Strategies for the Deployment of Inland Floating Solar – *The Dutch FPV technological innovation system and Solinoor's innovation ecosystem*

Final Client Report
Client: Solinoor
Supervisor: Dr. Joeri Wessling
Word count: 8989

Steven van Trooijen (6684319)
Cas Raedts (2857472)
Jurian van Elsen (6593844)
Elin Harms (6914357)
Christopher Kimmel (1886347)

Date: 28th of June, 2024



Universiteit Utrecht



Management advice

The purpose of this research is to assist Solinoor in deploying inland floating solar in the Netherlands, considering as many relevant actors and stakeholders as possible. To do so, the report focuses on answering the following research question:

What strategies can Solinoor use to drive deployment of inland floating solar in the Netherlands considering the technology's systemic barriers and Solinoor's innovation ecosystem's characteristics?

In the first part of the research question the Technological Innovation System (TIS) of inland Floating Photovoltaics (FPV) in the Netherlands was mapped by investigating the structure of the inland FPV innovation system and outlining its actors and institutions. Furthermore, the system functions necessary for an effective functioning of the system were assessed, and weak functions were identified. Second, Solinoor's Innovation Ecosystem (IE), including its stakeholders and their needs and interactions, was studied. The results of this approach are presented below. First, with regards to the inland FPV innovation system structure, the system involves a broad range of actors varying from typical supply and demand actors to knowledge institutions, and network or support organisations. Subsequent findings within the IE revealed that many of these actors are also stakeholders in Solinoor's innovation ecosystem. A more detailed overview of the TIS actors can be found in Figure 5 in Section 4.2.1.

Next, considering the institutional structure in the Dutch FPV innovation system, the following general trend was identified: Upper-level government bodies set the hard and formal rules which other actors must abide by. The project developers must act within this more general, top-down legislative framework and acquire permits for their ventures. However, the newness of the FPV field results in a difficulty to match this bottom-up solution with the current top-down requirements imposed by the government due to insufficient knowledge and standardisation. This results in FPV developing parties struggling to put projects into practice.

Furthermore, the TIS analysis assessed the system functions and their corresponding barriers. A detailed overview of this can be found in Figure 6 in Section 4.1.4. The combined perceptions reflect a system which is primarily limited by a lack of knowledge diffusion and a lack of guidance in FPV development. The associated barriers embody scattered responsibilities and a fragmented state of the diverse knowledge needed for FPV deployment. General uncertainties were found as in the case of governmental hesitance about inland FPV due to unknown long-term environmental impact and a higher potential seen in other technologies like offshore FPV (for a complete list of barriers, see Appendix 6). These issues may also reflect the disjointedness between top-

down and bottom-up institutions found in the structural components of the system. Thus, structural causes can be found in the still developing institutionalisation of FPV related practices and fragmentation of knowledge about FPV technology across relevant actors.

Then, with regards to the innovation ecosystem, an interaction map of all stakeholders was made, shown in Section 4.2.1 in Figure 7. Furthermore, an overview of stakeholder needs was made which is presented in **Error! Reference source not found.** below. A more detailed explanation of each need, including examples, and an overview of the needs per interviewed stakeholder, ranked based on importance, is in Appendix 4, table 8.4.2.

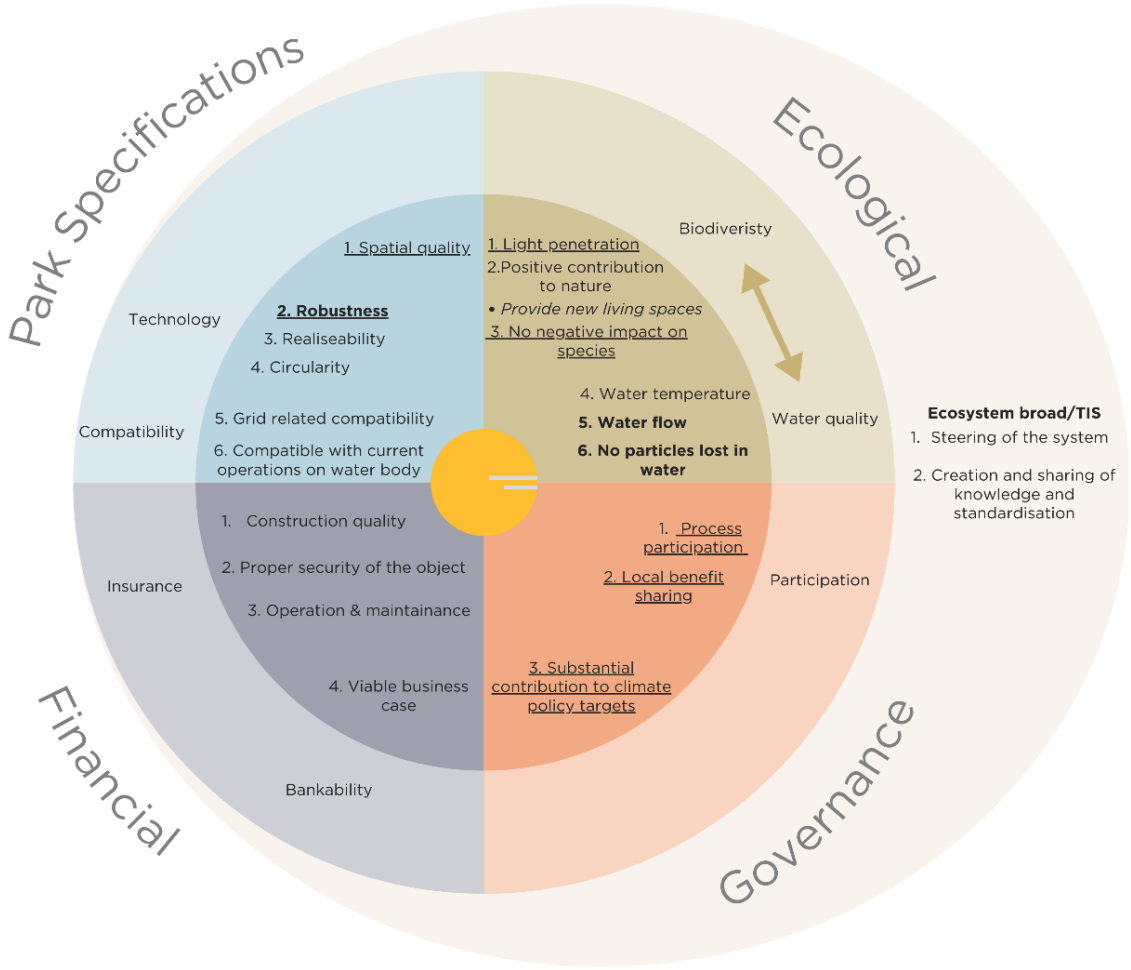


Figure 1: Overview of Solinoor's stakeholders' needs.

Figure 1 illustrates four main themes of importance. First, park specifications entail practical aspects that must be tailored to an FPV park's location and characteristics. Ecological needs refer to needs related to biodiversity and water quality which have high co-dependence. The governance quadrant relates to participation needs and alignment with governmental policy and targets. Lastly, the financial quadrant refers to needs

related to project financing. The specific needs most prominently discussed by the stakeholders related to spatial quality, light penetration, no negative effects on species, process participation and sharing the benefits, robustness, and the project having a substantial contribution to climate policy targets. Even though robustness was only mentioned explicitly by three stakeholders, it was mentioned more often as a natural requirement of a solar park, making its inclusion relevant. Furthermore, the broader needs of system steering, and creation and sharing of knowledge were mentioned frequently, showing a clear overlap with the TIS findings from the previous section.

As a final step, this overview of needs was compared to Solinoor's capabilities in addressing them. Given Solinoor's exclusive right to use the ETI Ecofloat system in the Netherlands for the coming 10 years, there are several technical competitive advantages Solinoor possesses. First, its vertical floater design gives the system an edge in dealing with rough water, wind, and general weather conditions compared to systems used by competitors, leading to an advantage on the 'robustness' need. Another advantage is the same technical specification allows for a much better water flow through the installation compared to competing system. Third, the floater materials are eco-friendly and does not release particles, contributing to ecological needs.

The findings as presented above have led to a set of general innovation system implications, and three recommendations on strategies for Solinoor. Regarding the inland FPV innovation system in the Netherlands, the most poorly performing system functions and dominant barriers should be addressed first. To do so, we advise Solinoor to initiate or participate in an existing overarching organisation or cooperative body between multiple actor groups that has the aim to increase knowledge sharing amongst actor and bridge 'knowledge silos' in the industry. Specifically, a bridge between governmental and knowledge organisations should be made. Another focus should be addressing governmental hesitance, thereby contributing to a clear directionality for the FPV innovation system. In setting up such an entity, organisations that are active in certifying and setting standards for FPV systems like DNV, or industry organisation Holland Solar can play an important role.

With regards to Solinoor's specific advice, our first recommendation is to ultimately consider all needs presented in Figure 1, but to direct the focus to the underlined needs. All needs hold an important stake in the project development. However, addressing them should accord with the prioritisation of needs, starting with the needs seen as most prominent by different stakeholders, being robustness, spatial quality, light penetration, participation and having a substantial contribution to climate policy targets.

Second, we recommend Solinoor to focus on creating more knowledge and setting standards in their ecosystem with regards to the prioritised needs from the previous section. To do so, this knowledge should be developed together with the relevant

stakeholders from the ecosystem as presented in Table 1 below. Important to note is that currently Solinoor has a competitive edge on the robustness need, creating less urgency to create additional knowledge there.

Table 1: Stakeholder involvement needed to create knowledge on the most prominent needs

Needs	Stakeholder cluster to consider
Spatial quality, participation and meeting climate policy targets	Local interest groups and local governments
Robustness	External knowledge, but also local interest groups and local governments
Light penetration and no negative impact on species	External knowledge, but also consider local interest groups and -governments

Lastly, we recommend Solinoor to use their well-connected ecosystem and their central position in the FPV innovation system to initiate the knowledge sharing body as mentioned above. However, given that benefits of such an organisation will have a spillover to the whole innovation system, costs of setting it up should be distributed equally amongst the innovation system, or largely carried by the government.

Table of contents

Management advice 2
Table of contents 6
1. Client problem statement 7
2. Research approach 10
3. Methods and data 13
4. Findings 18
5. Discussion 29
6. Conclusion 31
7. References 33
8. Appendix 38
8.1. Conceptual framework 38
8.2. Actor and stakeholder overview 45
8.3. Interviewee table 47
8.4. Stakeholder needs 48
8.5. Interview guide 54
8.6. Structural barriers for the system functions 64

1. Client problem statement

Transitioning to using more efficient and green technologies is an essential step for climate change mitigation and decoupling the economy from conventional fossil fuel technologies (Dinçer & Rosen, 2021; Chen et al., 2018; Kamran & Fazal, 2021). This notion led amongst others to the EU Renewable Energy Directive, setting a 45% renewable energy share target for 2030 (European Union, 2024). However, the implementation of renewables faces numerous difficulties, for instance, a lack of space for renewable production and net congestion (RVO, 2023; IEA, 2023). Solinoor, a Dutch company realising innovative renewable energy solutions and the client of this report, tries to address these issues by implementing innovative energy solutions, including floating solar.

Floating solar, or floating photovoltaic (FPV), is an innovative variation on regular photovoltaic (PV) technology adjusted to various water surfaces such as lakes and river beddings, and offshore projects (Vandest & Hemetsberger, 2023). Since these areas remain otherwise largely unused for renewable energy production, the technology provides opportunities for additional renewable energy generation (Yakubu et al., 2023). Also, whereas issues with regards to energy storage do not allow for fully local networks, the added flexibility in terms of land use FPV offers does create extra opportunities for local energy networks that provide a part of an off-taker's energy demand.

Current literature on FPV mainly focuses on the technological and physical aspects of FPV and its potential additions to the renewable energy industry (CJ et al., 2024; Spencer et al., 2018; Shi et al., 2023; Oliveira-Pinto & Stokkermans, 2020; Vandest & Hemetsberger, 2023). They refer to its advantages such as the exploitation of new spaces to produce renewable energy as well as possible social, economic and environmental benefits. Nevertheless, disadvantages are also mentioned by the authors including poorly documented environmental impact, activities on water being affected, high operation and maintenance costs and aesthetics.

Despite this available research on FPV, the technology's socio-technological aspects remain somewhat underexplored. Some authors, such as Lee (2022), Chen et al. (2024), Sianipar et al. (2023) and Bax et al. (2022) investigate this topic, by studying stakeholder networks, stakeholder needs and social support for FPV. Their findings indicate that governance should be tailored to local project needs, that inadequate stakeholder participation along with unclear property rights can lead to project discontinuance, that policymakers should engage with a diverse range of stakeholders, and lastly that uncertain impacts of the novel technology can cause stakeholder reluctance whereas positive attitudes towards specific authorities and broader societal benefits are seen to increase project support. However, all these insights and findings are on a rather abstract level and therefore do not give very concrete insights or implications. Given this

relatively small body of knowledge on more systemic aspects of FPV implementation and the importance of acknowledging project-specific differences, we aim to bring further insight into these topics for a company-specific and general context.

The company of focus, Solinoor, has a primary focus on implementing FPV on inland waters. They aim to provide the optimal FPV solution for a given project location, where there is high variation in terms of currents, waves, winds and general weather conditions. Moreover, each project poses a unique set of challenges regarding the involvement of surrounding communities as well as ecological considerations. While they have already successfully developed several parks that suit local conditions, insights into the typical needs of stakeholders involved in a project as well as broader system aspects of floating solar in the Netherlands can facilitate an effective and empirically founded approach to a more effective inland FPV deployment. By request of Solinoor, this research aims to provide them with strategic insights considering both general characteristics of the inland FPV innovation system in the Netherlands as well as specific needs of stakeholders in Solinoor's immediate networks.

To study the general characteristics of the inland FPV system, a technological innovation system (TIS) analysis is used, as described by Hekkert et al. (2007). This type of analysis allows us to first look into the structure of the Dutch inland FPV system, including its institutions, relevant actors and most important technologies. This is added to by subsequently studying the way the actors interact and how that shapes the development of the inland FPV technology. For the specific stakeholder needs from Solinoor's immediate networks, innovation ecosystem (IE) theory is employed, as used by Adner & Kapoor (2009) and Grandstrand & Holgersson (2020). This theory maps stakeholders as well as their interactions and needs that are important to the functioning of a specific firm. In this analysis, stakeholders are referred to as those having a direct interaction with or direct influence on the focal firm. To incorporate both the general FPV characteristics and the more firm-specific innovation ecosystem, the main research question is framed as such:

What strategies can Solinoor use to drive deployment of inland floating solar in the Netherlands considering the technology's systemic barriers and Solinoor's innovation ecosystem's characteristics?

To answer this question, several aspects have to be addressed. First of all, the factors hampering inland FPV development have to be analysed, using the systemic barriers derived from TIS along with their root causes. Thus, the first sub-question is framed:

RQ a: How is the inland floating solar innovation system in the Netherlands structured and what are the system's barriers and their causes?

Furthermore, the innovation ecosystem framework, central to the second part of the research question, maps stakeholders and interactions in Solinoor's direct ecosystem and provides an overview of the needs regarding inland FPV in that ecosystem. This motivates the second sub-question:

RQ b: How is Solinoor's ecosystem structured and what are its stakeholders' needs?

Lastly, Solinoor's capabilities in addressing the needs of their stakeholders are determined. Understanding the strengths and weaknesses of Solinoor can help determine what strategies should be focused on. Also, this will help assess for what needs Solinoor has a competitive advantage. This forms the last sub-question:

RQ c: What identified stakeholder needs can Solinoor address, given the company's capabilities?

The aim of this approach is to first recognise systemic barriers and their causes and second describe Solinoor's IE characteristics and needs. Based on these two sets of information, strategies will be developed that further benefit the deployment of FPV in inland water in the Netherlands by Solinoor.

2. Research approach

In this report, technological innovation systems (TIS) and innovation ecosystems (IE) are used as central theoretical perspectives. The perspectives are chosen for their differing focus, with TIS centring around a technology and IE focusing on a single firm (Hekkert et al., 2007; Adner & Kapoor, 2009; Granstrand & Holgersson, 2020). Table 2 below shows the main differences between the two approaches. For additional information on the theoretical perspectives and their complementarity, see Appendix 1.

Table 2: Comparing technological innovation system and innovation ecosystem.

