

THESIS FOR THE DEGREE OF LICENTIATE OF ENGINEERING

# Public intermediaries in the energy transition

A study of municipal energy advisors in Sweden

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Gothenburg, Sweden 2023

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## ABSTRACT

To mitigate climate change, a transition toward more sustainable energy production and consumption is crucial. In particular, this requires widespread adoption of renewable electricity technologies, such as solar photovoltaics (PV). As the adoption of such technologies can be challenging for new adopters, support actors such as intermediaries (i.e., brokers between actors in the adoption process), play a crucial part in facilitating adoption. While intermediaries have gained increased attention in the transitions research overall, the roles of public intermediaries (i.e., publicly funded intermediaries with a policy mission) in the energy transition remain unclear.

This licentiate thesis takes a mixed methods approach to increase the understanding of the roles of public intermediaries in the energy transition. More specifically, it studies how public intermediaries operationalize their policy mission, and why, as well as how public intermediation can be improved. To this end, the case of municipal energy advisors in Sweden is studied through 129 activity reports, 22 semi-structured interviews, and a survey to both the municipal energy advisors and solar PV installers. The outcome is presented in this compiling synthesis and three appended papers.

The findings reveal that the roles of public intermediaries depend on how they operationalize their policy mission. Public intermediaries perform a wide range of activities on both an actor and system level, thus displaying different behaviors. This varying operationalization results from top-down, middle-out, and bottom-up influences, where the middle-out influences are shown to be crucial in shaping the roles of public intermediaries. These findings stress the importance of considering public intermediaries' individual agency when designing and implementing policy missions to maximize their potential contribution to the energy transition.

Keywords: intermediaries, energy, sustainability, transitions, public, private, energy advising, Sweden, solar photovoltaic



## LIST OF APPENDED PAPERS

### **Paper I**

Mignon, I. & Winberg, L. (2023). The role of public energy advising in sustainability transitions – empirical evidence from Sweden. *Energy Policy*, 177, 113525.

An earlier version of the paper was presented at the 7<sup>th</sup> Network of Early Career Researchers in Sustainability Transitions (NEST) Conference, 5-6 May 2022, Lyon, France.

### **Paper II**

Bastås, L. & Mignon, I. (20XX). Institutional intermediaries in transitions – neutral policy implementers or self-driven change agents? Under review in *Technological Forecasting and Social Change*.

An earlier version of the paper was presented at the NORSI Research Conference, 26-27 January 2023, Stockholm, Sweden, and at the 5<sup>th</sup> EU-SPRI PhD Days Conference, 8-10 February 2023, Valencia, Spain.

### **Paper III**

Bastås, L. & Mignon, I. Similarities and differences between public and private intermediaries supporting the adoption of solar photovoltaics in Sweden. Work in progress, Chalmers University of Technology, Sweden.

An earlier version of the paper was presented at the 14<sup>th</sup> International Sustainability Transitions Conference, 30 August - 1 September 2023, Utrecht, Netherlands.



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# 1. INTRODUCTION

In the first section of this licentiate thesis, I provide the background and motivation for my research, introduce the aim and research questions, and present the outline for the rest of the thesis.

## 1.1. BACKGROUND

In mitigating climate change, it is essential to intensify actions that reduce greenhouse gas emissions (IPCC, 2023). A large potential is found in the energy sector, where power generation accounts for around one third of global greenhouse gas emissions (IEA, 2023a, 2023b). This sector is undergoing a transition from the prevalent reliance on fossil fuels to a growing deployment of renewable electricity technologies (RETs) (IEA, 2023a). To reach net zero emissions targets, decentralized RETs, such as solar photovoltaics (PV), require adoption from not only traditional RET adopters like governments and energy utilities, but also more and new types of adopters, such as private investors (Bergek et al., 2013; Wüstenhagen & Menichetti, 2012). However, these new adopters often face challenges due to lack of key resources required for adoption, such as knowledge, experience, and capital (Mignon & Bergek, 2016a). To overcome such challenges and facilitate adoption, it is important to have support systems in place (Bergek, 2020).

