the third risk is related to the external environment. Fliaster and Dellermann (2016) instead categorized the risks of collaboration as relational and performance risks. Relational risks are related to the relationship between actors and performance risks look at whether an actor has the requisite capabilities to collaborate. Relational risks can be said to include both the inter-organizational and external environment perspective, while the performance risks are included in the internal level of this study's framework.

To assess whether barriers or mechanisms have a direct or indirect impact on the business case the definition of financial risk has been considered when evaluating factors. This study defines financial risk as "the probability of not reaching adequate returns on investments or losing money", this is in accordance with the definition by Hayes (2024). With this definition in mind, direct impact then refers to actions that will directly lower the probability of not reaching an adequate return, either by lowering the discount rate, investments of a project, or guaranteeing certain revenues from the investment. Indirect factors are those factors which impacts intermediate variables or pathways that could affect discount rates, investment costs or revenues of a project.

6.1 Internal Environment-Level Barriers and Risk Mitigation Mechanisms

The internal level of the framework is focused on factors within an actor in the ecosystem that may have an impact on the business case. Within this level of analysis, there were both direct and indirect barriers identified, along with mechanisms. From the barrier perspective, this section will focus on the financial barriers in the direct section and internal governance barriers in the indirect one. On the mechanism side, operational mechanisms can arguably be said to have both direct and indirect impacts on the business case. Also, intra-organizational mechanisms arguably have an indirect impact on the business case.

Direct business case impact

The financial barriers such as high investment costs and IRR expectations and long payback periods directly affect the business case calculations that rely on NPV methods. High IRR expectations from a firm could signal that they believe an investment is risky since it indicates that the discount rate will be higher. A higher discount rate implies that the cost of capital and/or the risk is higher than before since these two factors combine to determine the discount rate (Pierru & Feuillet-Midrier, 2002). This happens as firms price in risk by seeking additional

compensation for taking on risk (Fischer, 2013). The problem of having too high discount rates was raised in the interviews and it was mentioned that high discount rates promote more short-term focus. This is because the later years in the business case calculation are so heavily discounted that the value is deemed exceedingly low. Since discount rates are impacted by how a firm prices risk, the risk appetite and organizational culture around risk becomes important factors in determining the discount rate. A high investment cost can also exacerbate the financial risk by requiring a larger amount of liquidity. This may in turn require a much higher IRR to off-set the risk of a larger investment cost. Long payback periods can be a barrier for new investments as it means it will take longer to turn a profit on an investment. This can be especially hindering if a discounted payback period is a metric used for investment decisions as it evaluates how long it will take NPV to reach zero (Dai et al., 2022).

When it comes to operational mechanisms, only use-case stacking has been identified as having a direct impact on the business case. The act of use-case stacking allows for optimizing the utilization of an energy asset by leveraging the multiple use-cases which are available to create valuable revenue streams. This is helpful in overcoming the financial barrier of high IRR expectation by potentially enabling a higher IRR solution. It may also help in potentially lowering the discount rate by helping to lower the risk of an investment through multiple revenue streams. This is a form of risk reduction, reducing severity of the risk, which is in line with the description of the risk reduction method suggested by Dorfman (1998).

Indirect business case impact

The internal governance barriers such as organizational silos, inert and bureaucratic decision processes, internal geographical competition, and reluctance to diversify have an indirect impact on the business case. These barriers will not directly affect the financial metrics that go into the NPV, but does so instead by limiting the chance of establishing successful partnerships. As defined by Baldwin et al. (2024), an innovation ecosystem generates a complementary surplus of value, and if these barriers make those collaborations less efficient it can indirectly result in lower value generation and value capture for actors.

Risk mitigation mechanisms that are related to the internal level and have an indirect impact on the business case are intra-organizational mechanisms and parts of the operational mechanisms. When it comes to intra-organizational mechanisms, two have been identified: adopt portfolio perspective and build organizational agility. Adopting a portfolio perspective could be argued to have an indirect impact on the business cases of a project portfolio for an actor by lowering the risk through diversification. It does not however directly impact a single project/investment decision's financial risk as it is more about spreading out risk across multiple projects.