Element under focus	Technological Innovation System	Innovation Ecosystems
Context	Technology as the focal point, often implemented within a national context (macro scale) (Markard & Truffer, 2008; Markard et al., 2015)	Actors' contributions and interactions as the focal point, often within one industry setting (meso scale) (Amitrano et al., 2018; Adner & Kapoor, 2009)
Aim	Drive development of a certain technology and overcome system barriers to improve the whole context (Hekkert et al., 2007)	Creating added value through complementation and cooperation that result in new combinations of stakeholders and resources (Guerrero et al., 2024)
Players	Referred to as actors (Edquist & Johnson, 1996)	Referred to as stakeholders (Amitrano et al., 2018)
Mechanisms	Functions and institutions between actors that characterise the system (Edquist & Johnson, 1996)	Needs and complex relations between stakeholders such as cooperation and communication (Autio et al., 2014)

As can be seen in the table above, while the TIS and the IE frameworks both discuss innovation activities, their general level of aggregation and conceptual focuses are different. The TIS framework provides a systemic approach for understanding technological development, involving the mapping of structures and activities surrounding a specific technology. Here, a system's technology, actors, institutions provide a static representation of the TIS, whereas the interactions between actors create a dynamic understanding of the system (Hekkert et al., 2007; 2011). This dynamic aspect is expressed in the seven system functions as proposed by Hekkert et al. (2007), which categorise the main innovation activities of the actors that shape the development process of a technology. A short description of each function can be found in the preparation documents for interviewees in Appendix 8.5. A combination of the static

structural elements and system function performance is often used to find systemic factors limiting the development process of a technology.

The IE framework takes a more specific focus, emphasising the interactions between stakeholders as jointly creating value (Adner & Kapoor, 2009; Granstrand & Holgersson, 2020). Stakeholders can according to Freeman (2010, p.53) be understood as ''groups or individuals that affect or be affected by the organization's activities.'' These stakeholders further consist of both essential parties and those offering implicit approval (Maon et al., 2008). According to Maon et al. (2008), the first consists of for example buyers, suppliers and internal stakeholders, while the implicit approval extends to NGOs, communities, regulatory bodies etcetera. These conceptualisations have led to the following definition of stakeholders being used throughout this analysis: stakeholders are actors directly interacting with or influencing the focal firm.

This differs from the term actors used for TIS, which refers to any player in the innovation system, whereas stakeholders are specified to a focal firm. Since the stakeholders are both part of a focal firm's innovation ecosystem and a broader technological innovation system, IE can be placed within a TIS (Amitrano et al., 2018). In Figure 2 below, this relationship is visualised, using a possible system configuration incorporating both the technological innovation system and innovation ecosystem of inland floating solar in the Netherlands.

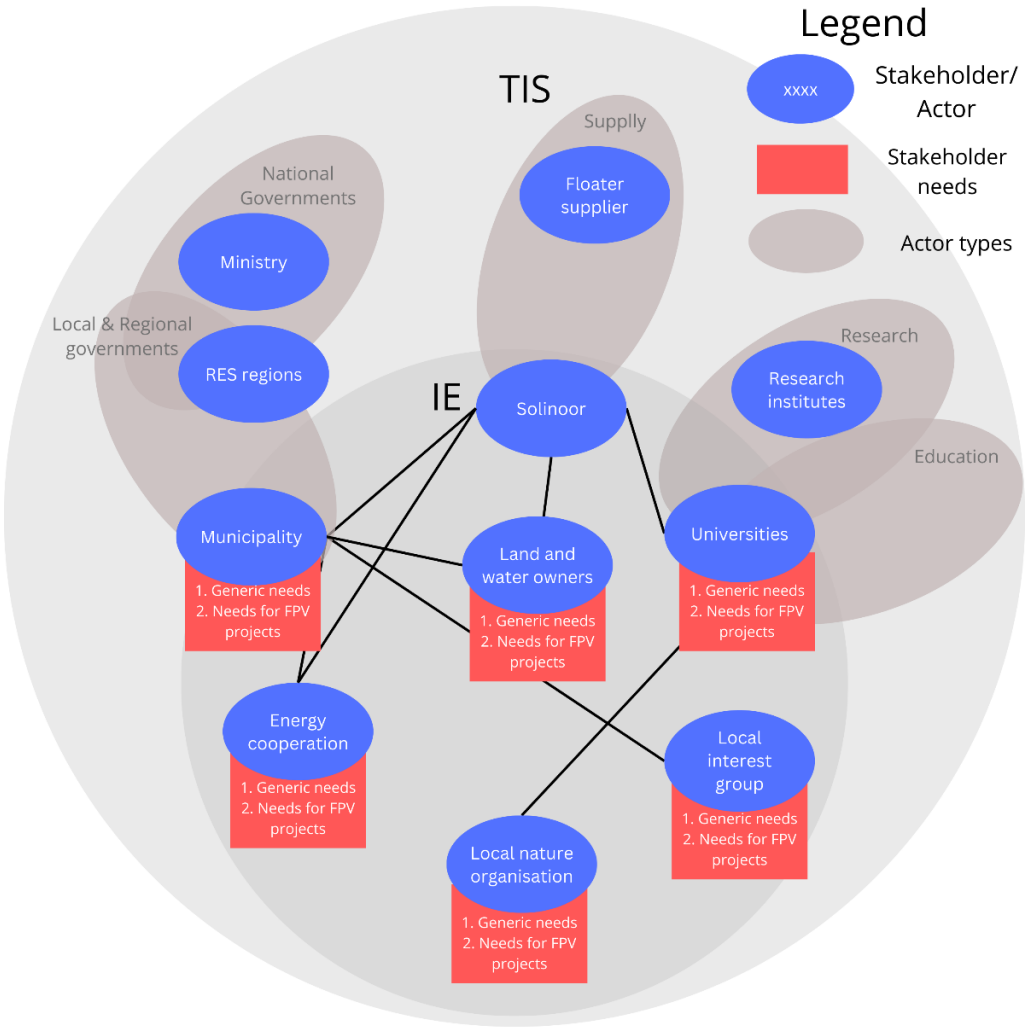


Figure 2: Overview of the conceptual framework

In Figure 2, IE and its stakeholders can be seen to fall within a TIS. Each of these stakeholders have a direct link with the focal firm, visualised as Solinoor, or a direct influence on it in the absence of such a link. The stakeholders all have different needs, which influence the types of interactions they have with the focal firm. They furthermore operate in a broader system of actors, institutions, technologies and functional activities, for example relating to the state of knowledge on the technology laws, regulations, and pilot projects. This context influences the needs that the stakeholders will have, as for instance regulations can be argued to influence project requirements and subsequent stakeholder needs.

3. Methods and data

Answering the main research question consists of several parts, in line with sub-questions a, b, and c. An overview is shown in Figure 3, distinguishing between concepts pertaining to the TIS framework and concepts from the IE perspective. The research methods used in this study are desk research and semi-structured interviews. The procedural parts are detailed in the sections below.

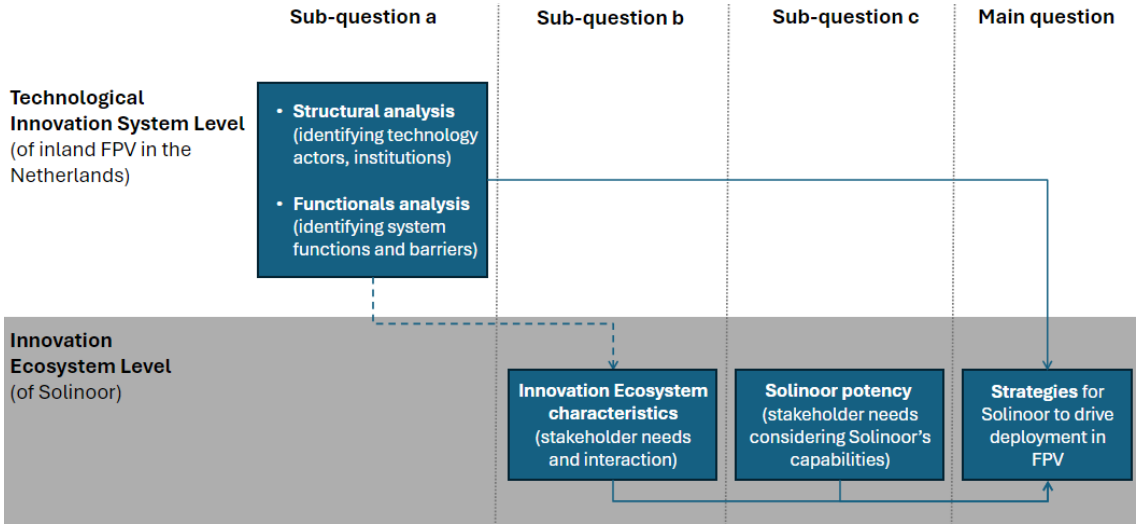


Figure 3: Research design structured according to the research questions.

3.1. Methodological approach

Evaluating the structure then entailed mapping actors and institutions based on their role and effect on the technology of inland floating solar in the Netherlands. The performance of the FPV innovation system was evaluated based on the original definitions of the seven system functions by Hekkert et al. (2007), using a 5-point Likert scale to make the functions measurable (see interview guide, Appendix 8.5). These scores were placed into context by relating them to the findings from the structural analysis. This allowed us to derive the system's overall performance and critical barriers in a deductive manner, given the specific context and phase of the technology's development in the Netherlands. In doing so it became clear what is currently obstructing the FPV innovation system and thus what should be the objectives of this innovation system collectively.

The second step is dedicated to answering sub-question b, for which a more inductive research approach was followed to map relevant stakeholders, their interactions, and their needs in Solinoor's innovation ecosystem. Stakeholders in this context are defined through their direct interactions with, or influence on, Solinoor's activities around FPV deployment. Individual stakeholder needs were identified based on interests and goals

that the different stakeholders have in relation to inland FPV. These needs were then prioritised by asking the interviewee to order them based on their importance. These aspects together informed the structure and characteristics of Solinoor's innovation ecosystem, which was used to determine what stakeholder requirements Solinoor is faced with when it comes to the deployment of the inland FPV technology.

The third sub-question compares these identified stakeholder needs with Solinoor's specific capabilities. This entails identifying the stakeholder needs that Solinoor can already address given their capabilities and is mainly targeted at assessing what needs can give Solinoor an edge over competition. This therefore leads to more specific knowledge on their competitive advantage and achievable deployment strategies.

In short, insights about the general structural elements of the technological innovation system gained from sub-question a provided the broader context behind the nuanced innovation ecosystem characteristics from sub-question b. Further strategies are derived from this sub-question and its structural barriers, providing more systemic recommendations to improve the deployment of inland FPV in the Netherlands. Deployment strategies more specifically linked to Solinoor are derived from sub-questions b and c, which both focus on addressing specific stakeholder needs in Solinoor's ecosystem to drive the deployment of the inland FPV technology in the Netherlands.

3.2. Data collection, sampling, and analysis

To collect and analyse the data needed to perform the steps described in the previous section, a combination of desk research and semi-structured interviews was used. Rudimentary desk research was performed as a basic starting point of the research, which including academic papers, grey literature, and internal client documents and consultations with Solinoor. This was used to prepare for interviews, structure the interview guide, and further contextualise findings.

To select the right interviewees for the semi-structured interviews, both a purpose sampling, resulting in 14 interviewees, and snowball sampling strategy, resulting in an additional 2 interviewees, were used (Naderifar et al., 2017). Appendix 8.3 shows a more detailed overview of these interviewees. For the purposive strategy, the selection took place in a strategic rather than random way (Bryman, 2012, p.418). In the context of this research, selection for both TIS and IE interviews took place based on their inclusion within the inland floating solar innovation system. To determine beforehand who to include, a short literature review on inland floating solar actors and stakeholders was conducted. The actors identified in this literature were assigned to either an actor or stakeholder table based on the extent to which they influence or interact with Solinoor.

This allocation was made in consultation with Solinoor, and the final categorisation can be found in Appendix 8.3. Figure 4 presents an overview of the analytical steps.

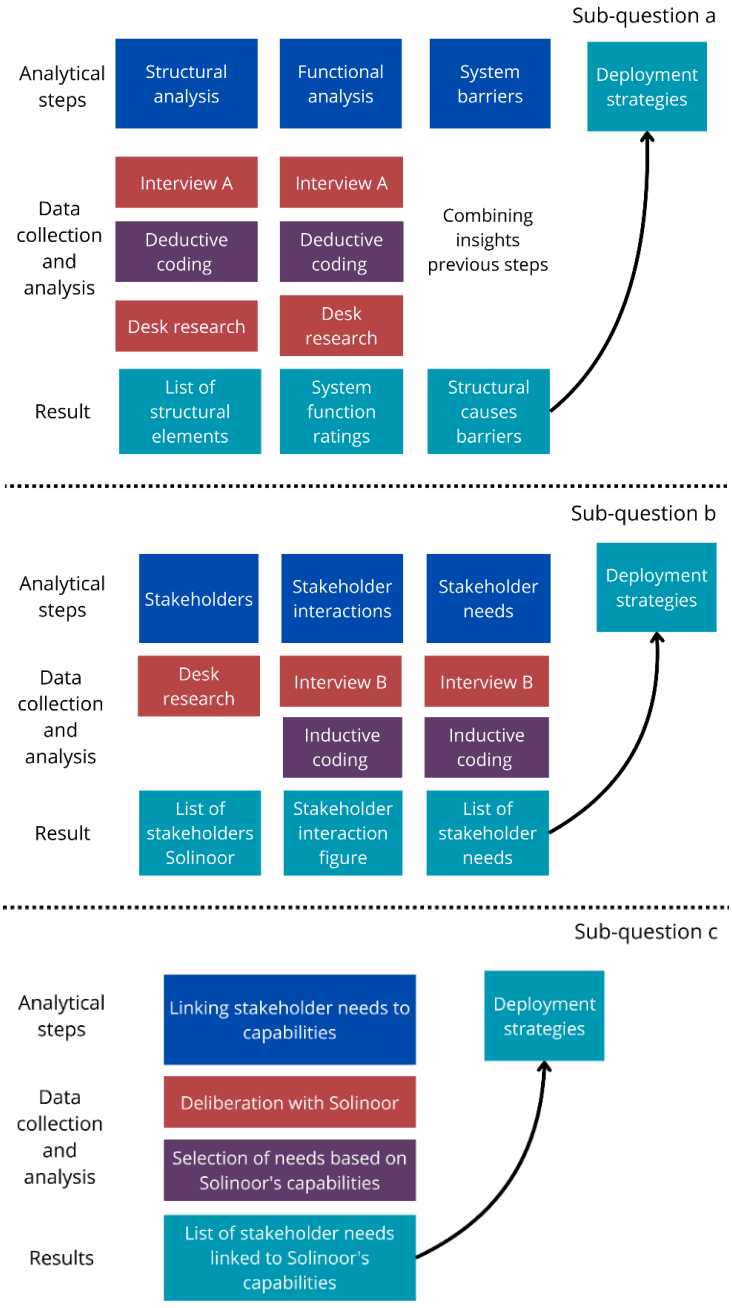


Figure 4: Data collection and analysis steps structured according to the research questions. Here, interview A refers to part A of the interview guide and interview B to part B. See Appendix 8.5 for the complete interview guide.

To answer sub-question a, a structural analysis was first performed. This entailed mapping the structural components of technology, actors and institutions in our case specifically for the Dutch inland FPV system (Hekkert et al., 2007; 2011). For this end desk research in the form of scholarly articles was used which was complemented by a total of eight semi-structured interviews focused on TIS. The interview results were coded into the actor categories as used by Hekkert et al. (2011) (see also Appendix 8.5).

The second step for sub-question a, is the assessment of system functions. This was mainly based on the results from the same semi-structured interviews. These interviews were deductively coded based on the pre-defined functional categories provided by Hekkert et al. (2007), which are described in more detail in Appendix 8.5. The ratings provided by each of the interviewees on the performance of the functions were used to determine an overall rating, which is presented in the form of a figure showing to what extent each system function is fulfilled, as recommended by Hekkert et al. (2011).

Lastly, the results for the first two steps were brought together to determine the structural elements limiting the performance of the system functions (Hekkert et al., 2011). These barriers were used to inform deployment strategies for inland FPV on innovation system level.

For the second sub-question, Solinoor's stakeholders were first determined using academic literature as described above, which was later verified and added on during the interviews to reach saturation. Their interactions and needs regarding inland floating solar in the Netherlands were subsequently mapped using semi-structured interviews. Both the needs and interactions were coded in an inductive way, which means using conventional coding to derive categories directly from data rather than using pre-defined codes (Hsieh & Shannon, 2005). This created an overview of the most important needs for different stakeholders along with a stakeholder interaction figure of Solinoor's innovation ecosystem surrounding inland FPV. To derive the deployment strategies, the interaction figure was used to determine where links between stakeholders are still insufficiently available, and the most important stakeholder needs formed informal requirements for Solinoor to adhere to.