In Sweden, one type of adoption support is municipal energy advising, which is a public service free of charge for households, companies, and associations. It is funded by the Swedish Government as a policy instrument to reduce the environmental and climate impact from energy use by providing information and advice about e.g., energy efficiency and solar PV (Swedish Government, 2016). As the municipal energy advisors are distributed across Sweden's 290 municipalities, they are tasked to operationalize their policy mission to their local contexts. While previous studies have followed the historical development of municipal energy advising (Kjeang et al., 2017), evaluated different program periods (Eriksson & Kjeang, 2021; Khan, 2006), and assessed homeowners' perception of the provided advising services (Mahapatra et al., 2011a, 2011b), the impact of municipal energy advising has proven difficult to assess and remains uncertain. Although municipal energy advising is considered an important policy instrument to accelerate the energy transition, it is thus still unclear what role they play.

Given their position in-between adopters, suppliers, and policymakers, the Swedish municipal energy advisors can be defined as public intermediaries, i.e., actors that broker between other actors and levels in the energy system (Howells, 2006). Intermediaries have been acknowledged to facilitate adoption processes through different activities, for instance by providing information and technological advice, connecting actors with complementary resources, and coordinating adoption processes (Aspeteg & Mignon, 2019; Bergek, 2020; Owen et al., 2014). The public funding of municipal energy advisors distinguishes them from private intermediaries, which are commercial actors financed through revenues (Mignon & Kanda, 2018). This organizational difference seems to influence which activities the intermediaries undertake (Intarakumnerd & Chaoroenporn, 2013; Mignon & Broughel, 2020).

In order to maximize the potential benefits of intermediaries in adoption processes, it is therefore crucial to understand why intermediaries perform different activities (Hyysalo et al., 2022; Talmar et al., 2022). In fact, studies have shown that beyond the intermediaries being public or private, some of the variations among intermediaries can be explained due to their scope of action, i.e., if they operate on an actor or system level (Klerkx & Leeuwis, 2008b; Mignon & Kanda, 2018). Intermediaries with a scope of action on an actor level support individual actors in their adoption processes, whereas intermediaries with a systemic scope of action address systemic challenges to adoption and perform activities such as enabling networking and knowledge diffusion (Mignon & Kanda, 2018; Polzin et al., 2016; van Lente et al., 2003).

Although there is an emerging interest in public intermediation as an important policy instrument (De Silva et al., 2022; Rossi et al., 2022), their role in energy transitions is still unclear. Public intermediaries are often seen as static policy implementers, that fulfill the policy missions that are given to them (Backhaus, 2010). Meanwhile, some scholars argue that public intermediaries may in fact deviate from their policy missions when operationalizing them, based on personality and personal skills, thus displaying individual agency (Eriksson & Kjeang, 2021; Parag & Janda, 2014). While agency is being increasingly acknowledged as important in bringing about changes in transitions (Duygan et al., 2019; Patterson et al., 2017), the concept is still emergent in the intermediary literature. Given the inherent dynamics of transitions, it is therefore crucial to acknowledge the agency of individual public intermediaries and adapt public intermediaries' policy missions accordingly (Talmar et al., 2022). Consequently, public intermediary services can be developed to meet the varying needs and demands from the heterogeneous group of adopters (Bergek et al., 2013; Talmar et al., 2022).

From a policy perspective, it is important that policy instruments, such as public intermediaries, are used as effectively as possible. Since they rely on taxpayers' money, they should be implemented as interventions where market or system failures are not sufficiently handled by commercial actors (Schot & Steinmueller, 2018). For the Swedish municipal energy advisors, it is thus important to further study their role, also in relation to private intermediaries, to assess their potential contribution to both the adoption of solar PV and the wider energy transition. Since it can be difficult to measure the impact of municipal energy advising in terms of CO<sub>2</sub> savings, it is even more important to understand what they do when operationalizing their policy mission. While the Swedish model of energy advising is unique, lessons from this understanding can be applied also to other contexts with decentralized energy goals.