Adopting a portfolio perspective can indirectly lower the total financial risk for an actor as they do not need to be dependent on the success of a single project, but instead a project portfolio with multiple projects. This can be a helpful tool in both avoiding the barriers organizational silos and a reluctance to diversify. With a portfolio of projects, information is more likely to

be shared across projects and knowledge sharing can happen more easily. Additionally, the project portfolio could allow for more smaller projects that could be helpful in overcoming the reluctance to diversify in organizations. Finally, adopting a portfolio perspective could be helpful in alleviating some of the intra-company geographical competition that may occur in multi-national companies as actors are able to make multiple investments.

One could make the case that having a portfolio of projects with varying risk is a form of risk retention as outlined by Dorfman (1998) in one of his four ways to handle risk. Reim et al. (2016) states that risk retention can be a beneficial method for an actor to pool all the risks and build a larger portfolio of risk. The reason this can be beneficial is because an actor can then capture most of the upside, however it becomes crucial to have the capability of correctly pricing risk in the portfolio to avoid large losses. This explanation of pricing portfolio risk explains how a portfolio perspective could indirectly help to lower the financial risk for an actor and improve the business case. In addition to correctly pricing the risk and passing on the risk premium to customers, an actor would have to be capable of mitigating and reducing the risk of projects or investments.

The second intra-organizational mechanism, organizational agility, can also have an indirect impact on the business case. Increasing organizational agility allows for improved adaptability to new situations, empowered project teams, iterative processes, and increased learning. These properties can help to mitigate both relational and performance ecosystem risks as they were defined by Fliaster and Dellermann (2016). Being able to adapt to a collaboration partner's needs and empowered project teams can be helpful in improving both the effectiveness and efficiency in projects. This helps to lower the relational risk mentioned by the authors. These factors also highlight how increased organizational agility could be helpful in avoiding some of the previously mentioned barriers such as bureaucratic decision processes and a reluctance to diversify by creating more agile organizations. Agile project teams are empowered to take more and often better decisions which can help to avoid bureaucratic decision processes. The increased efficiency and effectiveness indicate that scope and schedule have a higher likelihood of being kept. Since project time and scope is related to financial cost, this indirectly lowers risk of going over the budget, thus indirectly positively impacts the business case. In regards to the performance risk described by Fliaster and Dellermann (2016), the iterative processes and increased learning should help to lower that by ensuring further development of internal capabilities. Again, this will not have a direct impact on the cash flows generated by a project but could indirectly help to increase the likelihood of success in projects.

When it comes to operational mechanisms, there are two that indirectly impact the business case in the internal level: scenario-based assessments and leveraging energy flexibility. Scenario based assessments are a tool to improve risk management within an actor by creating a better understanding of existing risks and how to manage those. Understanding risks is often the first step towards mitigating them, which is also in line with the three-step method outlined by Dorfman (1998): identify risks, choose the risk response strategy and monitor the outcomes. These assessments are a good operational tool to lower the risk in the projects which can then end up indirectly lowering the financial risk of projects. This can also be an effective tool to combat reluctance to diversify as it helps to educate stakeholders on the risks. The second

operational mechanism, which is leveraging energy flexibility, can also be helpful to lower risks. Flexible energy solutions offer actors a way to benefit from complementarity as they can take advantage of the volatility of energy prices, while stabilizing the grid as well. Baldwin et al. (2024) stated that complementarity is a key part of an innovation ecosystem and helps to create the complementary surplus which is one of the main benefits of the ecosystems. More created value implicates that more value could be captured and therefore indirectly improves the business case.

6.2 Inter-Organizational Environment-Level Barriers and Risk Mitigation Mechanisms

The inter-organizational level of the framework refers to factors between actors in the ecosystem in regards to relationships and collaborations. From the barrier perspective, this section is focused on the financial barriers which can be perceived as a barrier that directly impacts the business case while inter-organizational barriers do so indirectly. On the direct mechanism side, the structuring mechanisms are highlighted. Communication and a certain operational mechanism, strategic alliance, are assumed to have an indirect impact.