The last sub-question concerns assessing stakeholder needs based on Solinoor's capabilities. To determine the stakeholder needs Solinoor is already able to address with their current capabilities, and to verify if they have any competitive advantages for specific needs, direct deliberation was performed with Solinoor. This took place in the form of an open interview where they, based on our identified stakeholder needs, assessed where their competitive advantage currently lies.

3.3. Data quality

To ensure high data quality in this research, the research uses multiple methods of data collection. Inductive interviews are used for the innovation ecosystem, while a more deductive methodology is followed for the technological innovation system interviews. This can contribute to data triangulation, as multiple methods and perspectives are used to describe the social phenomenon of inland floating solar deployment (Bryman, 2012, p.392). Furthermore, to ensure proper research steps are being taken, weekly updates on the progress are given to Solinoor. In addition, weekly feedback meetings with the supervisor group from Utrecht University contributed to the auditing of the research process (Bryman, 2012, p.392). Reflexivity is another crucial step to establish rigor, in which the biases of researchers are acknowledged and reviewed iteratively throughout the project (Bryman, 2012, p.393). Thus, the desk research involved an iterative approach that assessed if the data collected remained relevant for the research.

4. Findings

The findings consist of three parts relating to the technological innovation system, Solinoor's innovation ecosystem, and their capabilities in addressing stakeholder needs.

4.1. Technological Innovation System

The findings on the TIS include the structural elements (actors, technologies, and institutions), the rating of the seven system functions, and structural barriers and their causes.

4.1.1 Technologies

Several different variations of FPV technologies were found to be used in the Netherlands. The standard structural setup consists of so-called floaters, on which the PV panels are mounted, and which are anchored into the body of water of use. This underlying architecture was not found to vary significantly, as the technological variants can all be categorised as such pontoon-based systems. What does vary, however, are the type of materials used, the specific geometry and configuration of the floaters, and the type of anchoring used. Depending on the conditions of a specific location, the structure of floating PV plants generally differs in these core aspects. Additionally, multiple supplementary technological components important for FPV plants were identified and include for example cable management, panel coating, transformers, sun-tracking systems, and PV-panel cleaners.

Further, a clear distinction between inland and offshore FPV systems was identified. While this study focused on inland bodies of water, the offshore use was repeatably identified as a promising but challenging opportunity for large-scale FPV deployment by our interviewees. Due to the rougher condition and abrasive salt water, offshore systems require a higher structural integrity than inland, sweet water plants.

4.1.2. Actors

The actor groups active in the FPV technological innovation system are depicted in the following Figure 5. The figure also includes several examples for each group that were found to be particularly relevant in the TIS through based on stakeholders relevant to FPV in literature.

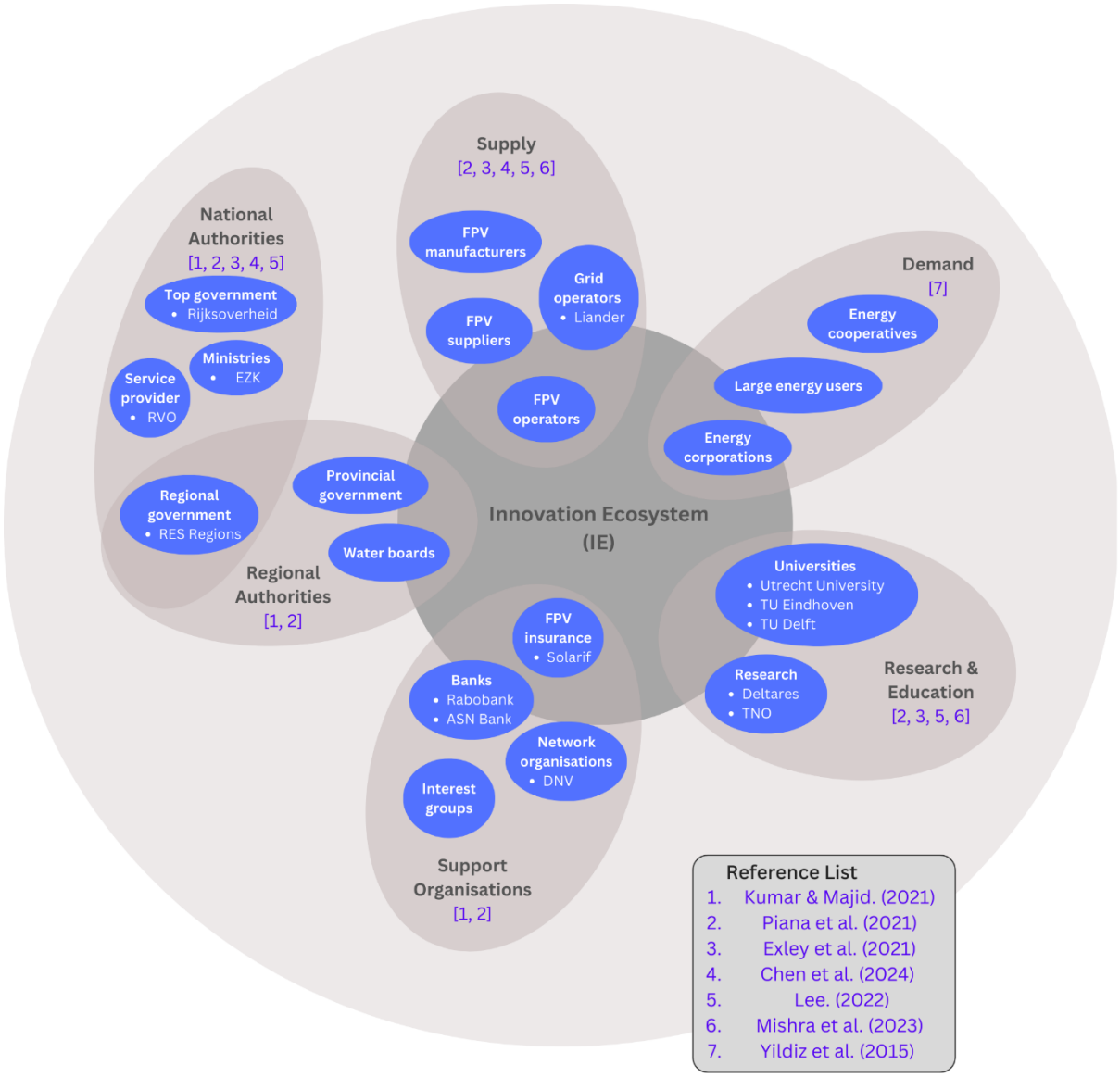


Figure 5: Map of FPV Technological Innovation System with actor groups.

As becomes evident from the figure, the TIS is comprised of a wide range of actors varying from typical supply and demand segments and knowledge institutions to supporting institutions and governmental bodies that guide and facilitate FPV development. For instance, with energy cooperatives, social acceptance for renewable energy technologies increases by engaging with communities (Yildiz et al., 2015; Delicado et al., 2023). These actors can interact on a general systemic level but can also function as direct stakeholders to FPV project developers within a concrete innovation ecosystem. One exception is the national government which acts completely external to the innovation ecosystem. The other actors also partly operate in Solinoor's innovation ecosystem.

4.1.3. Institutions

The relations and institutions permeating the actor configuration of the FPV technology in the Netherlands can be best described as having a high degree of interdependency whilst also displaying a lack of integrated processing of efforts. One clear dependency-relation was observed between the governmental bodies on the one hand, and FPV project developers and most of the other actors on the other (interviewee R2; R3; G3).

The role of upper governmental bodies such as the national government, provinces, and Rijkswaterstaat predominantly consists of setting requirements about certain aspects that relate to, for instance, energy generation, ecological aspects, and spatial aspects. While these often take the form of hard and formal legislations and clear national as well as international policy targets, the specific ways in which those are to be achieved are left open. The concrete realisation of suitable projects is delegated to lower governmental bodies such as municipalities, which translate the broader goals into soft requirements, or a "wish list" (interviewee G3), for the development of renewable energy solutions.

The suppliers of energy solutions are faced with the challenge of realising their projects within the more general institutional frameworks of the government. This requires them to independently act within a dense actor network of knowledge institutions, insurance companies, banks, the public, and other facilitating organisation to acquire the necessary ecological and construction related permits to realise their specific technological solution. Further, developers also rely on informal feedback from the public to find out pressing matters citizens might have about the construction of a FPV park.

The brief outline of the institutional structure highlights the general trend identified: Upper-level government bodies set the hard and formal rules which other actors must abide by. The project developers must act within this more general, top-down legislative framework and must acquire permits for their ventures. However, the newness of the FPV field results in a difficulty to match this bottom-up solution with the current top-down requirements imposed by the government due to insufficient knowledge and standardisation which results in uncertain permitting processes.

4.1.4. Functional analysis and system barriers

The TIS interviews yielded the system function (SF) rating depicted in Figure 6.

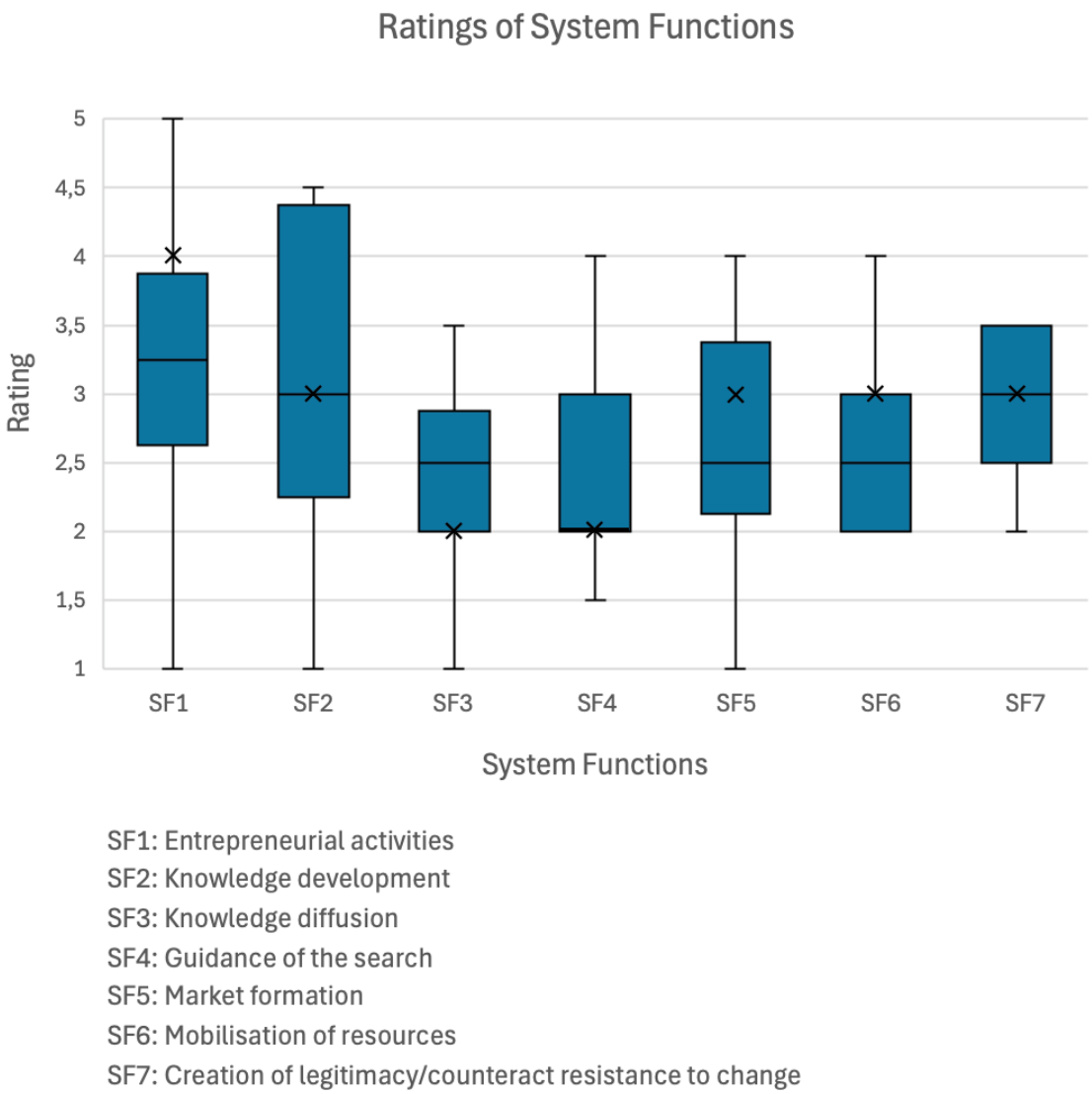


Figure 6: Rating of the system functions in the form of box-plots. Horizonal lines indicate the median; X are the ratings given by the researchers based on the combined insights of the TIS findings.

Considering the discrepancies of the ratings provided by the interviewees, as reflected in the large variance in several of the system functions, a final rating based on the collective knowledge gained by the researchers is included in Figure 6. The ratings were also determined based on the barriers underlying the system functions, as identified during the interviews and analysis process. The following Table 3 provides a shortlist of those barriers. For a more detailed description of the 14 types of barriers and their manifestations see Appendix 8.6.

Table 3: List of barriers found in the FPV innovation system.

System Function	Barriers
SF1: Entrepreneurial activity	Unstable political environment Stringent permitting
SF2: Knowledge development	Time-consuming knowledge development Stringent permitting Lack of shared responsibility
SF3: Knowledge diffusion	Knowledge silos (unawareness of knowledge) Knowledge silos (retention of knowledge) Actor multitude Lack of shared responsibility
SF4: Guidance of the search	Diverging perspectives Lack of perceived potential Unstable political environment Precautionary principle Lack of engagement Lack of standardisation
SF5: Market formation	Unstable political environment Lack of perceived potential Lacking business case
SF6: Mobilisation of resources	Unstable political environment Risk-averse behaviour Lack of perceived potential
SF7: Creation of legitimacy/ Counteract resistance to change	Precautionary principle Diverging perspectives

In general, the functional performance and identified barriers displayed a high degree of interdependence. While barriers were found for all the system functions, the root causes were predominantly found to lie within SFs 3 (diffusion of knowledge) and 4 (guidance of the search). For instance, while entrepreneurial activities and knowledge development (SFs 1 and 2) received the highest average ratings, the scores for these two functions also display a high variance, with entrepreneurial activities even being evaluated at the best as well as the worst rating (1 and 5) by different interviewees. In relation to the other system functions, this high variance indicates a fragmented state of the system in which knowledge silos and scattered activities are the reasons for starkly varying perceptions. Thus, the focus is put on the underlying barriers found within the bold SFs 3 and 4 in Table 3.

SF3 received the worst rating overall. The underlying barrier for the lack of diffusion in the current system were found in *knowledge silos*, which result in simple unawareness to active retention of knowledge, as one of our interviewees pointed out:

"I think what is also quite important for the knowledge development is the availability, accessibility of data. And what you see is that a lot of companies are just protecting their data, or the data are not released for further investigations or for model developments. And that will, in the end, inhibit, I think, the progress." (interviewee R2)

The unawareness of knowledge was mentioned with regards to governmental organisation not engaging in the dissemination of knowledge effectively, linking to the barrier of *lack of engagement* in SF4:

"I never see them [local and regional governments] at these conferences. They really have been shouting for years that we don't know anything. But yes, they want ready-made answers. […]. So yes, you can call out there is no knowledge. But it is being developed. It just doesn't appear by itself." (interviewee R3)

Closely related, a *lack of shared responsibility* was found to prevent an effective flow of information between different actors and hampered the creation of an integrated understanding across actors within the field. Further, diffusion of knowledge was also hindered by the sheer multitude of relevant actors to involve, making it difficult to know who to involve and where to find necessary information.

Perhaps related to the knowledge silos, guidance of the search (SF4) and market formation (SF5) received a lot of varying and rather low performance scores. While FPV was positively perceived as a renewable energy solution, *diverging perspectives* about the current and future developments of inland FPV was identified as a common barrier throughout the interviews. As only one of many renewable energy solutions and because of its relative novelty, governmental bodies such as municipalities, provinces, and supporting organisation such as insurance agencies still hold reservations about the deployment of FPV or about related operations and processes. Further hesitance is caused by the *precautionary principle* especially followed by governmental bodies, in which limited action is taken due to unknown environmental impacts of FPV parks. However, specific guidelines as to how these concerns should be addressed remain limited. The unclear guidance is further exacerbated by the barrier of *unstable political environments*, which describes the fact that the guidance and support on the national level may vary with changing regulations, laws, and governments.