## 1.2. AIM AND RESEARCH QUESTIONS

Against this background, the aim of this thesis is to increase the understanding of the role of public intermediaries in the energy transition. The aim is broken down into three research question guiding this research:

RQ1: How do public intermediaries operationalize their policy mission?

RQ2: What influences the way public intermediaries operationalize their policy mission?

RQ3: How can public intermediation be improved?

To address this aim and answer the research questions, the thesis follows a mixed methods approach using municipal energy advising in Sweden as an empirical case of public intermediation in the energy transition.

## 1.3. THESIS OUTLINE

The rest of the thesis is structured as follows. Section 2 gives an overview of the streams of literature that together form the analytical framework for this research. Section 3 presents the research design and study context as well as methodological reflections. Section 4 summarizes the three appended papers and Section 5 discusses them in relation to each other. Section 6 provides concluding remarks through conclusions, implications, and the thesis ends in Section 7 with thoughts on further research avenues.



## 2. THEORETICAL FRAMEWORK

This thesis builds on the concept of intermediaries, which has been discussed within different theoretical fields, including, but not restricted to, innovation management, innovation studies, systems of innovation, sustainability transitions, urban planning, transitions management, diffusion of innovation, institutional theory, and energy research. I start by reviewing definitions and perspectives on intermediaries based on these different fields. Thereafter, I focus on three key characteristics of intermediaries, scope, organizational form, and agency. Finally, I provide a summary of the theoretical framework and the remaining gaps.

### 2.1. DEFINING INTERMEDIARIES

The intermediary concept emerged to describe actors who fulfill a brokering role between various actors within innovation processes (e.g., suppliers, adopters, and other stakeholders), as these processes required increasing interrelations and collaborations (Bessant & Rush, 1995; Carlsson & Stankiewicz, 1991; Chatterji, 1996). Intermediary actors include, for instance, consultancy firms, industry associations, research institutes, government agencies, research and technology organizations private research institutes, voluntary groups, and labor unions (Bergek, 2020; Glaa & Mignon, 2020; Hargreaves et al., 2013; Howells, 2006). There have been ongoing efforts to define intermediary roles and functions from different theoretical perspectives within the broader field of innovation studies, resulting in different streams of the intermediary literature (Caloffi et al., 2023). Below, I elaborate on eight theoretical perspectives on intermediaries that are of relevance to this thesis: innovation intermediaries, systemic intermediaries, institutional intermediaries, transition intermediaries, municipalities as intermediaries, diffusion intermediaries, and middle actors. Apart from which theoretical stream they build on, these intermediary types differ in their primary focus and who they intermediate between.

The literature on innovation management has its focus on innovation processes, mostly taking organizations, industries, or regions as units of analysis. In these contexts, an intermediary, also called *innovation intermediary*, is defined as “an organization or body that acts as an agent or broker in any aspect of the innovation process between two or more parties” (Howells, 2006, p.720). Hence, the primary focus is to facilitate innovation processes by acting in-between diverse actors. As examples of innovation intermediaries, the literature study e.g., consultants, innovation centers, science parks, and knowledge intensive business services (KIBS) (Bessant & Rush, 1995; Caloffi et al., 2023; Klerkx & Leeuwis, 2009). Typically, innovation intermediaries act on a project level, where they play a central role in facilitating bilateral relations and providing support to individual organizations (Bessant & Rush, 1995; Howells, 2006). In his seminal paper, Howells (2006) listed ten main functions of intermediaries: (1) foresight and diagnostics, (2) scanning and information processing, (3) knowledge processing and combination/recombination, (4) gatekeeping and brokering, (5) testing and validation, (6) accreditation, (7) validation and regulation, (8) protecting the results, (9) commercialization, and (10) evaluation of outcomes.