Direct business case impact

Similar to what was described on the internal environment level, financial barriers are also prevalent on the inter-organizational environment level. This applies both for high investment costs and IRR expectations, and also for long payback periods. Between two firms, there might be an imbalance in how much each actor is willing to commit to a collaborative project and there might be requirements on minimum levels of investments. This can create a situation where that minimum level exceeds what one actor is willing to invest, thus withdrawing from the project – leaving the other party with a potentially greater financial downside. The differing view on risk is accordance with the insights from Li et al. (2013) – that firms have different risk appetites. Similarly, long payback periods may also be a deterrent for an actor to join in on a collaboration. This in turn will impact how the organization still within the project chooses the discount rate to account for the additional risk of handling all the risk by themselves.

To have a direct positive impact on the business case and overcoming the barriers which have been discussed, the structuring mechanisms can be applied. These mechanisms are related to the four methods of responding to risk that Dorfman (1998) identified. When it comes to structuring mechanisms, both co-investments or joint ventures and transactional contracts can have a direct impact on the business case and are related to risk mitigation. Co-investing is a clear way to spread out investment costs and risk across multiple actors and thus lower the financial risk by lowering the investment cost for a single actor. As highlighted in the case description, many of the ecosystem actors stand to gain significant value from seeing The Storage Project being undertaken. This might incentivize them to co-invest or form a joint venture with Vattenfall, which would lower the latter’s risk. According to Reim et al. (2016),

contracts are an important part in ensuring proper division of responsibility in risk transfers. This suggests that transactional contracts are an important part of effective risk sharing, but they could also be leveraged for risk retention. According to Reim et al. (2016), risk retention is the process where an actor retains the risk with the intention of profiting from it by applying a premium, and this is something that could be done with transactional contracts.

Indirect business case impact

Inter-organizational governance barriers are a natural part of the inter-organization level of analysis. Adner (2006) mentioned interdependence risk, uncertainties of coordinating with complementary actors, as an important aspect to consider for ecosystems. Dependency reluctance, misalignment, and trust and transparency challenges can all be said to have indirect effects on the business case as these could all lower the chance of establishing successful partnerships.

Adner (2006) highlighted that assessing risks can help firms decide whether to shoulder risks internally or share them with other actors. From the findings, it was found that firms on occasion are reluctant to be dependent on other actors in regards to operations or control in a project – despite the potential of obtaining mutual benefits. Fliaster and Dellermann (2016) mentioned that relational risks, the probability and consequence of not having satisfactory cooperation, can be prevalent within ecosystems. Misalignment between actors, which was described in the findings, has shown to be a hindering factor to establishing successful collaborations and can be considered as a relational risk. Adler et al. (2016) highlighted that risk sharing is a complex business relationship and that the fear of deception between actors can be a challenge. Although interviewees never mentioned examples where one actor had been deceived, it was mentioned of how trust and transparency between actors can be a challenge. Holgersson et al. (2022) stated that actors who pursues closer relationships with other actors must actively manage intellectual property matters. It became evident through interview that actors can be hesitant to share sensitive information to other actors, which suggest that there can be more work done in bridging this barrier.

There have been two kinds of indirect risk mitigation mechanisms identified within this level of analysis. These are the communication mechanisms and also strategic alliances from the operational mechanisms category. Through these, there can be greater chances of establishing more successful collaborations which could have an indirect positive impact on the business case as it allows for shared investments, better chances of more revenue and overall lower risk represented in the discount rate.