Next, the FPV field itself displays an apparent bifurcation between inland and offshore FPV, in which a *lack of perceived potential* in inland FPV is expressed as compared to offshore parks. This is mainly due to the less strict rules and less

involvement of other actors necessary for offshore projects. While these technological trajectories were said to be complementary, it was also stated that the lack of perceived potential in inland FPV leads to an incongruent mobilisation of resources (SF6) in the floating solar arena.

Finally, a *lack of standardisation* was found to be a significant limiting factor for the guidance of inland FPV, playing a role in the convoluted permitting processes, among other things. This presents a dilemma, as knowledge development and its diffusion are necessary for standardisation to happen in the first place, as one interviewee pointed out:

"And this [FPV project development] requires, of course, a lot of knowledge. But also, I would say, spread of knowledge so that one can finally come to recommended practices [and] standardisation." (interviewee R2)

As such, the barriers within SFs 3 and 4 form what Hekkert et al. (2007) refer to as a 'vicious cycle' by forming a mutually enforcing barrier which negatively impacts activities related to other system functions. Overall, the combined perceptions of the system functions and barriers reflect a state in which many system activities are limited by their interdependencies with functions 3 and 4. The associated barriers embody scattered responsibilities, fragmented knowledge, and general uncertainties, which may also reflect the disjointedness between top-down and bottom-up institutions described in the previous section. Thus, structural causes can be found in the still developing institutionalisation of FPV related practices and fragmentation of knowledge about FPV technology across relevant actors.

4.2 Solinoor's Innovation Ecosystem

When looking specifically at Solinoor's ecosystem, different stakeholders are found to have direct interactions with them or influence them in a direct way. These stakeholders are shown in Figure 7 below and in Appendix 8.2. The interactions they have as well as their needs are discussed after, forming the basis for possible strategic leverage points for Solinoor.

4.2.1 Stakeholder interactions

Figure 7 below shows all stakeholders of importance in Solinoor's ecosystem based on interviews with stakeholders surrounding multiple projects in the regions of Gelderland and Utrecht. All identified stakeholders with an orange edge have a direct interaction with Solinoor. All without have a direct influence on the outcomes of FPV project that Solinoor has undertaken or can undertake in the future.

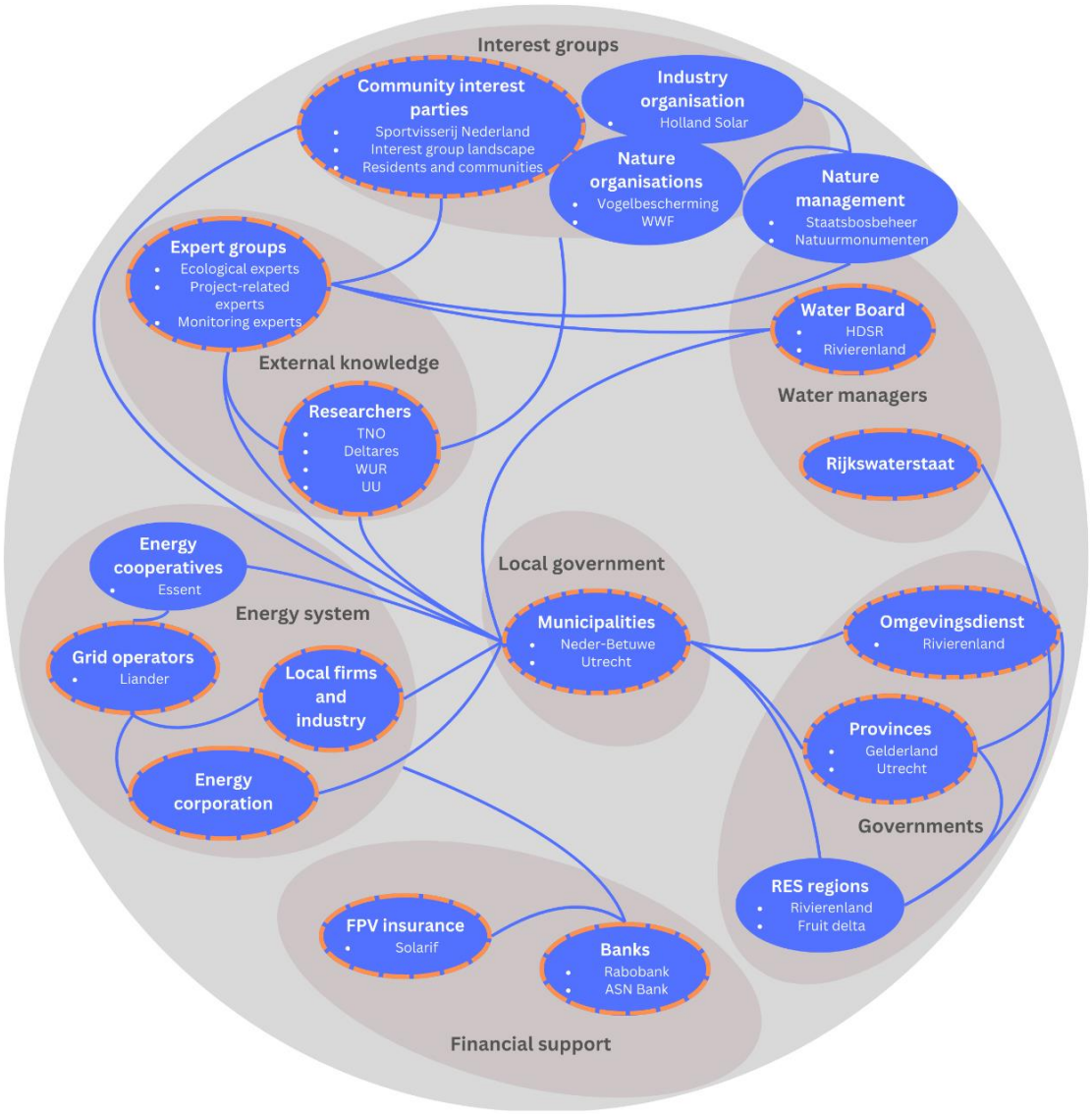


Figure 7: Stakeholder interactions as mentioned by the interviewees. The orange dotted lines show what stakeholders Solinoor itself interacts with directly.

What stands out in the interaction map is firstly the high degree of interactions and centrality the municipalities have within these projects. Furthermore, we note that the cluster of governments is relatively poorly connected, and only connects to municipalities and Rijkswaterstaat (and Solinoor). For example, no direct interactions between external knowledge organisations and research groups and the governments were found. Something similar goes for the financial support organisations, that only directly interact with stakeholders from the energy system. Despite its lacking direct interaction with governments, the cluster of external knowledge stakeholders does form a central section of the network and shows a relatively high number of interactions with other stakeholders.

4.2.2 Stakeholder needs

While many of the identified needs and requirements were expressed using different terms, a general classification was established which groups the needs into four categories depicted as four quadrants in Figure 8 below. The next sections will focus on the different categories and mention the most prominent needs put forth in the interviews, which are underlined in Figure 8. A more specific overview for each aspect is given in Appendix 8.4.

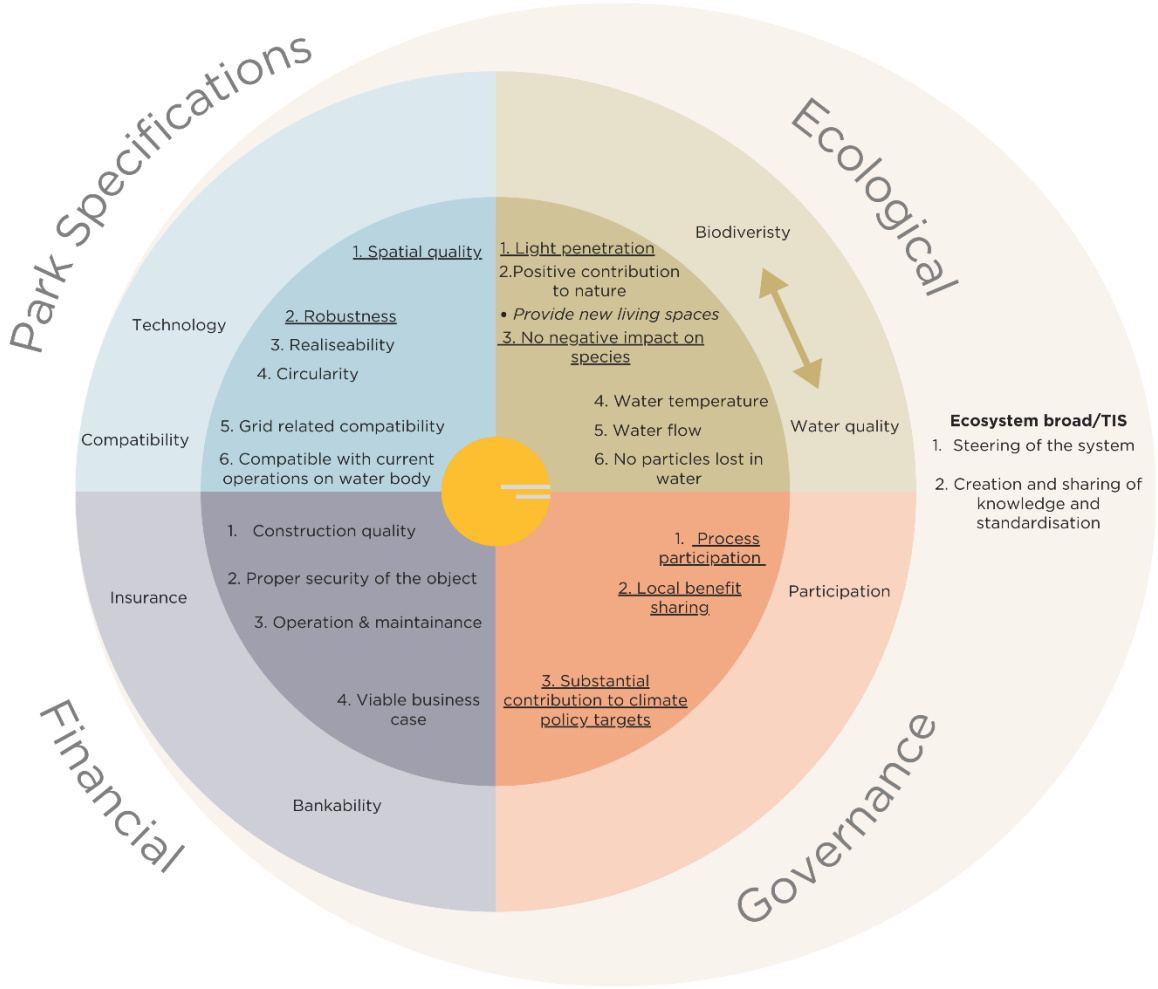


Figure 8: Needs within Solinoor's ecosystem.

The first category of needs, park specifications, relates to the specific design of each individual FPV park. The most prominent need here is spatial quality, as mentioned by 10 out of 11 interviews considered for this section. Spatial quality can be divided into aesthetics of the park, keeping or improving the nature, recreational functions of the site, and keeping or improving the accessibility. Another important need is the robustness, meaning that FPV parks should be able to withstand larges waves, winds, and general bad weather and storms. Although this need was not explicitly mentioned by many

stakeholders (mentioned by three in total) it is taken as a 'given' or basic requirement by many others. Furthermore, compatibility with current water functions is mentioned, with for example Sportvisserij Nederland highlighting the recreational functions of water bodies and Rijkswaterstaat stressing the importance of shipping routes.

Second, ecological needs were frequently mentioned in the interviews, mostly focusing on light penetration in the water, delivering a positive contribution to the natural environment, and bringing no negative effect to species, each mentioned by seven interviewees. The specifics within this category varied a lot, with, for example, the maximum water surface area allowed to be covered ranging from 20% to 50% with different stakeholders. The other specifics of water temperature, water flow, and no particles being lost in the water were mentioned relatively little, but still play a vital role in the needs with regards to biodiversity and can thus be deemed equally important.

The interviewees also raised needs related to governance of FPV. Participation in the development process, as well as having local benefits of the park were both deemed quite important (mentioned six and four times respectively). One such possibility is shared ownership of the produced energy, such as in the following quote:

"[...] from the national government, we have a wish for 50% participation, financial participation. But that's a wish. It's not a hard criteria. So the developers, they have to give a motivation, what they have done to achieve those 50%." (interviewee G3)

Furthermore, nine interviewees mentioned that FPV parks should have substantial contributions to climate targets, given that they are generally more time consuming for stakeholders to co-create compared to more 'conventional' renewable energy sources.

The fourth category concerns the financial aspects of the project, which mainly relate to banks and insurance companies. Insurance stressed the importance of a rigid and high-quality system, strongly relating to park specifications, and proper security. Also, a viable business case is important, which entails good return on investment, but also considers ecological and societal impact of projects more and more. Next to these more practical needs, also two broader ecosystem needs were mentioned that relate to all the four quadrants. These are that stakeholders miss steering of the system and the creation and sharing of knowledge. These needs seem to be strongly related to the barriers we have found at the TIS analysis.

4.2.3 Linking needs to Solinoor's capabilities

This section is based on a deliberation of the identified stakeholder needs with Solinoor in which the needs found in our research, presented in seen in Figure 8, were presented to Solinoor. In this deliberation, Solinoor stated that many of the needs were familiar, and that the big majority of them is already being considered by Solinoor. The wish for a circular system is rather new for Solinoor, although they have encountered it before. This need is also the only one that Solinoor does not have the direct (technical) capabilities to address the need to at least a minimal extent.

Moreover, they confirmed that the specific needs of robustness, water flow and no particles lost in water are met through their unique technical capabilities. This advantage is acquired through the characteristics of their novel floater technology. This technology, the ETI Ecofloat system, has technical superiority with regards to these needs. First, the needs of robustness and water flow are particularly well addressed by the 'pilar' structure that Solinoor's floaters have, compared to the 'ponton' structure that the competition uses. This feature makes the technology much better at dealing with waves, winds, and other heavy weather conditions compared to competing systems, giving them an advantage on the robustness need. Furthermore, this design element allows for a better water flow under the park. Other systems have a more closed structure, which makes water flow less possible and can potentially harm water quality. Lastly, the materials used in their floaters ensure that there is no exchange or decay of particles of the floating system into the water body, something that is poorly ensured in competing floater systems. Solinoor stated, they are the only company in the Netherlands with access to this technology for the coming 10 years. This technology grants Solinoor an advantage compared to different floater systems of competitors, as they can cover needs other companies cannot, or can only do to a limited extent.

5. Discussion

This research builds on a theoretical framework combining the Technological Innovation system and the Innovation Ecosystem concepts. Even though this is a rather uncommon combination, it proved to be insightful on several elements as will be described below. Specifically in a niche industry in which there is a lot of overlap between the innovation ecosystem and the technological innovation system the combination seems to be useful.

TIS provides systemic guidance with very clear functions of the innovation system to assess. These functions then translate into barriers, which can be turned into implications for the system easily and offer clear insights on a macro level. The IE theory on the other hand, offers insights into the dynamics of an innovation ecosystem in terms of stakeholders, their interactions and their needs. These meso-level scale insights give the research a rich understanding of the dynamics within the innovation ecosystem. The combination of these frameworks then provides the opportunity to compare macro-level barriers with ecosystem dynamics, giving more substance to the clear, but sometimes abstract, barriers from TIS. Furthermore, this comparison also allows to look for solutions to those barriers that might be more visible on an ecosystem scale, but that can provide insights into solutions for the whole innovation system. Adding to that, the insights into the ecosystem characteristics and the barriers in the larger system can be combined to leverage certain ecosystems within the innovation system that have the right capabilities to address system barriers.

One example of a combined insight form TIS and IE in this research is how the barrier of knowledge silos in the innovation system is exemplified by the lack of interaction between governments and external knowledge bodies in Solinoor's IE. The solution for this barrier also finds its foundations in the IE, where we recommend Solinoor to leverage their well-connected position to both these groups to stimulate knowledge sharing between them by initiating an overarching entity such as an industry organisation.

The results of this research impose several practical implications. First, it provides insight into the most pressing barriers for the inland FPV innovation system in the Netherlands and suggests a solution to these barriers in terms of an industry overarching organisation promoting knowledge sharing by bridging gaps between knowledge silos and aligning different actors to support the creation of guidance.

Second, the report offers several practical implications for the client firm, Solinoor. Starting, the research provides a set of needs that should be prioritized in FPV project development. Also, this same overview combined with the analysis of their capabilities in addressing the needs suggest that more effort in knowledge creation should go to the needs that should be prioritized but where Solinoor not yet possesses sufficient knowledge, or an edge over competition.