In the innovation studies literature, one large strand relates to systems of innovation (Lundvall, 1992; Nelson, 1993) and technological systems (Carlsson & Stankiewicz, 1991). This literature

addresses long-term and complex changes of systems, such as transformations leading to sustainable development (van Lente et al., 2020). There, focus is on understanding the actors, networks, and institutions that influence the development, diffusion, and use of (technological) innovations (Edquist, 2010). Scholars investigate functions of (innovation) systems, such as entrepreneurial activities, knowledge development, knowledge diffusion through networks, guidance of search, market formation, resources mobilization, and creation of legitimacy (Bergek et al., 2008), as well as system failures that “block the operation and the development of innovation systems” (Negro et al., 2012, p.3838), such as problems related to market structure, infrastructure, institutions, interactions and capabilities (Negro et al., 2012). Within this literature, *systemic intermediaries* are introduced as contributing to desired system functions and overcoming system failures, in contrast to traditional innovation intermediaries that mainly operate bilaterally (van Lente et al., 2003). Examples of systemic intermediaries include research and technology organizations (RTOs), science parks, technology parks, and providers of advisory services (Caloffi et al., 2023; van Lente et al., 2003). These systemic intermediaries play a strategic role in facilitating systemic processes by three main functions: articulation of options and demand, alignment of actors and possibilities, and support of learning processes (van Lente et al., 2003). This is operationalized by acting in-between entities in a network, in-between networks of entities, and in-between actors, networks, and institutions (Kanda et al., 2020).

Within the innovation systems literature, in particular technological innovation systems (Bergek et al., 2008), one important (and sometimes challenging) system function is the mobilization of resources, such as finance. In this context, intermediaries can facilitate this mobilization by linking the financial system with the innovation system (Polzin et al., 2016). This intermediary type has been referred to as *institutional intermediaries*, which are actors that are affiliated with, and most often funded by, governmental bodies (Polzin et al., 2016). Hence, they often have a policy mission to address (systemic) failures within innovation processes (Kivimaa, 2014; Polzin et al., 2016). Examples of institutional intermediaries include government agencies, government-owned companies, and government-initiated foundations (Kivimaa, 2014). Their primary focus is to facilitate innovation processes by intermediating between public actors (e.g., government, research organizations) and private actors (e.g., firms). This is done by intermediating in both directions: translating policy objectives (public to private) and bring forward requests and demands (private to public) (Klerkx & Leeuwis, 2009).

Another theoretical field where intermediary actors are receiving growing attention is the sustainability transitions literature. It addresses grand societal challenges, such as climate change, loss of biodiversity, and resource depletion, that call for radical changes to socio-technical systems such as electricity, heat, buildings, and mobility (Köhler et al., 2019). In this field, *transition intermediaries* are acknowledged for their role in facilitating (socio-technical) transitions (e.g., Bush et al., 2017; Gliedt et al., 2018; Kivimaa et al., 2019). Transition intermediaries encompass a wide range of actors (Caloffi et al., 2023), including, for instance, innovation funders, energy agencies, membership organizations, project developers, consultancies, and internet discussion forums (Kivimaa et al., 2020). They perform a range of activities that contribute to transitions, operating across different levels (Gliedt et al., 2018).



Kivimaa et al. (2019) have defined transition intermediaries as “actors and platforms that positively influence sustainability transition processes by linking actors and activities, and their related skills and resources, or by connecting transition visions and demands of networks of actors with existing regimes in order to create momentum for socio-technical system change, to create new collaborations within and across niche technologies, ideas and markets, and to disrupt dominant unsustainable socio-technical configurations” (Kivimaa et al., 2019, p.1072).