Process-oriented contracts were mentioned in the findings as a useful tool to mitigate uncertainties in how a collaboration should work. They could be seen as particularly important to overcome dependency reluctance as well a trust and transparency challenges. Through them, the parties can clearly outline the responsibilities in regards to operations which might overcome the fear some actors have in losing control. Literature also suggests that agreements, which process-oriented contracts can be considered as, are important to coordinate between

ecosystems actors (Kretschmer et al., 2022; Jacobides et al., 2024; Baldwin, 2024). Interviewees mentioned the importance of clearly stating intentions to ensure stronger alignment in regards to direction and desired outcomes. Hurmelinna-Laukkanen and Nätti (2018) mentioned how it is important for the success of an innovation ecosystems to have clear direction. Clear statement of intentions may thus also mitigate the risk of the misalignment barrier highlighted. While process-oriented contracts and clearly stating intentions are mostly associated with phases before the project has been initiated, it is important with communication throughout the collaboration. Continuous communication may contribute to overcoming inter-organizational barriers in a similar way as process-oriented contracts and clearly stated intentions, but with more emphasis on the phases where the collaboration is on-going.

Lastly, another mechanism that can play a role in lowering financial risk, is strategic alliances. They allow actors to have a more loosely held connection as compared to co-investing or joint ventures. Strategic alliance allows actors to explore collaborations in old or new industries with new actors without committing to a more deeply held partnership, such as a joint venture. This form of commitment, as described by interviewees, can bring out synergies between actors where complementary capabilities are shared. This could lead to better operational performance and more revenues in future, indirectly impacting the business case.

6.3 External Environment-Level Barriers and Risk Mitigation Mechanisms

The last level of analysis, the external environment, focuses on factors impacting the ecosystem environment, along with the actors within it. It also highlights the barriers and mechanisms and how they impact the business case. From the barrier perspective, this section focuses on the regulation and policy barriers both in the direct and indirect section. On the mechanism side, engagement mechanisms are mentioned the overcome the direct and indirect regulatory and policy barriers and improve the business case.

Direct business case impact

Within regulatory and policy barriers, regulatory uncertainty can arguably be seen as a barrier which directly impacts the business case. Smith (2013) mentioned that participation in ecosystems induces risks, including rapid changes in the external environment, which regulatory uncertainty is a testament of. As mentioned in the findings section, regulatory uncertainty may lead to actors having to make costly changes and increase the overall risk of investments. Also mentioned in the findings, under the intra-organizational mechanisms section, one can apply different discount rates depending on the risk level of a project. It is stated by Pierru & Feuillet-Midrier (2002) that the discount rate represents perceived financial risk of an investments. Therefore, ultimately, the uncertainty of regulations may often impact the discount rate applied for a business case and thus directly impacts its NPV. Furthermore, it was highlighted in the findings section that the magnitude of regulatory uncertainty can be even

higher in transition projects, which are characterized by more novelty than already existing solutions. Ahmed (2017) stated that the novelty aspect of innovative projects, which The Storage Project can be regarded as, brings further uncertainty. Also, Fliaster and Dellermann (2016) highlighted how ecosystems of innovative character carry greater risk. To account for the regulatory uncertainty surrounding the energy sector, also including a novel solution such as The Storage Project, a higher discount rate may be inevitable – causing the business case to be perceived as less attractive.

Indirect business case impact

In the findings section, permit delays were described as a barrier which causes projects to slow down or halt. According to Pierru and Feuillet-Midrier (2002), investments come with a cost of capital. Therefore, delays come with an indirect cost element as there is a capital cost for investments which increases if there is a delay. A second indirect impact caused by permit delays is that they delay the point in time when an investment starts to generate revenues. The notion by Smith (1937), that firms should take business only if it results in profits, can be applied and suggests that actors can deal with this risk through the methods proposed by Dorfman (1998) - either avoiding, reducing, sharing, or retaining the risk. Nevertheless, while these can mitigate some of the risk, permitting processes were described to cause challenges in taking decision and creates a barrier for the projects to be handled smoothly. This can arguably cause indirect impacts on the business case. Collaboration-restricting regulations can arguably also have an indirect impact on the business case. As described in the findings, there are regulations prohibiting certain actors from having deeper collaborations with one another. There are several risks that can be shared with other actors (Adkins & Paxson, 2017; Adler et al., 2016; Figueiredo et al., 2007; Fischer, 2013). This was also supported by interviewees in the findings section, i.e. co-investment and transactional contracts. But because of regulations restricting certain actors from collaborating with each other, it limits the opportunity to share or transfer risks over to other parties, as described by Reim et al. (2016).