Then, the report also provides theoretical implications. The combination of the TIS and IE frameworks has shown to give a useful combination of insights into systemic barriers and ecosystem dynamics that gives extra substance to the identified barriers. These extra insights are later also useful in providing solutions to barriers. Therefore, this could pave the way for a more large-scale use of this implementation, especially for similar situations in which the TIS is still in some kind of niche.

The research setup also imposes certain limitations, both theoretical and practical. Regarding the theory, the main issue was to differentiate between the two innovation systems and above all to define clear boundaries. Furthermore, the synergies mentioned above will most probably be less valuable when an industry or technological innovation system is larger in absolute terms since then specific innovation ecosystem will most probably play a less significant role and combining insights between the two theories will in that case likely be more difficult and less insightful. For the practical limitations, one issue encountered was the information quality where misunderstanding of certain theories sometimes led to less valuable data collected in interviews. Furthermore, despite efforts to have a complete data collection, a larger number and variety of interviewees could provide a more holistic insight into main the TIS, but also the ecosystem findings.

Regarding future research, there is a set of directions that our report points towards both for our client Solinoor as well as for academic purposes. First, regarding the practical directions, we advise Solinoor to further assess their technology to investigate how it can further facilitate stakeholder needs and keep iterating with the supplier to reach a dominant design. These efforts should also contribute to Solinoor acquiring a competitive advantage on more of the priority needs then it does now. Also, the embodiment overarching organisation that we recommend Solinoor to initiate should be further investigated together with other relevant actors like governments and knowledge institutions.

With regards to academic research, there should be more research towards the combination of the IE and the TIS framework, specifically regarding the combination of TIS barriers and ecosystem characteristics that can lead to solutions for those barriers. Also, research should focus on establishing boundaries for the two system when used next to each other. Lastly, it should focus on investigating the cases in which this combination is useful, as our report suggests that the specific niche industry might be the reason that there was a useful complement between the two theories.

6. Conclusion

The research was composed with the aim to answer the following research question:

What strategies can Solinoor use to drive deployment of inland floating solar in the Netherlands considering the technology's systemic barriers and Solinoor's innovation ecosystem's characteristics?

To answer this research question, we formulated three sub-questions that will be answered first. The first one being: *How is the inland floating solar innovation system in the Netherlands structured and what are the system's barriers and their causes?* The technological innovation system of inland floating solar in the Netherlands was found to involve a wide array of different actors ranging from governmental bodies and research institutions to FPV developers, environmental organisations and others. The relations and institutions permeating the actor configuration can be best described as having a high degree of interdependency while at the same time displaying a lack of standardisation and maturity.

Next, the analysis of the seven system functions indicated that diffusion of knowledge and guidance of the search are the worst performing aspects of the system, forming a mutually enforcing barrier in the TIS. Governmental hesitance about inland FPV due to unknown long-term environmental impact and a higher potential seen in offshore FPVs were found to be the leading reasons behind the lack of guidance. Limited knowledge diffusion was found to be caused by little transparency between knowledge consortiums, the fragmented state of the diverse knowledge needed for FPV deployment, and a lack of engagement from governmental actors to acquire necessary knowledge. Then with regards to the second sub-question: *How is Solinoor's innovation ecosystem structured and what are its stakeholders' needs?* This innovation ecosystem is mostly structured around the municipalities, which have a central position given their connection to almost all other stakeholders. Furthermore, it seems that the rule-setting bodies do not connect as well with the other stakeholders, as can be seen by the lack of interactions from the national government and financial institutions to other stakeholders.

The needs found by stakeholders refer to four different categories, being project specific, ecological, governance and financial needs. All the needs found are important since the stakeholders mentioning them all have a direct or a strong indirect influence on the project development. However, the needs most prominently discussed in interviews are robustness, spatial quality, light penetration, no negative impact on species, participation and having a substantial contribution to climate policy targets, coming from the park specific, ecological and governance categories. Also, two

overarching needs in the ecosystem were found were stakeholders show a need for increased guidance and knowledge production and sharing in the ecosystem.

Moving on to our third sub question: What identified stakeholder needs can Solinoor address, given the companies capabilities? Based on the needs as presented above and, in more detail in the findings, we conclude that Solinoor possesses the capabilities to address all these needs, except circularity. Furthermore, the characteristics of the technology, that Solinoor has the exclusive rights to give them an advantage over competition considering the needs of robustness, water flow and no particles lost in the water. This gives them not only the possibility to fulfil most stakeholders' needs but also to outperform competition on those aspects.

Based on these three sub-questions, we formulate three strategies. The first strategy is for Solinoor to address all stakeholder needs, but with a strong focus on the most prominent needs e.g. robustness, spatial quality, light penetration, no negative impact on species, participation, and a substantial contribution to climate policy targets. Solinoor can, as a provider of systems, rather than owner of them, offer unique knowledge and flexibility in tailoring FPV systems to meet individual project needs. These strengths can allow Solinoor to be a leader in FPV development.

Second, Solinoor should focus on strengthening their capabilities with respect to the prioritised needs as mentioned in the previous point. To do this, we advise them to interact with selected stakeholder groups in the ecosystem. Table 4 below explains per need what group(s) of stakeholders are best to include.

Table 4: Stakeholder involvement needed to create knowledge on the most prominent needs.

Needs	**Stakeholder cluster to consider**
Spatial quality, participation and meeting climate policy targets	Local interest groups and local governments
Robustness	External knowledge, but also local interest groups and local governments
Light penetration and no negative impact on species	External knowledge, but also consider local interest groups and -governments

Third, Solinoor's close relations with governmental bodies and research institutions such as universities can facilitate strong knowledge flow. By coordinating with these actors, and other essential ones, Solinoor can become a matchmaking intermediary facilitating the sharing of knowledge and help establish a clearer guidance of the search. By doing so, a standard of FPV can be sought out more effectively by developing this knowledge consortium and bridging the gap between government bodies, knowledge institutions and research institutions.

7. References

1. Adner, R., Kapoor, R., 2009. Value creation in innovation ecosystems: How the structure of technological interdependence affects firm performance in new technology generations. ,
2. Amitrano, C. C., Tregua, M., Russo Spena, T., & Bifulco, F. (2018). On technology in innovation systems and innovation-ecosystem perspectives: a cross-linking analysis. Sustainability, 10(10), 3744. ,
3. Autio, E., Kenney, M., Mustar, P., Siegel, D., & Wright, M. (2014). Entrepreneurial innovation: The importance of context. Research policy, 43(7), 1097-1108. ,
4. Bax, V., Van De Lageweg, W. I., Van Deexln Berg, B., Hoosemans, R., & Terpstra, T. (2022). Will it float? Exploring the social feasibility of floating solar energy infrastructure in the Netherlands. Energy Research & Social Science, 89, 102569. https://doi.org/10.1016/j.erss.2022.102569
5. Bertassini, A. C., Zanon, L. G., Azarias, J. G., Gerolamo, M. C., & Ometto, A. R. (2021). Circular Business Ecosystem Innovation: A guide for mapping stakeholders, capturing values, and finding new opportunities. Sustainable Production and Consumption, 27, 436-448. ,
6. Bryman, A. (2012). Social research methods. Oxford University Press, USA. ,
7. Camargo, M., Palominos, P., Marche, B., Toledo, F., Boly, V., & Alfaro, M. (2021). A multi-stakeholder system-based methodology to evaluate the needs of innovation ecosystems. Research in Engineering Design, 32(4), 489-506.
8. Carlsson, B., & Stankiewicz, R. (1991). On the nature, function and composition of technological systems. Journal of Evolutionary Economics, 1(2), 93–118. https://doi.org/10.1007/bf01224915
9. Cazzaniga, R., & Rosa-Clot, M. (2021). The booming of floating PV. Solar Energy, 219, 3-10. ,
10. Chen, F., Pao, F., & Yin, H. (2018). Advanced Building Integrated Photovoltaic/Thermal Technologies. In Elsevier eBooks (pp. 299–319). https://doi.org/10.1016/b978-0-12-811479-7.00014-2
11. Chen, Y., Dy, K. B., Chang, C., & Hsu, S. (2024). Property rights arrangement and stakeholder networks hindering floating photovoltaics: A case of private open-access ponds in Taiwan. Energy Policy, 184, 113886. https://doi.org/10.1016/j.enpol.2023.113886
12. CJ, R., Lim, K. H., Kurnia, J. C., Roy, S., Bora, B. J., & Medhi, B. J. (2024). Towards sustainable power generation: Recent advancements in floating photovoltaic technologies. Renewable & Sustainable Energy Reviews, 194, 114322. https://doi.org/10.1016/j.rser.2024.114322
13. Da Silva, G. D. P., Magrini, A., & Branco, D. a. C. (2019). A multicriteria proposal for large-scale solar photovoltaic impact assessment. Impact Assessment and Project Appraisal, 38(1), 3–15. https://doi.org/10.1080/14615517.2019.1604938

14. Dinçer, İ., & Rosen, M. A. (2021). Exergy, environment, and sustainable development. In Elsevier eBooks (pp. 61–89). https://doi.org/10.1016/b978-0-12-824372-5.00004-x
15. Deltares. (2023, October 10). Advancing floating solar - Impact Report 2023. https://specials.deltares.nl/impact_report_2023/advancing_floating_solar
16. Edquist, C., & Johnson, B. (1996). Institutions and organizations in systems of innovation.
17. European Union. (2024). Fact sheets on the European Union - 2024. In www.europarl.europa.eu/factsheets/en. https://www.europarl.europa.eu/erpl-app-public/factsheets/pdf/en/FTU_2.4.9.pdf
18. Exley, G., Hernandez, R., Page, T., Chipps, M., Gambro, S., Hersey, M., Lake, R., Zoannou, K., & Armstrong, A. (2021). Scientific and stakeholder evidence-based assessment: Ecosystem response to floating solar photovoltaics and implications for sustainability. Renewable & Sustainable Energy Reviews, 152, 111639. https://doi.org/10.1016/j.rser.2021.111639
19. Freeman, R. E. (2010). Strategic management: A stakeholder approach. Cambridge university press.
20. Granstrand, O., & Holgersson, M. (2020). Innovation ecosystems: A conceptual review and a new definition. Technovation, 90, 102098.
21. GroenLeven. (2023, December 4). Drijvend zonnepark de Uivermeertjes | Zonnebron | GroenLeven. groenleven.nl. https://groenleven.nl/projecten/drijvend-zonnepark-de-uivermeertjes/
22. GroenLeven. (2024, April 2). Drijvend zonnepark Sellingen | Op zandwinplas | groenleven.nl. https://groenleven.nl/projecten/drijvend-zonnepark-sellingen-met-batterijopslag/
23. Guerrero, M., & Siegel, D. S. (2024). Schumpeter meets Teece: Proposed metrics for assessing entrepreneurial innovation and dynamic capabilities in entrepreneurial ecosystems in an emerging economy. Research Policy, 53(5), 104984. ,
24. Hekkert, M. P., Negro, S. O., Harmsen, R., & Heimeriks, G. J. (2011). Technologie innovation system analysis: a manual for analysts. Utrecht University. ,
25. Hekkert, M. P., Suurs, R., Negro, S. O., Kuhlmann, S., & Smits, R. (2007). Functions of innovation systems: A new approach for analysing technological change. Technological Forecasting & Social Change/Technological Forecasting and Social Change, 74(4), 413–432. https://doi.org/10.1016/j.techfore.2006.03.002
26. Hsieh, H. F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. Qualitative Health Research, 15(9), 1277–1288. https://doi.org/10.1177/1049732305276687
27. IEA. (2023). Electricity grids and Secure Energy Transitions. https://www.iea.org/reports/electricity-grids-and-secure-energy-transitions
28. ING. (2018, January 19). Netherlands home to first floating solar park in Europe. ING.com. https://www.ing.com/Newsroom/News/Netherlands-home-to-first-floating-solar-park-in-Europe.htm

29. Jacobsson, S., & Bergek, A. (2011). Innovation system analyses and sustainability transitions: Contributions and suggestions for research. Environmental Innovation and Societal Transitions, 1(1), 41–57. https://doi.org/10.1016/j.eist.2011.04.006
30. Jiao, J., & Zhang, Y. (2005). Product portfolio planning with customer-engineering interaction. IIE Transactions, 37(9), 801–814. https://doi.org/10.1080/07408170590917011
31. Johnson, A., & Jacobsson, S. (2001). Inducement and blocking mechanisms in the development of a new industry: the case of renewable energy technology in Sweden. In Edward Elgar Publishing eBooks. https://doi.org/10.4337/9781843762867.00012
32. Kamran, M., & Fazal, M. R. (2021). Fundamentals of renewable energy systems. In Elsevier eBooks (pp. 1–19). https://doi.org/10.1016/b978-0-12-823538-6.00009-9
33. Kumar, J. C. R., & Majid, M. (2021). Floating solar photovoltaic plants in India – A rapid transition to a green energy market and sustainable future. Energy & Environment, 34(2), 304–358. https://doi.org/10.1177/0958305x211057185
34. Lee, J. (2022). A governance structure based on an opinion analysis of local stakeholders of Saemangeum Floating Photovoltaic Power Plants project: using text mining for each subject. Journal of People, Plants, and Environment, 25(6), 595–606. https://doi.org/10.11628/ksppe.2022.25.6.595
35. Lundvall, B. (2007). National Innovation Systems—Analytical Concept and Development Tool. Industry and Innovation, 14(1), 95–119. https://doi.org/10.1080/13662710601130863
36. Mahajan, R., Lim, W. M., Sareen, M. L., Kumar, S., & Panwar, R. (2023). Stakeholder theory. Journal of Business Research, 166, 114104. https://doi.org/10.1016/j.jbusres.2023.114104
37. Maon, F., Lindgreen, A., & Swaen, V. (2008). Designing and Implementing Corporate Social Responsibility: an integrative framework grounded in theory and practice. Journal of Business Ethics, 87(S1), 71–89. https://doi.org/10.1007/s10551-008-9804-2
38. Markard, J., & Truffer, B. (2008). Technological innovation systems and the multi-level perspective: Towards an integrated framework. Research policy, 37(4), 596-615. ,
39. Markard, J., Hekkert, M., & Jacobsson, S. (2015). The technological innovation systems framework: Response to six criticisms. Environmental innovation and societal transitions, 16, 76-86. ,
40. Marshall, A. (2009). Principles of economics: unabridged eighth edition. Cosimo, Inc..
41. Mielke, J., Vermaßen, H., Ellenbeck, S., Milan, B. F., & Jaeger, C. (2016). Stakeholder involvement in sustainability science—A critical view. Energy Research & Social Science, 17, 71–81. https://doi.org/10.1016/j.erss.2016.04.001
42. Mishra, S., Harish, V., & Saini, G. (2023). Developing design topologies and strategies for the integration of floating solar, hydro, and pumped hydro storage system. Sustainable Cities and Society, 95, 104609. https://doi.org/10.1016/j.scs.2023.104609
43. Moore, J. F. (1993). Predators and prey: a new ecology of competition. Harvard business review, 71(3), 75-86.