In the intersection between the literatures on sustainability transitions, urban planning, and transition management, scholars have highlighted that municipalities can take an intermediary role by translating national and international goals and visions to the local context (Gustafsson & Mignon, 2019; Hodson & Marvin, 2009; Hodson et al., 2013). This translation is crucial to mobilize local actors and stimulate change (Köhler et al., 2019). Given the institutional position of municipal administrations, they have the capacity to develop long-term strategies that drive transitions towards sustainability forward (Gustafsson & Mignon, 2019). Municipalities translate visions through delegating tasks to other actors or networks, forming coalitions with others, and performing local experiments (Gustafsson & Mignon, 2019). For instance, in Sweden, the national goal of providing information and advice to citizens is delegated to the municipalities in the form of the municipal energy advising service studied in this thesis (Kjeang et al., 2017).

By integrating the sustainability transitions literature with the literature on diffusion of innovation (Rogers, 2003), focus is drawn to the later stages of innovation, namely the diffusion of new (sustainable) technologies (Aspeteg & Bergek, 2020). Indeed, in order for sustainability transitions to occur, new technologies need not only be developed but also diffused in society (Elzen et al., 2004). From this point of view, *diffusion intermediaries* are defined as “individuals or organizations that act as brokers between technology adopters and other stakeholders of an implementation process (e.g. different solution providers), including (but not restricted to) brokering activities such as the transfer of goods and services, matchmaking and coordination in a many-to-one-to-one relationship” (Bergek, 2020, p.381). These are often funded by client fees and can be e.g., consultants, project developers, or retailers (Bergek, 2020). Through their activities, diffusion intermediaries play an important part in bridging the gap between technology providers and adopters, thereby contributing to the successful diffusion of innovative technologies. Hence, much like innovation intermediaries, diffusion intermediaries primarily operate on a project level. They play a significant role in facilitating individual adoption processes, which involve technology transfer and coordination efforts throughout planning and implementation phases, which, in turn, contributes to accelerating socio-technical transitions.

Lastly, the literature on energy research has also given specific attention to actors who act in-between individuals, bodies, or organizations. This research stream has its roots in the field of sociology and focuses on the relationships between the energy system and society to address how social and technical issues related to energy production and consumption interact (Sovacool, 2014). In energy research, the brokering role in-between is acknowledged as important to stimulate change, and actors playing such roles are referred to as *middle actors*

(Janda & Parag, 2013; Parag & Janda, 2014). Similar to intermediaries, middle actors are defined as actors situated in the middle, between a top (such as governmental bodies) and a bottom (demand) (Parag & Janda, 2014). Examples of middle actors in the energy context include religious congregations, building professionals, and commercial building communities (Parag & Janda, 2014). While middle actors share certain characteristics with traditional intermediaries (such as the in-betweenness and brokering function), Parag and Janda (2014) argue that the intermediary concept is too passive and does not sufficiently acknowledge these actors' agency. Instead, they advocate for the concept of middle actors to underscore their dynamic role as change agents from the middle-out. These middle actors do not only mediate between other entities, but they also actively shape outcomes and initiatives, taking on an active and influential role. It should be noted that, while this perspective views intermediaries as passive agents, other scholars emphasize the active role of intermediaries in enabling change and do not agree that the middle actor concept is different from intermediaries (Hodson et al., 2013; Kivimaa et al., 2019).