Although engagement mechanisms will not directly impact the business case, they may be used to mitigate the direct regulatory uncertainty barrier as well as the indirect barriers: permit delays and collaboration-restricting regulations. Interviewees described how actors actively engage with regulators, both to build resilience but also to co-create with them. This approach is in accordance with Sanchez' et al. (2009) risk-based approach where firms analyze and focus on finding solutions to the identified risks – regulatory and policy barriers in this case. Adner (2006) also highlight the importance of understanding and formulating strategies for handling ecosystem risks. By building regulatory resilience, actors may anticipate the regulatory direction and act accordingly to avoid costs or other setbacks that otherwise could have impacted the business case. Having regulatory resilience might also lead to a certain project being perceived as less risky, which could also pave the way for the discount rate being set lower and more favorably. Furthermore, it may also decrease the risk of permit delays which would allow for more revenues and less costs for the business case. Co-creating with regulators could lead to the regulatory environment being more collaboration-friendly and allow for

collaborations that might not have been possible before. This could also open the chances of a better business case by allowing shared investments and options to ensure future revenues by transactional contracts. This form of soft influence on regulators is something that often takes place in ecosystems to align actors. According to Pitelis and Teece (2018), leveraging this form of soft influence is something an orchestrator can do to ensure mutual value creation, co-creation and ecosystem value capture.

7. Conclusions

This master's thesis has explored the topics of innovation ecosystems and financial risk mitigation within the energy sector. The thesis was conducted in collaboration with Vattenfall in regards to a potential energy storage project that they are contemplating – The Storage Project. The focus has been to explore the innovation ecosystem around The Storage Project and how financial risks of the project could be mitigated. A core assumption in the thesis has been that actors in an ecosystem can achieve greater value through collaboration than individually. Because of this, the thesis has focused on identifying barriers that might hinder collaboration and risk mitigation mechanisms that addresses collaborative aspects and operational behavior. Connections were then drawn between the barriers and risk mitigation mechanisms and how they might impact discount rates, initial investments, or future revenue streams – directly or indirectly.

The chapter further highlights theoretical and practical implications from the study. For the theoretical implications, elaborations are made on how the study contributes to knowledge in the intersection of innovation ecosystems, financial risk mitigation, and the energy sector. The chapter also informs practitioners on practical implications the study might have on future projects within the energy sector that are characterized by large investments and a diverse set of actors. Lastly, limitations of this study and suggestions for future research are outlined.

7.1 Theoretical Implications

The findings of this thesis support the existing literature on innovation ecosystems. Especially, it does so within the energy sector and in the context of financial risk mitigation and value creation in a region with specific circumstances. This study advances the understanding of innovation ecosystems by providing a detailed exploration of barriers to collaboration and their connection to risk mitigation mechanisms, which were subsequently used to propose a novel framework. The framework presented extends beyond identifying barriers and mechanisms, incorporating their direct and indirect effects on NPV and its elements – discount rate, initial investments and future revenues. The study thus aligns ecosystem dynamics with the practicalities of investment decision-making. This research also centers on a large-scale energy storage ecosystem in the south of Sweden – something that has not been examined earlier, especially not in connection with innovation ecosystems. This contrasts prior studies on innovation ecosystems within the energy sector, which have predominantly focused on digitalization (Almpanopoulou et al., 2019; Kolloch & Dellermann, 2018), renewable energy production (Alam & Ansari, 2020), and smart grids (Kotilainen et al., 2016) and within other geographical areas (Yakovlev & Volkova, 2018; Weil et al., 2014).

7.2 Practical Implications

Practitioners in the energy sector can leverage the insights from this study to enhance collaboration within innovation ecosystems and pave the way for a more favorable business case for upcoming projects. The insights could be applied by practitioners at electricity producers at, and similar to, Vattenfall, but also in other organizations seeking to enhance collaboration within their ecosystem. This study highlighted that the business case of a project can be directly impacted in regards to discount rates, initial investments and future revenues – but also that there are factors impacting these indirectly. The analysis of barriers for collaboration underscores that these can come in many forms, both from within an organization but also at the interfaces with other organizations and the external environment. Moreover, the proposed risk mitigation mechanisms provide actionable strategies for reducing financial exposure and fostering trust among ecosystem actors.