44. Naderifar, M., Goli, H., & Ghaljaie, F. (2017). Snowball sampling: A purposeful method of sampling in qualitative research. Strides in development of medical education, 14(3). ,
45. NWO. (2023). Consortium investigates nature-inclusive use of fFloating solar panels through NWA programme responsible upscaling of 'Floating Solar'. https://www.nwo.nl/en/news/consortium-investigates-nature-inclusive-use-of-floating-solar-panels-through-nwa-programme-responsible-upscaling-of-floating-solar
46. Oliveira-Pinto, S., & Stokkermans, J. (2020). Assessment of the potential of different floating solar technologies–Overview and analysis of different case studies. Energy Conversion and Management, 211, 112747. ,
47. Pagnussatt, D., Petrini, M., Da Silveira, L. M., & Santos, A. C. M. Z. D. (2018). Who are they, what they do, and how they interact: understanding stakeholders in Small Hydropower Plants. Gestão & Produção, 25(4), 888–900. https://doi.org/10.1590/0104-530x3676-18
48. Piana, V., Kahl, A., Saviozzi, C., & Schumann, R. (2021). Floating PV in mountain artificial lakes: a checklist for site assessment. Renewable Energy and Environmental Sustainability, 6, 4. https://doi.org/10.1051/rees/2021002
49. PowerField. (2024, May 14). Zonnepark Hattemerbroek. https://www.powerfield.nl/locatie/zonnepark-hattemerbroek/
50. Precedence Research. (2023, October 19). Floating solar market. https://www.precedenceresearch.com/floating-solar-market
51. RVO. (2023). Netcongestie, flexibel energieverbruik en opslag van energie. RVO.nl. https://www.rvo.nl/onderwerpen/netcongestie-en-opslag-van-energie
52. Shi, W., Chen, Y., Ren, Z., Yuan, Z., Liu, Y., Zheng, S., Li, X., & Han, X. (2023). Review on the development of marine floating photovoltaic systems. Ocean Engineering, 286, 115560. https://doi.org/10.1016/j.oceaneng.2023.115560
53. Sianipar, C. P. M., Chao, Y., & Hoshino, S. (2023). Multi-Actor Systems in Water–Energy Nexus: Identifying critical stakeholders in Floatovoltaic (Floating Photovoltaic) project. Water, 15(6), 1241. https://doi.org/10.3390/w15061241
54. Smorodinskaya, N., Russell, M., Katukov, D., & Still, K. (2017). Innovation ecosystems vs. innovation systems in terms of collaboration and co-creation of value.
55. Spencer, R., Macknick, J., Aznar, A., Warren, A., & Reese, M. O. (2018). Floating Photovoltaic systems: Assessing the technical potential of photovoltaic systems on Man-Made water bodies in the continental United States. Environmental Science & Technology, 53(3), 1680–1689. https://doi.org/10.1021/acs.est.8b04735
56. Suominen, A., Seppänen, M., & Dedehayir, O. (2019). A bibliometric review on innovation systems and ecosystems: a research agenda. European Journal of Innovation Management, 22(2), 335-360. ,
57. Thomas, L. D., & Autio, E. (2019). Innovation ecosystems. Available at SSRN 3476925.
58. TNO. (n.d.). Floating solar panels. Retrieved May 22, 2024, from https://www.tno.nl/en/sustainable/renewable-electricity/sustainable-solar-land-water/floating-solar-panels/

59. Trapani, K., & Redón Santafé, M. (2015). A review of floating photovoltaic installations: 2007–2013. Progress in Photovoltaics: Research and Applications, 23(4), 524-532. ,
60. Vandest, E., & Hemetsberger Walburga. (2023). Floating PV Best Practice Guidelines Version 1.0. In SolarPower Europe. ,
61. Wang, W., Liu, W., & Mingers, J. (2015). A systemic method for organisational stakeholder identification and analysis using Soft Systems Methodology (SSM). European Journal of Operational Research, 246(2), 562–574. https://doi.org/10.1016/j.ejor.2015.05.014
62. Wood J, Sarkani S, Mazzuchi T, Eveleigh T (2012) A framework for capturing the hidden stakeholder system. Syst Eng 16(3):251–266. https://doi.org/10.1002/sys.21224
63. Xu Q, Jiao RJ, Yang X, Helander M, Khalid HM, Opperud A (2009) An analytical Kano model for customer need analysis. Des Stud 30:87–110
64. Yakubu, R. O., Quansah, D. A., Mensah, L. D., Ahiataku-Togobo, W., Acheampong, P., & Adaramola, M. S. (2023). Comparison of ground-based and floating solar photovoltaic systems performance based on monofacial and bifacial modules in Ghana. Energy Nexus, 12, 100245. https://doi.org/10.1016/j.nexus.2023.100245

8. Appendix

8.1. Conceptual framework

Studying both general systemic barriers as well as more specific ecosystem needs pertaining to the floating solar technology in the Netherlands necessitates a research approach that reconciles different system aspects. The conceptual framework is thus comprised of two theoretical perspectives, each emphasising different aspects of innovation systems.

On a more general scale, a systemic approach for understanding technological development is given by the technological innovation system (TIS) framework introduced by Hekkert et al. (2007). This approach involves mapping structures and activities surrounding a specific technology. In doing so, the aim is to identify obstructions on the wider system-level, and thus what are the possible avenues of improvement for this innovation system collectively.

While the TIS framework provides a structured approach to analysing key innovation activities and how a technological system performs, it is less focused and individual needs in the context of a smaller group of players, let alone a single firm (Amitrano et al., 2018). Thus, another strand of literature discussing so called innovation ecosystems (IEs) has emerged in which a narrower focus is put on the collaborative efforts of individual firms (Adner & Kapoor, 2009; Granstrand & Holgersson, 2020). This lower-level ecosystem perspective takes nuanced aspects of a selected set of actors into account, acknowledging their needs and relations within the broader context of the TIS (Amitrano et al., 2018).

Thus, combining a broader perspective on the system's overall performance via the TIS framework with a more concrete understanding of individual stakeholder relations and needs in a specific ecosystem may provide a holistic understanding of efforts surrounding a technology. This may also provide the foundation for developing strategic interventions based on wider systemic as well as more contextual considerations. However, acknowledging that systemic factors are generally not something that can provide concrete strategies for a single company, or even a whole ecosystem, the compatibility of TIS and IE warrants further discussion. In the following, TIS and IE are thus explained in detail, explicating what specific elements of the two frameworks are relevant and how they link within the conceptual framework.

2.1. Concepts from Technological Innovation Systems

The technological innovation system is a systems-perspective devised to understand and evaluate the dynamics inherent in technological change of a particular technology (Hekkert et al., 2007). Here, technological change is not limited to activities that are

linked to directly developing and producing technology. Rather, it is the result of various actors interacting within a bigger system that shapes a technology, referred to as the technological innovation system (TIS). Within such a TIS, the following conceptual elements are of prime importance: a system's technology, actors, institutions, the phase of the system, functions, and system barriers (Hekkert et al., 2011).

At the core of a TIS lies that system's focal technology and potential variations thereof. It can be characterised by, among other things, patent classifications or techno-economic attributes such as including market costs (Hekkert et al., 2011). The technology is the central element and thus delineates the boundaries of the TIS.

What qualifies an actor in this context, is that they must have a relevant impact on the innovation process of the technology (Hekkert et al., 2007). This may include any form of impact, be it positive, negative, directly, indirectly, or any other form, resulting in a large variety of potential actors. Some examples of actors include technological developers, adopters, manufacturers, governmental institutions, financial institutions, lobbies, and users, which individually and collectively shape the development of a technology.

Next, a technological innovation system is permeated by so called institutional structures. As described by Edquist & Johnson (1996), these institutions define the interplay between the various actors and thus impact how a technology develops. In this sense, the institutional structure is the actionable landscape within which the different actors operate and can include such things as laws, rules, established practices, and routines. A further distinction between institutions can be made by considering formal or informal and hard or soft institutions (Edquist & Johnson, 1996). While informal institutions refer to tacit and implicitly understood aspects, such as acceptable social behaviour, norms of cooperation, and conventions, formal institutions reflect codified rules that are made explicit by, for example, policy interventions or government laws. Relatedly, hard institutions are considered mandatory and are enforced, while soft institutions allow for some manoeuvring. Together, a technological innovation system's different actors and institutions comprise what is herein referred to as that innovation systems' general structure.

The way in which a TIS should be structured depends to some degree on the phase of the innovation system (Hekkert et al., 2011). Depending on the developmental stage of the technology, these phases are 1) pre-development phase, 2) development phase, 3) take-off phase, 4) acceleration phase, and 5) stabilisation phase. As described by Hekkert et al. (2011), the phase of the TIS determines what activities are of importance, thus forming the baseline against which the performance of the system is evaluated against.

The main activities and relational elements between the various actors are given by the concept of a system's functions. While a system's structure with its actors and

institutions presents a rather static representation of the TIS, functional aspects can be introduced to analyse more dynamic elements. Hekkert et al. (2007) propose seven system functions, which categorise the main innovation activities present in the actor network that shape the development process of a technology. These functions are 1) entrepreneurial activities, 2) knowledge development, 3) knowledge diffusion through networks, 4) guidance of the search, 5) market formation, 6) resource mobilization, and 7) creation of legitimacy/counteract resistance to change. The importance of any one of these functions depends on the phase of the TIS. Thus, these system functions, as defined by the Hekkert et al. (2007), can be used to evaluate how a technological innovation system of a particular phase performs.

In combination, structural and functional analyses may lead to the identification of a system's barriers. Such barriers are understood as systemic factors limiting the innovation process of a technology. Thus, by applying the TIS framework to a technology and studying its actors, institutions, and functional aspects, insights on the overall state and performance of a technology's system can be gained.

2.2. Considerations about the Concepts of TIS

Considering the client-specific focus in this research, some considerations about the use of TIS framework are in order. First, while a system is subject to a broad range of different actors and institutions, this all-encompassing nature may result in the failure to identify core structures and thus generic results. The original authors of the TIS framework thus acknowledge that the delineation of the technology's system can be defined on a case-by-case basis (Markard et al., 2015). Analytical choices based on the study purpose and specific research questions then set the system boundaries, often resulting in a TIS perspective being used within a specific country setting.

Further, the authors also address the apparent lack of context specific aspects. This reflects the notion that analysing technological development primarily via a system's functional performance may neglect more nuanced aspects that can occur on other system levels. (Jacobsson & Bergek, 2011). Thus, as Johnson & Jacobsson (2001) point out, additional systemic approaches can be implemented to consider further conceptual elements that lie outside the traditional scope of TIS. One such approach is given by the innovation ecosystem approach discussed in the following, which puts more theoretical emphasis on context-specific aspects such as needs and relations of stakeholders within a smaller network.

2.3. Concepts from Innovation Ecosystems

When taking a less broad perspective then the system level of the TIS, one can take the perspective of innovation ecosystem (IE), considering more context-specific aspects.

There are many different perspectives on innovation ecosystems and its definition. Based on work from Moore (1993), the analysis of industrial districts (Marshall, 2009), innovation systems (Lundvall, 1992), and clusters (Porter, 1998), They Amitrano et al. (2018, p.2) propose the following definition: "innovation ecosystem focus on how different actors interplay through complex and dynamic interactions to achieve innovation-driven goals, with technology playing a central role in favouring knowledge flows and integrations" (Amitrano, 2018, p.2). These interactions are oriented at creating value within the ecosystem through new combinations of actors, also referred to as stakeholders, and resources (Adner & Kapoor, 2009; Thomas et al., 2020; Guerrero & Siegel, 2024).

2.3.1 Stakeholders within Innovation Ecosystems

As mentioned, innovation ecosystems emphasise interactions between stakeholders targeted at creating value. Therefore, it is important to understand the concept of stakeholders. Freeman (2010, p.53) defined an organisation's stakeholders as "groups or individuals that can affect or be affected by the organization's activities". Stakeholders in such an ecosystem can be of different types, such as economic or social and they can have different types of relations, such as communicating and cooperating (Autio et al., 2014; Guerrero & Siegel, 2024). Based on these descriptions, Bertassini et al. (2021) propose a layered framework consisting of three categories of stakeholders. As can be seen in Figure 1, these three categories are 1) internal stakeholders, 2) value chain stakeholders, and 3) value network stakeholders. Internal stakeholders are those that are responsible for the organisation's decision and activities comprising, for example, shareholders, employees, supervisors, managers, and departments. Value chain stakeholders are defined as actors that are directly affected by or directly influencing the organisation. Examples include consumers, users, suppliers, retailers, and recycling cooperatives. Lastly, value network stakeholders are those that are directly

or indirectly related to the organisation such as the government, competitors, inspection agencies and regulatory bodies, universities, and local communities.

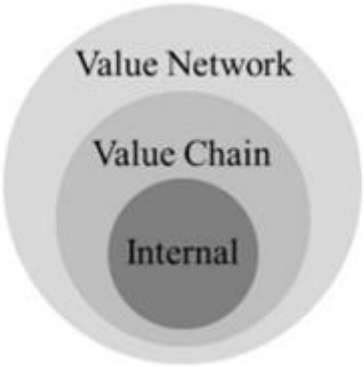


Figure 1: Categories of stakeholders in the innovation ecosystem (Bertassini et al., 2021)

2.3.2 Stakeholder needs

As mentioned previously, the interactions between different stakeholders in the ecosystem form a vital aspect of the functioning of these ecosystems (Camargo et al., 2021). Therefore, considering the needs of these stakeholders is a common component within the IE framework. Multiple scholars have shown that for innovation to thrive, businesses must consider the needs of stakeholders in their innovation ecosystem (Jiao & Zhang, 2005; Xu et al., 2009; Camargo et al., 2021). Furthermore, Wood et al. (2012) argue that given the rise in complexity and scope of developing current products and services, projects are increasingly overcome with diverse stakeholder needs.
Further, projects involving multiple stakeholders often concern needs that relate to each other, highlighting the importance of considering multiple stakeholders' needs simultaneously (Camargo, 2021). Reconciling possible differences or complementarities between stakeholders' needs becomes an important task, which is why developers or project managers must safeguard and guide this process by, for example, prioritising the different needs (Camargo, 2021).

2.4. Comparing TIS and IES

Comparing the above sections on the TIS and IE reveals the subtle differences and complementarities in the conceptual focuses of the two frameworks. The main differences and compatibilities are summarised in the following Table 1.

Table 1: Comparing technological innovation systems and innovation ecosystems

Element under focus	Technological Innovation System	Innovation Ecosystems
Context	Technology as the focal point, often implemented within a national context (macro to meso scale) (Markard & Truffer, 2008; Markard et al., 2015)	Actor's contributions and interactions as the focal point, often within one industry setting (meso to micro scale) (Amitrano et al., 2018; Adner & Kapoor, 2009)
Aim	Drive development of a certain technology and overcome system barriers to improve the whole context (Hekkert et al., 2007)	Creating added value through complementation and cooperation that result in new combinations of stakeholders and resources (Guerrero & Siegel, 2024)
Players	Referred to as actors (Edquist & Johnson, 1996)	Referred to as stakeholders (Amitrano et al., 2018)
Mechanisms	Functions and institutions between actors that characterise the system (Edquist & Johnson, 1996)	Needs and complex relations between stakeholders such as cooperation and communication (Autio et al., 2014)

As depicted, the two frameworks differ in their typical contextual setting, their main aim, and their understanding and definition of structural elements such as the players acting in the system and mechanisms between them.

Regarding the general context, while a TIS is built up around a specific technology, the IE revolves more around the relational aspects in a network of specific players (Amitrano et al., 2018). Consequently, the system boundaries of TIS are, in theory, given by the reach of the activities related to the technology. However, as already mentioned above, the TIS approach is frequently used within a national context (Markard et al., 2015). Thus, this systems-approach is applicable to different levels of aggregation, reaching from the meso-level, in case of a selected technology within a selected country, to a macro-level, in the case of a global technology spanning multiple nations. The IE on the other hand, addresses one or multiple firms' immediate network and focuses on individual contributions and interactions within that setting (Adner & Kapoor, 2009). The focus of this analysis therefore lies more on the micro- to meso-scale.

Furthermore, the aim within the TIS context is to address system barriers that hamper actors and technological change more generally. From an IE perspective, the main objective is for firms to optimally make use of their immediate network and resources to create value than no single firm could have created by itself (Adner & Kapoor, 2009). This added value in return, can fall on an individual firm or the whole ecosystem. Relatedly, these distinct objectives in the two frameworks result in different conceptual mechanisms being used to analyse the system. While the TIS consists of structural elements such as actors and institutions as well as seven generic functions, the

ecosystem perspective acknowledges context-specific aspects by taking specific stakeholders, their needs, and their relations into account (Edquist & Johnson, 1996; Amitrano et al., 2018). At this point, the distinction between actors and stakeholders becomes apparent. Players in the TIS framework are called actors, while in IE they are referred to as stakeholders.

Thus, while the TIS and the IE frameworks both discuss innovation activities, their general level of aggregation and conceptual focuses are different. With regards to our client's problem statement, the TIS framework is thus well suited for gaining more general information on system barriers and key innovation activities surrounding the inland floating solar technology in the Dutch context. A more concrete understanding of Solinoor's setting within the broader system can be gained via the IE perspective, stressing the needs and relations of stakeholders in Solinoor's ecosystem. These conceptual elements form the basis of the study, and their operationalisation is discussed in the following section.

8.2. Actor and stakeholder overview

This appendix provides an overview of the actors and stakeholders involved in the Dutch inland floating solar sector. The distinction between actors and stakeholders is the level of direct interactions with Solinoor, where entities with direct interactions or influence are seen as stakeholders and others are deemed actors. For this end, the general table provided in the theoretical background of this report is shown. This table was discussed with Solinoor to identify the stakeholders and actors they deemed most applicable based on their expertise. This is added to by the information provided by the interviewees. The tables that followed from this are shown below.

Table 8.2.1: identified actors and stakeholders in inland floating solar literature.