As the variety of definitions illustrates, intermediaries can be studied from different theoretical angles and perspectives. Yet, all definitions and perspectives share certain characteristics on the notion of intermediaries. For instance, all intermediaries are positioned in-between other actors which allows them to facilitate interactions between diverse parties when it is challenging, e.g., due to high transaction costs or communication issues (Howells, 2006; Kanda et al., 2020; Kivimaa et al., 2019). Further, the in-betweenness of intermediaries entails a brokering function that characterizes intermediaries, which includes three main brokering mechanisms: transfer of resources between parties, matchmaking, and coordination (Aspeteg, 2019; Spiro et al., 2013). In the operationalization of this brokering function, intermediaries engage in a range of activities encompassing provision of essential information about innovations, facilitation of the development and diffusion of knowledge, mediation between different actors in the innovation process, and guidance on securing funding and support (Howells, 2006; Kanda et al., 2020; Klerkx & Leeuwis, 2008b). Nevertheless, it should be stressed that, apart from these shared characteristics, there are indeed important disparities among the definitions of intermediaries, which are, for instance, due to the research setting and the objectives of the theoretical stream applied. For instance, the different streams of literature assign different roles to intermediaries and suppose that they intermediate in-between diverse types of actors. Consequently, there are different insights to be achieved from using different theoretical approaches when studying intermediaries.

Table 1 provides an overview of the primary focus of each theoretical stream with a particular attention to the role of the intermediary as well as the entities it intermediates between.

*Table 1. Summary of the different intermediary definitions.*

<b>Definition</b>	<b>Key References</b>	<b>Role of intermediaries</b>	<b>Intermediate between</b>
<b>Innovation intermediaries</b>	Howells (2006)	Facilitate innovation processes	Actors in the innovation process
<b>Systemic intermediaries</b>	van Lente et al. (2003, 2020)	Facilitate long-term and complex changes	Actors, networks, and institutions
<b>Institutional intermediaries</b>	Kivimaa (2014), Polzin et al. (2016)	Facilitate innovation processes by addressing (systemic) failures	Public and private actors in the innovation system
<b>Transition intermediaries</b>	Kivimaa et al., (2019)	Facilitate (socio-technical) transitions	Actors (new entrants and incumbents) and their activities, skills, and resources
<b>Municipalities as intermediaries</b>	Gustafsson & Mignon (2020), Hodson & Marvin (2009)	Translate national and international visions and goals to the local context.	Different levels of the (innovation) system.
<b>Diffusion intermediaries</b>	Bergek (2020)	Facilitate adoption of new (sustainable) technologies	Adopters and input providers
<b>Middle actors</b>	Janda & Parag (2013), Parag & Janda (2014)	Promote (social and socio-technical) change	'Top' and 'bottom' level actors

In this thesis, I draw from all the above streams to study intermediaries from different perspectives in the context of energy transitions. Combining insights obtained from these diverse perspectives provides the opportunity to shed light on new aspects of public intermediaries in the large-scale diffusion of solar PV, such as why they choose certain activities instead of others. Consequently, I follow the suggestion of Caloffi et al. (2023) of considering the literature on innovation intermediaries as a single field with common theoretical underpinnings and an increasingly homogeneous language.

## 2.2. KEY CHARACTERISTICS OF INTERMEDIARIES

There are certain key characteristics employed to describe and classify the large variety of intermediaries that are common regardless of theoretical lens. For instance, intermediaries can be characterized based on their scope of action and whether they are public or private (Mignon & Kanda, 2018). These characteristics have been shown to influence the roles and activities the intermediaries undertake (Bergek, 2020; Kivimaa et al., 2019; Klerkx & Leeuwis, 2008a, 2008b; Mignon & Kanda, 2018; Stewart & Hyysalo, 2008). Apart from organizational characteristics, some scholars also address individual characteristics of intermediary actors, particularly by considering the individual agency of these actors as well as its impact on intermediary activities (Duygan et al., 2019; Farla et al., 2012; Upham et al., 2020). Below, these three characteristics are explained in more detail.

### 2.2.1. INTERMEDIARIES' SCOPE OF ACTION

In the literature, intermediaries are often characterized with regard to their scope of action, i.e., whether they are active at a project level or a system level (Kivimaa et al., 2019; Mignon & Kanda, 2018). Depending on their scope, the intermediaries address different challenges which, in turn, require different types of activities.