The study further sheds light on challenges within the energy sector that arise when energy production and consumption are not synchronous. Building a future proof energy system requires balance between energy production and consumption along with solutions, such as The Storage Project. It should be within many's interests to see a better functioning grid and energy system overall. An inferior energy system leads to inefficiencies among electricity producers and grid operators, and customers are often the ones compensating through more expensive energy bills. This underscores the importance of actors within the energy sector coming together to solve challenges through collaboration. It is thus important for policymakers to draw upon the findings to incentivize solutions that benefits the energy system as a whole, not individual organizations or projects. One way of achieving this might be through designing regulations that promote ecosystem resilience and incentivize collaboration, ensuring the timely deployment of critical energy infrastructure.

7.3 Limitations and Future Research

While this study provides valuable insights into an innovation ecosystems in the Swedish energy sector, several avenues for future research remain. First, studies across different geographical regions could explore how contextual factors influence ecosystem dynamics. The energy sector is characterized by complexity and region-specific circumstances. Other regions have different regulations, actors, and market circumstances which might not be directly comparable to those of The Storage Project in this case. One might also expand the scope to include suppliers of equipment or solutions and also actors that would assume a similar role to Vattenfall but in another setting. The choice of conducting qualitative research, in combination with a limited sample size of interviewees of interpretivist nature, could arguably present limitations in that the full diversity of perspectives within the ecosystems might not have been captured.

Secondly, further research could investigate other aspects that impacts the business case of a project – going beyond the barriers for collaboration and risk mitigation mechanisms for collaborative aspects and operational behavior considered in this study. For instance, the thesis did not examine technological or construction risks – both presumed to have notable impacts

on a large-scale infrastructure project's business case. Similarly, further research could quantify how much the identified barriers and risk mitigation mechanisms could influence the NPV calculation of a project.

Further research could focus on the evolution of collaboration mechanisms in similar large-scale infrastructure projects in the energy sector. This may allow for deeper insights into their long-term effectiveness and adaptability. As the energy market is ever evolving, certain risk mitigation mechanisms may not be as applicable as time progress and new ones might emerge. While this may influence dependability on some aspects of the study, most other findings are assumed to apply at other times. There is also room to investigate how barriers for collaboration and risk mitigation mechanisms would play out in another large-scale infrastructure sector and compare it with the energy sector. This study is limited in this regard as it was carried out as a single case study, whereas a multiple case study could have captured complexities that differs between sectors.

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Appendix

Interview guide – exploratory phase

Topic list:

- Introduction to the master's thesis
- Their company's/authorities' involvement in the energy sector
- Value chain and revenue streams in energy (storage) industry
- Innovation Ecosystem
- Partnership / collaboration
- Risk in new projects
    - Financial risk
    - Risk mitigation strategies
- Decision-making process

Interview guide – refining phase

Questions:

- What is your role in the energy sector?
- How do you envision a successful partnership with another company?
- What do you see as the potential value for you or other parties to see the project getting undertaken?
- Do you know any partnerships within the energy sector? Successful/unsuccessful ones?
    - What are the factors behind their success/failure?
    - What are your take aways from collaboration X and others?
- What do you consider as the largest barriers for successful collaborations between actors?
- What are the key factors affecting decision-making processes for new projects within your organization?
    - How do you perceive that actors within the ecosystems considers risk?
    - What financial metrics/measure are usually the most critical for actors within the ecosystem?
    - How are risk factors considered when evaluating project according to your experience?
    - Do you have any risk mitigating strategies for helping reducing risks connected to collaborations in new projects?
- How do you perceive that the organization works with their portfolio of investments?
    - What changes do you believe would have been beneficial in this regards?
- How does the dialogue with X/Y and other regulators look like?
- What might make you hesitant to enter closer collaborations with other organizations?
    - What would be needed to overcome this hesitation?
- What is the outlook of the energy sector according to you?

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