System-level actors	**Ecosystem-level stakeholders**
Environmentalists (Bax et al., 2022; Lee, 2022; Chen et al., 2024 ; Da Silva et al., 2019 ; Exley et al., 2021)	Local companies and associations (Bax et al., 2022; Lee, 2022;)
Regional authorities (Piana et al., 2021; Kumar & Majid, 2021)	Community interest parties (Chen et al., 2024; Bax et al., 2022 ; Exley et al., 2021 ; Sianipar et al., 2023)
National authorities (Piana et al., 2021; Exley et al., 2021; Chen et al., 2024; Lee, 2022; Kumar & Majid, 2021)	Water body managers (Bax et al., 2022; Exley et al., 2021)
Experts and researchers (Piana et al., 2021; Exley et al., 2021; Lee, 2022)	Residents and communities (Chen et al., 2024; Da Silva et al., 2019; Sianipar et al., 2023 ; Exley et al., 2021)
FPV providers (Piana et al., 2021; Chen et al., 2024)	FPV operators (Lee, 2022; Sianipar et al., 2023; Exley et al., 2021; Kumar & Majid, 2021)
Water industry (Exley et al., 2021)	Pond and landowners (Chen et al., 2024; Sianipar et al., 2023)
Trade associations (Exley et al., 2021)	Developers FPV installation (Kumar & Majid, 2021; Da Silva et al., 2019; Exley et al., 2021)
Central energy provider (Chen et al., 2024)	Local authorities (Bax et al., 2022; Piana et al., 2021; Exley et al., 2021; Da Silva et al., 2019)
Investors (Piana et al., 2021; Kumar & Majid, 2021)	

Table 8.2.2: innovation system actors in Dutch inland floating solar based on deliberation with Solinoor.

General actors from literature	Dutch inland floating solar actors
Regional authorities (Piana et al., 2021; Kumar & Majid, 2021)	Waterschappen RES regions
National authorities (Piana et al., 2021; Exley et al. 2021; Chen et al., 2024; Lee, 2022; Kumar & Majid, 2021)	Rijksoverheid Ministry of EZK
Experts and researchers (Piana et al., 2021; Exley et al. 2021; Lee, 2022; Mishra et al., 2023)	Universities / higher education Research institutes
FPV providers (Piana et al., 2021; Chen et al., 2024)	FPV suppliers Machine manufacturers Assembly producers Maintenance and service providers
Water industry (Exley et al., 2021)	-
Trade associations (Exley et al., 2021)	Water partnerships
Central energy provider (Chen et al., 2024; Pagnussatt et al., 2018)	Grid operator Energy provider
Investors (Piana et al., 2021; Kumar & Majid, 2021)	Banks Insurance companies

Table 8.2.3: identified innovation ecosystem stakeholders for Solinoor

General stakeholders from literature	Solinoor specific stakeholders
Local companies and associations (Bax et al., 2022; Lee, 2022)	Sportvisserij Nederland Nederlandse Onderwatersport Bond
Community interest parties (Chen et al., 2024; Bax et al., 2022 ; Exley, 2022 ; Sianipar et al., 2023)	Energy users (local firms, cooperatives, corporation)
Water body managers (Bax et al., 2022; Exley, 2022)	Waterschappen Rijkswaterstaat Staatsbosbeheer
Residents and communities (Chen et al., 2024; Da Silva et al., 2019; Sianipar et al., 2023 ; Exley, 2022)	Local residents and communities
FPV operators (Lee, 2022; Sianipar et al., 2023; Exley, 2022; Kumar & Majid, 2021)	(Solinoor)
Pond and landowners (Chen et al., 2024; Sianipar et al., 2023)	Waterschappen Rijkswaterstaat Staatsbosbeheer
Developers FPV installation (Kumar & Majid, 2021; Da Silva et al., 2019; Exley, 2022)	

Local authorities (Bax et al., 2022; Piana et al., 2021; Exley, 2022 ; Da Silva et al., 2019)	Municipalities Omgevingsdienst
Environmentalists (Bax et al., 2022; Lee, 2022; Chen et al., 2024 ; Da Silva et al., 2019 ; Exley, 2022; Pagnussatt et al., 2018)	Staatbosbeheer WWF Vogelbescherming

8.3. Interviewee table

Here, an overview of all the interviewees along with their in-text reference (abbreviation) can be found. The function of the interviewees within their respective organization is not mentioned, given the anonymity of the interviewees. Nevertheless, this information is known to the researchers and is taken into account when drawing conclusions if deemed necessary. The abbreviations are based on the TIS actor categories as mentioned by Hekkert et al. (2011) and shown in the adapted figure in the interview guide. These categories are governmental bodies, research, education, supply, demand and supporting organisations.

Table 8.3.1: Overview of interviewees

Abbreviation	Organisation	Main purpose	Type of organisation within TIS	Date and language of interview	Type
G1	Municipality of Utrecht	Implementation of policies	Governmental body	28-05-2024 English	IE
SO1	Sportvisserij Nederland	Advocating for fishers' rights	Supporting organisation	28-05-2024 Dutch	IE
G2	RES Rivierenland	Intermediary between implementation and policy	Governmental body	29-05-2024 Dutch	TIS
G3	Province of Gelderland	Creating policy	Governmental body	29-05-2024 English	IE
SO2	Staatsbosbeheer	Nature conservation	Supporting organisation	30-05-2024 Dutch	IE
R1	Utrecht University	Research	Research	04-06-2024 English	TIS
S1	Rijkswaterstaat	Provision of land/water	Supply	06-06-2024 Dutch	IE
S2	Solinoor	Floating solar project developer	Supply	06-06-2024 English	TIS
G4	Ministry of Economic Affair and Climate Policy (EZK)	Formulating policy	Governmental body	07-06-2024 Dutch	TIS

SO3	Solarif	Inspections, insurance and matchmaking of solar projects	Supporting organisation	10-06-2024 Dutch	IE
R2	TNO	Applied research institute	Research	10-06-2024 English	TIS
SO4	Rabobank	Financing projects	Supporting organisations	11-06-2024 Dutch	TIS
G5	RVO	Executive governmental body	Governmental body	12-06-2024 English	TIS
G6	Water board HDSR	Advising and permitting projects	Governmental body	12-06-2024 Dutch	IE
G7	Municipality of Neder-Betuwe	Implementation of policies	Governmental body	13-06-2024 Dutch	IE
R3	Deltares	Applied research institute	Research	13-06-2024 Dutch	TIS

8.4. Stakeholder needs

Table 8.4.1. Aggregated stakeholder needs

Quadrant	Category	Need	Specifics	Times mentioned by stakeholder
Project specific	Technology	Robustness	Solar parks need to be able to withstand storms and the related wind and waves on their respective water	3 *(Interviewee R1; SO3; SO4)*
	Technology	Realisability	- Project developer needs to possess the expertise to develop the project - All partners in a project should have the required skills - The location's characteristics should allow for a FPV park The security standards of a park should be tailored to the location's specifications so that vandalism and theft are minimised	3 *(Interviewee R1; SO3; SO4)*
	Technology	Circularity	FPV parks should (as much as possible) be realised taking Circular Economy principles into account	2 *(Interviewee G2; SO3)*
	Compatibility	Grid related compatibility	- Have the correct technical specifications to be directly connected to the grid	4 *(Interviewee R1; S1; SO4; G5)*

			Contribute to net congestion as little as possible	
		Compatible with current water functions	Do not obstruct current functions that the water body has as for example shipping route, harbour, industrial fishing etc.	2 *(Interviewee S1; G6)*

	Spatial quality	Spatial quality	- Protect the spatial quality of the location. This entails matters like:
			  o Aesthetics
			  o Nature and recreation
			  o Accessibility
			- Using residual areas of land first before highly used areas are looked at
			- Breach the aesthetics of the water body as little as possible, compensate for any negative changes. This means to 'hide' the park as much as possible and to make the panels as flat as possible
			If the spatial quality for any stakeholder goes down, compensate this negative impact (Added social value). For example: build piers and a parking lot for fishermen if a part of their area is used, or provide new recreational purposes for an area around a FPV park
				10 *(Interviewee G1; R1; SO1; S2; SO2; G2; G3; R3; G6; G7)*

Ecological	Water quality	Water temperature	The water temperature cannot be altered substantially by the FPV park	1 *(Interviewee SO1)*
	Water quality	Water flow	The water flow cannot be altered substantially by the FPV park	1 *(Interviewee SO1)*
	Water quality	No particles lost in the water	- The FPV park cannot release any particles into the water body For some stakeholders this release should be as small as possible	2 *(Interviewee SO1; SO2)*

		Impact on local environment	- A FPV project should take into account:
			  o Nitrogen effects
			  o Soil quality
			Infiltration and groundwater
				1 *(Internal permitting documents Rijkswater-staat*

				and Water-schappen)
	Biodiversity	Light penetration	- As much light penetration as possible needs to be established - A maximum surface coverage area of between 20% and 50% of the water body is used by different interviewees - The lack of light penetration cannot substantially change the water temperature The lack of light penetration cannot seriously harm plant growth in plant rich areas.	7 *(Interviewee G1; S1; G2; SO2; G3; R3; G7)*
	Biodiversity	Positive contribution to nature	- The project should come with a measurable positive impact to nature As a part of this process, a project should contribute to new living spaces for animals	7 *(Interviewee G1; S1; G2; SO2; SO4; G6; G7)*
		No negative effect on species	There cannot be a negative effect on species because of a project, also not when that is compensated by a big growth in other species	7 *(Interviewee G1; R1; S1; SO1; SO2; G3; SO3)*
Governance	Participation	Process participation	All stakeholders (from local governments to civilians) should be included in the process	6 *(Interviewee G1; SO1; G2; G3; SO3; G7)*
	Participation	Financial participation	- There should be a financial benefit for local parties For example in terms of investment in the region, a local fund or -ownership	4 *(Interviewee G2; G3; SO4; G7)*
	Policy	Contribution to policy targets	Projects should have a sufficient contribution to policy targets of (local) governments, mainly translated in the RES targets	9 *(Interviewee G1; S1; SO1; SO2; G2; G3; SO4; G6; G7)*
Financial	Insurance	Construction quality	Projects should be of decent structural quality and adhere to safety measure, all as defined in the 'Scios scope 12'	1 *(Interviewee SO3)*
		Proper security of the object	The park should be sufficiently guarded to make insurance payable and feasible. These measures are location specific and should be discussed with the	1 *(Interviewee SO3)*

			insurance broker but typically include fencing, camera installations and an emergency service that can reach the location within a certain timeframe	
		Operation & maintenance	The park should have proper operation and maintenance plans, which should beforehand be discussed with the insurance	1 *(Interviewee SO3)*
	Bankability	Viable business case	Projects need to have a viable business case. This notion is constructed out of a workable return on investment, but also the positive climate impact and local impact are considered	6 *(Interviewee G1; S1; SO2; R3; SO3; SO4)*
Ecosystem needs	Broader ecosystem needs	Steering of the system	Linked to the TIS system function guidance of the search, we see that many stakeholders feel the lack of direction in the ecosystem and want clear targets and goals with regards to FPV	7 *(Interviewee R1; S1; SO1; R2; SO2; SO4; G5)*
Ecosystem needs	Broader ecosystem needs	Creation and sharing of knowledge & standardisa-tion	Similarly to the previous need, this need is linked to the TIS system functions knowledge diffusion, knowledge development and also partially to creation of legitimacy. Where stakeholders mention they lack sufficient knowledge and expertise to actually effectively work with FPV and contribute to a more efficient IE	11 *(Interviewee G1; R1; S1; G2; R2; S2; R3; SO3; SO4; G5; G6)*

Table 8.4.2.: Order of needs for each stakeholder interviewed

Stakeholders	Needs	Comments
Staatsbosbeheer	1. Revenue for ecological preservation 2. Energy transition Ecological component and market conformity as boundary conditions	The ecological component and market conformity were given as basic requirements. For that reason, Staatsbosbeheer ranked them as option three, as they are standardly taken into account rather than forming organisation specific needs.
Sportvisserij Nederland	1. Fishing possibilities 2. Aesthetics and recreation Ecological impact	They mentioned that their first need is by far the most important. Also, the ecological impact could impact the fishing possibilities, therefore it can become more important when there are for examples issues with the fish populations
Rijkswaterstaat	1. Knowledge on effects on ecology, water quality, water safety, water maintenance 2. Continuity of current operations, maintaining water quality etc. (formal requirement) Not fully cover the water body, up to 20-50% coverage	Again, the second need is a formal requirement and thus a dealbreaker if not met. However, they say they have the most need for the first one mentioned.
Neder-Betuwe Municipality	1. Added value for residents and community 2. Ecological improvement 3. Contribution to energy transition 4. Specific requirements a. 50% of the water surface covered b. Panels as flat as possible 5. Well-functioning communication process	The interviewee found it hard to give a formal order of the needs, but ended up with the order that is presented here. However, it was also stressed that all of them are hard requirements and are therefore all vital to the success of a project.
Insurance (Solarif)	1. Safe, well-functioning project system (scope 12 certified)	Mainly, the insurance mentioned that parks should have the correct construction quality

	2. Properly functioning insurance system	(according to Scios scope 12), and that guarding of the object should be as agreed upon: "if the park doesn't fly away, and no one steels anything, we are happy."
Province of Gelderland	- Having participation (financial, and process) i.e. involving others - Solution for net congestion - Spatial quality: how well the FPV park fits into the location and how people like it - Ecologically responsible	This interviewee had issues providing an order of the needs and would rather "have them all". The only hard requirement seems to be the impact on nature. Furthermore, they mention participation and net congestion are most interesting for their managers. The final order has been made based on this combined with judgement of the interviewers.
Hoogheemraadschap Stichtse Rijn (Water board)	1. Maintaining water quality (20% coverage of FPV on water body) 2. Contributing to energy transition Compatibility with current functions such as water recreation	
Municipality of Utrecht	1. Net positive impact (on CO2 reduction) + that the project will be realized on short term 2. A positive feeling for stakeholders, by (process) participation of locals 3. There should be an ecological plus and water quality should be maintained 4. There should be expertise from all partners, both from Solinoor but also other parties like for example ecologists	
The next interviews were originally conducted as TIS interviews. However, their stakeholder needs were also discussed in the interview		
Rabobank	1. Viable business case	Rabobank mentioned to mainly be interested in the

		viability of the business case. For them, this is determined by factors such as having a proven technology, knowledge and insights into uncertainty factors, a stable political environment and energy storage options.
RES	1. Ecological impact and circularity of project 2. More sustainable energy production 3. Involving local residents and stakeholders Local energy ownership	For the specific parks, the RES region mainly mentioned that impact on the environment should be as low as possible. Both in terms of local impact (ecological and practical) as well as global (circularity) Also, they have a large emphasis on the local benefits that should come from such projects. This entails local participation, but also financial benefits like local ownership
Deltares	- Light penetration past the floating panels, at same time recognise the need to catch as much light as possible with the solar park for a good business model - Using residual areas with limited added value to nature to place solar parks	The needs were not listed explicitly or ranked at the end of the interview. Instead, they were found to be mentioned by the interviewee throughout the interview. Here these needs based on theory are mentioned.

8.5. Interview guide

Information to be sent to the participants:

As this interview will focus on several concepts from scientific literature you might not completely be familiar with, this mail provides some explanations. In this way, we all know what we are talking about and can have a nice discussion together.

First of all, we use the term inland floating solar deployment to discuss the development and diffusion of floating solar technologies that are applied away from the shore. Therefore, offshore floating solar technology development is out of the scope of our research.

Second, in our research we use system functions. For our research, these functions describe activities that aim to build up a well-functioning system for inland floating solar in the Netherlands. The following functions will be used in our research, based on Van Der Loos et al. (2020) and Hekkert et al. (2007):

1. Entrepreneurial activities

This function concerns engagement of companies in projects, product testing, diversifying into new industries, increased commercial activity and new entrants. To determine the quality of this system function for inland floating solar in the Netherlands, you can ask yourself the following questions:

- To what extent does your sector or broader environment include novel developments aimed at inland floating solar in the Netherlands?
- Is your firm contributing in some way to these novel developments?
- Are there enough entrepreneurial activities concerning inland floating solar in the Netherlands for your firm or sector?

2. Knowledge development

This function describes knowledge development occurring either in private R&D departments or in publicly funded institutes or universities. This is important to learn about floating solar technology and its possibilities. It can concern learning by searching and/or learning by doing. To determine the quality of this system function for inland floating solar in the Netherlands, you can ask yourself the following questions:

- To what extent do knowledge development projects exist within your sector or broader environment aimed at inland floating solar in the Netherlands?
- Is your firm contributing to this knowledge development in some way?
- Is there enough knowledge development for inland floating solar in the Netherlands for your firm or sector?

3. Knowledge diffusion through networks

Knowledge diffusion concerns the exchange of information in the form of partnerships, networks, and collaborations. This is important for the deployment of inland floating solar, as it creates both learning by interacting as well as possibly learning by using. To

determine the quality of this system function for inland floating solar in the Netherlands, you can ask yourself the following questions:

- To what extent are collaborations and networks concentrated around inland floating solar within your sector or broader environment?
- Does your firm also have such collaborations, partnerships or networks?
- Are there enough networks and collaborations for your firm or sector with regards to the deployment of inland floating solar in the Netherlands?

4. Guidance of the search

This function analyses whether the technology development is steered in a certain direction with shared discourse, targets, and visions. This steering can be done by private sectors or the government and can either stimulate or discourage the use of the technology. To determine the quality of this system function for inland floating solar in the Netherlands, you can ask yourself the following questions:

- Is there generally a positive or negative attitude towards inland floating solar in your sector or broader environment?
- To what extent are your activities steered towards inland floating solar deployment by your sector or broader environment?
- Does your firm contribute to this steering towards inland floating solar deployment?

5. Market formation

Market formation concerns creating favourable circumstances for the novel technology to develop and diffuse. This can include forming niche markets that are protected from embedded technologies or creating competitive advantage with tax exemptions for example. To determine the quality of this system function for inland floating solar in the Netherlands, you can ask yourself the following questions:

- To what extent are favourable market conditions created for inland floating solar within your sector or broader environment?
- Does your firm contribute to these favourable market conditions in some way?
- Are there enough favourable market conditions for inland floating solar for your firm or sector?

6. Resource mobilisation

This function maps whether there are sufficient resources allocated to the specific technology, in our case the inland floating solar technology in the Netherlands. These resources can be both financial and human in nature and are usually supplied using government funds, market subsidies, and private investments. To determine the quality of this system function for inland floating solar in the Netherlands, you can ask yourself the following questions:

- To what extent are resources available to inland floating solar technology in the Netherlands within your sector or broader environment?
- Does your firm contribute to the availability of these resources for inland floating solar?
- Are there sufficient resources for the deployment of inland floating solar for your firm or sector?

7. Creation of legitimacy and/or counteract resistance to change

This last function maps whether conditions are created where the new technology can become part of the existing regime or even overthrow it. This therefore entails creating societal legitimacy and possibly reducing legitimacy for the inland floating solar and possibly reducing the legitimacy of vested technologies. Often this is achieved by interest groups and their lobby actions. To determine the quality of this system function for inland floating solar in the Netherlands, you can ask yourself the following questions:

- To what extent are interest groups active in creating legitimacy for inland floating solar in the Netherlands within your sector or broader environment?
- Does your firm in some way collaborate or interact with these floating solar interest groups?
- Is there enough lobbying activity for inland floating solar in the Netherlands for your firm or sector?

Interview guide

First of all, thank you for participating in our interview. As you probably already read somewhere in one of our mails, our research is about the implementation and development of inland floating solar in the Netherlands, which is performed for the solar company Solinoor. To determine strategies for this company with regards to this more novel inland floating solar technology, we first look at the system level and determine how well the system around the technology performs. This could for example be about the people involved around the technology, the knowledge development for the technology and the markets that are formed around it. That in the end determines how well the technology can perform compared to other more established technologies. Then we also in separate interviews look into stakeholders from Solinoor and what requirements they have of inland floating solar projects and floating solar in general. This then informs actions that Solinoor can take to meet those stakeholder needs. In this interview, we will focus on either this system level or stakeholder level. Possibly add on what level we will interview them and how they are relevant at that level.

Do you have any additional questions about our research and what we aim to achieve with it?

- Introduce yourself: name, education, role
- This interview is confidential so nothing will be made public without your permission.
- Do you give permission for recording this interview?
- Do you give permission to us using your position and company/organization for this research? The names will be anonymized.
- What is your career background and expertise in?
- Do you have any relevant work experience?
- Explanation of what floating solar is (Show Solinoor's FPV pamphlet)
- Is the concept of floating solar clear to you?

Part A – System Level

1. System structure

1.1. Technology

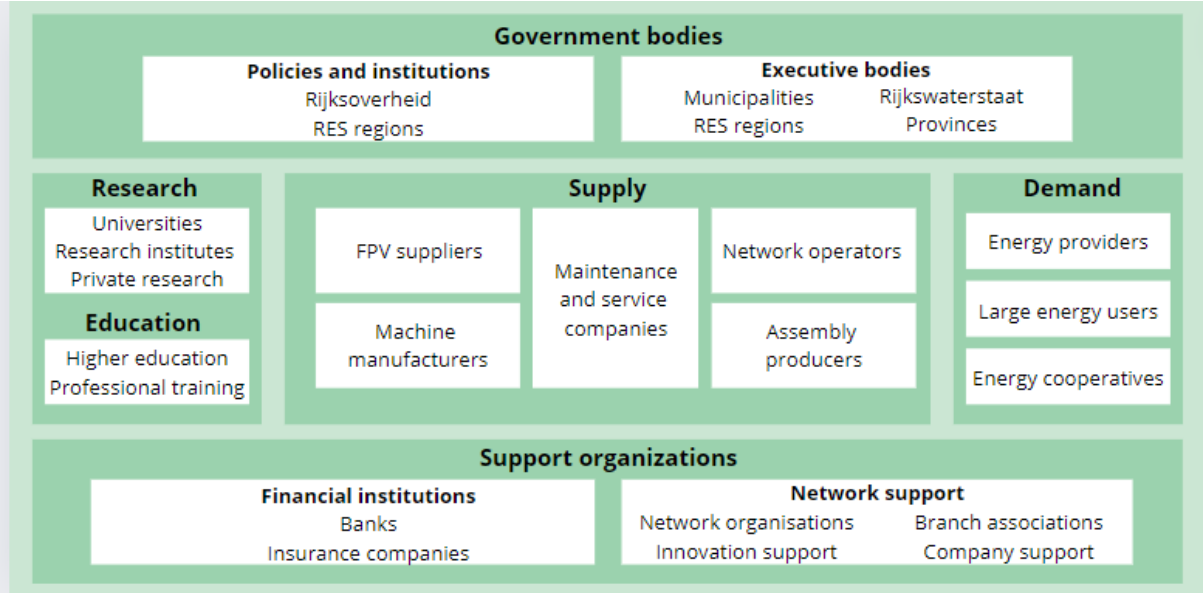
Inland floating solar technology has many possible adaptations, such as different types of floaters and anchoring types. Furthermore, the inland floating solar technology itself is integrated into a broader energy system. These different technologies together

influence the safety, reliability, possibilities for scaling up and cost of the overall technological system. We would now like to ask you whether:

1.1.1. Do you see different technologies surrounding inland floating solar technology in the Netherlands and if so, which one are you most familiar with?

1.2. Actors

Different actors interact with the inland floating solar technology, who can either positively, negatively or neutrally influence the development and diffusion of the technology. We already tried to somewhat map this system and were wondering who you feel are relevant in the system around inland floating solar. This is based on research on innovation systems, which found research, education, supply, demand and government bodies as important actor categories.



Examples:

- Knowledge institutions: research institutes, universities, private research
- Educational organisations: higher education, professional training
- Suppliers: raw material supplier, subsystem supplier, machine manufacturers, assembly producers, service providers
- Demand side: consumers, clients, suppliers/installers, companies
- Governmental bodies: municipalities
- Other organisations, people, or groups of people either facilitating or hampering development of the system: banks, network organisations, innovation, and company support

1.2.1. What actors are active in the Netherlands when it comes to the deployment of floating solar technology?

1.3. Institutions

Apart from these actors and technologies, different rules and routines also influence what can be done in terms of inland floating solar technology. For example, laws influence the possibilities of inland floating solar deployment, just as more informal networks and values can create positive conditions for floating solar and sustainability in general or hinder it.

1.3.1. What laws, regulations, and policies are most applicable to you, given your role in the deployment of inland floating solar technology?

Examples: formal standards and rules, legislation, property rights

1.3.2. What networks of actors exist around inland floating solar in the Netherlands and what is the purpose of these networks?

1.3.3. What is the general perception of different actors with regards to inland floating solar in the Netherlands? Do they tend to be sceptical or optimistic about the ability of it to fit within the current system of technologies, practices and values?

Examples: community support for sustainability, traditional water management and integration of novel technologies into these existing systems, community networks, risk perception of novel technologies for different actors, media portrayal

2. System functions

As already shortly explained in our mail beforehand, system functions describe actions that are taken which can either positively or negatively influence the development and diffusion of inland floating solar. This could for example include actions regarding knowledge development, knowledge exchange, obtaining sufficient resources and creating separate niche markets. For each of the system functions as defined in the literature as important we will ask you to rate their performance in your experience. This would go according to the following scale:

1. There are no activities within the area of this system function or the ones that are there seriously hinder the deployment of inland floating solar

2. I know some activities exist within this function, but am not quite sure which ones or know they perform very badly

3. There are several activities within this system function to my knowledge and these seem to perform reasonably

4. The activities within the functions seem to be abundant and also perform well

5. The activities within the functions are abundant and perform (almost) perfectly

Is this clear to you or is there anything you would still like to ask?

2.1. Entrepreneurial activities
Examples: pilot projects, product testing, startups, projects, experimentation
2.1.1. On a scale from 1 to 5, do you feel there are enough entrepreneurial activities surrounding inland floating solar in the Netherlands?
2.1.2. Why do you assign it this rating?
2.1.3. What do you see as possible problems in this area?
2.1.4. Do you also see possible opportunities and if so which ones?

2.2. Knowledge development
Examples: R&D, scientific publications
2.2.1. On a scale from 1 to 5, do you feel there is enough knowledge development surrounding inland floating solar in the Netherlands?
2.2.2. Why do you assign it this rating?
2.2.3. What do you see as possible problems in this area?
2.2.4. Do you also see possible opportunities and if so which ones?

2.3. Knowledge diffusion through networks
Examples: partnerships, collaborations, conferences
2.3.1. On a scale from 1 to 5, do you feel there is enough knowledge diffusion surrounding inland floating solar in the Netherlands?
2.3.2. Why do you assign it this rating?
2.3.3. What do you see as possible problems in this area?
2.3.4. Do you also see possible opportunities and if so which ones?

2.4. Guidance of the search
Examples: news articles, policy targets, shared visions
2.4.1. On a scale from 1 to 5, do you feel there is enough steering of technology development towards inland floating solar in the Netherlands?
2.4.2. Why do you assign it this rating?
2.4.3. What do you see as possible problems in this area?
2.4.4. Do you also see possible opportunities and if so which ones?

2.5. Market formation

Examples: protected markets (niche), tax exemptions, subsidies

2.5.1. On a scale from 1 to 5, do you feel markets are sufficiently formed for inland floating solar in the Netherlands?

2.5.2. Why do you assign it this rating?

2.5.3. What do you see as possible problems in this area?

2.5.4. Do you also see possible opportunities and if so which ones?

2.6. Resource mobilisation

Examples: government funds, private investments (both financial and human)

2.6.1. On a scale from 1 to 5, do you feel there is enough mobilisation of resources for inland floating solar in the Netherlands?

2.6.2. Why do you assign it this rating?

2.6.3. What do you see as possible problems in this area?

2.6.4. Do you also see possible opportunities and if so which ones?

2.7. Creation of legitimacy/counteract resistance to change

Examples: interest groups, lobby actions

2.7.1. On a scale from 1 to 5, do you feel enough legitimacy is created for inland floating solar in the Netherlands?

2.7.2. Why do you assign it this rating?

2.7.3. What do you see as possible problems in this area?

2.7.4. Do you also see possible opportunities and if so which ones?

That was the interview, thank you for participating!

Ask whether there are still other actors that are important to talk to for our interviews.

Part B – Ecosystem Level

1. Goals, Stakeholders, and Needs

1.1. What are your goals regarding the deployment of FPV in the Netherlands? (What is your role regarding FPV?)

1.2. What stakeholders do you interact with to reach those goals?

Explanation: Stakeholder interactions are seen as interactions with actors in your firm's immediate network. Collaborations with such stakeholders can take place to create added value.

1.3.1. What needs/requirements do you have to achieve your goals within this ecosystem?

Explanation: stakeholder needs are seen as requirements that stakeholders have for their efforts in fulfilling the broader interest of that specific stakeholder in relation to inland floating solar in the Netherlands. We categorise these in project requirements (solar panels can be max 2 meters high), and general ecosystem needs (the need for more alignment in the ecosystem).

Note for interviewer: Try to find out where exactly this need comes from, i.e. what is the cause for this need? Not on a general level, but specific. Also write all the needs down so they can order them already in this interview.

1.3.2. What specific project requirements do you have for inland floating solar in the Netherlands?

1.4. Can you place these needs in order of importance? (max. 10)

That was the interview, thank you for participating!

Ask whether there are still other stakeholders that are important for us to talk to in our interviews.

8.6. Structural barriers for the system functions

Table 8.6.1.: Order of needs for each stakeholder interviewed

System Function	Barrier	Manifestation
SF1: Entrepreneurial activities	Unstable political environment (SO4; G5; R2)	Changing laws, regulations, and uncertain support dissuades entrepreneurs from entering the FPV field.
	Stringent permitting (R3; S1; R2)	Stringent permitting exists for pilots, especially in Natura 2000 areas. This dissuades entrepreneurs from developing projects in those areas.
SF2: Knowledge development	Time-consuming knowledge development (S1; G6; R2; R1)	Long-term impacts of inland FPV parks are unknown as the field is young.
	Stringent permitting (R3; SO3; R2)	Stringent permitting, especially in Natura 2000 areas, causes a lack of field labs for knowledge development on ecological impacts.
	Lack of clearresponsibility (S1; R2; R1)	A lack of clear responsibility exists in determining the long-term impacts of inland FPV as well as in developing technological components.
SF3: Knowledge diffusion	Knowledge silos - Retention of knowledge (R3; G5; S2; R2; R1)	There exists unwillingness of commercial parties to share data. For instance, sectoral data is often only available behind a paywall.
	Knowledge silos - Unawareness of knowledge (S2; R2)	Absence of governmental bodies at knowledge diffusion activities limits the flow of information.
	Lack of shared responsibility (SO4; S2; R2; R1)	Lack of shared responsibility results in seeing projects as being made up of independent components rather than creating an integrated understanding.
	Actor multitude (S2; G5; R2; R1)	A large number of actors are involved, making it harder to know who to involve and where to find information.
SF4: Guidance of the search	Diverging perspectives (G4; S2; SO1; SO2; SO4; G5; R1)	Diverging perspectives between different layers and within different layers, such as between municipalities, results in, for example, unrealistic expectations.
	Lack of perceived potential (S2; G2; G4; G5)	Offshore solar and wind energy are prioritised due to a perceived higher potential of those.

	Unstable political environment (G4; SO4; G5; R2)	Changing laws, regulations, and changing governments leads to varying governmental support.
	Precautionary principle (G2; G6; S2; SO4; G5; R2; R1)	Limited actions are taken before impacts on natural environment and residuals are certain.
	Lack of engagement (S1; SO2; G5; R1)	A lack of engagement from, for example, governmental bodies leads to a mismatch between expectations and facilitation.
	Lack of standardisation (G2; SO2; R2; R1)	A lack of standardised procedures and technological components makes a clear focus for inland FPV development challenging.
SF5: Market formation	Unstable political environment (G4; R3; G5)	Changing rules and regulations, for example with planned subsidy cuts in SDE++. This creates unfavourable market conditions for inland FPV.
	Lack of perceived potential (G4; S2)	Offshore FPV is prioritised due to its perceived higher potential. This causes subsidies to be focused on offshore FPV
	Lacking business case (SO3; SO4)	Lacking perceived business case given the high costs and low market revenue.
SF6: Mobilisation of resources	Unstable political environment (G4; R3; G5; R2)	Changing rules and regulations, for example with planned subsidy cuts in SDE++. This hinders stable resource availability.
	Risk-averse behaviour (R3; SO4)	Knowledge gaps and expected consequences of inland FPV projects leading to a lack of financial support.
	Lack of perceived potential (G2; G4; R1)	Prioritisation of offshore solar and wind energy due to perceived higher financial and sustainable potential of those. This leads to resources mainly flowing to these other projects.
SF7: Creation of legitimacy/Counteract resistance to change	Precautionary principle (S1; G5)	Resistance given the uncertain impacts on the natural environment and circularity.
	Diverging perspectives (R3; G5; R2; R1)	Conflicting interests from actors (public, government, nature organisations, etcetera) at different project locations makes devising blanket strategies for creating legitimacy especially challenging.