At a project level, intermediaries address challenges related to technology adoption, such as lack of resources (e.g., knowledge and experience, financial resources, physical resources, and social capital) and behavioral challenges (e.g., adoption motives, norms, values, characteristics, and strategies) (Bergek & Mignon, 2017; Jager, 2006; Mignon & Bergek, 2016a; Palm, 2017; Palm & Tengvard, 2011). They provide customized support to actors and individual organizations, by providing information and knowledge or by brokering between suppliers and adopters (Aspeteg & Bergek, 2020). The adopters face different challenges along the adoption process, hence, different intermediary activities are required and expected (Glaa & Mignon, 2020).

In the literature on innovation adoption, the adoption process is commonly divided into three phases: pre-decision, decision-making, and post-decision (Glaa & Mignon, 2020). These phases include the steps of knowledge and persuasion in the pre-decision phase, decision in the decision-making phase, and implementation and confirmation in the post-decision phase (Rogers, 2003).

In the pre-decision phase, adopters become aware of an innovation and seek information, knowledge, and opinions about it in order to create their own view (Rogers, 2003). Consequently, intermediaries help the adopters to identify and create opportunities for adoption, select relevant information, and support demand articulation (Glaa & Mignon, 2020; Klerkx & Leeuwis, 2008a). In the decision-making phase, adopters decide whether or not they adopt the innovation, and, if so, design their investment (Rogers, 2003). Here, intermediaries support the adopters by providing business and investment support, facilitating networking, and providing or facilitating access to funding (Glaa & Mignon, 2020). In the post-decision phase, adopters implement the innovation and start using it, but their lack of knowledge and expertise about the innovation may hamper the process. Hence, intermediaries provide or coordinate expertise about the innovation, train adopters on how to use it, and adapt the implementation to fit adopters' needs (Glaa & Mignon, 2020). For intermediaries facilitating adoption processes, it is important to have a local anchoring, especially in the early stages of adoption (Darby, 2020). This allows the intermediaries to build the legitimacy and capacities required to support adoption effectively (Bush et al., 2017).

In contrast, intermediaries active at a system level target systemic actors such as municipalities or policymakers, helping with articulating needs and options, aligning relevant actors and supporting learning processes (van Lente et al., 2003). They address systemic challenges that may hamper adoption, such as institutional, market structure, infrastructure, interaction, financial, and capability challenges (Jacobsson & Bergek, 2004; Mignon & Bergek, 2016b; Negro et al., 2012). Institutional challenges encompass formal and informal rules that can slow down diffusion, including shifting legislation and subsidies, as well as issues related to legitimacy and opposition. Market structure challenges arise when existing markets favor incumbent actors and technologies, thus inhibiting the entry of new technologies. Infrastructure challenges involve deficiencies in physical and knowledge infrastructure, such as gaps in electricity grids and knowledge transfer between academia and industry. Interaction challenges

emerge when interactions between actors in the system are either too weak, limiting knowledge exchange, or too strong, potentially excluding new actors. Finally, financial challenges relate to the initial investment-return gap and access to capital, while capability challenges involve a lack of competence and resources among various actors in the innovation system.

In these contexts, intermediaries can lower systemic challenges, in particular institutional, infrastructure, and interaction challenges, through their brokering role between actors, networks, and institutions of the system (Negro et al., 2012; van Lente et al., 2020). They help articulating options and demand, align relevant actors, and support learning processes (van Lente et al., 2003). Further, by coordinating collaboration of networks, they contribute to the creation of system structures, acting as system builders (Musiolik et al., 2020).

While intermediaries often have a main scope, it can be hard to draw a clear line between the actor and system levels in their activities. Often, there are overlaps between project- and system-oriented intermediaries, where for instance project-oriented intermediaries perform activities directed at the system level and vice versa (Mignon & Kanda, 2018). As a result, a clear overview of activities that are performed at each level is lacking.

### *2.2.2. PUBLIC AND PRIVATE INTERMEDIARIES*

In the literature, intermediaries are often characterized based on whether they are public (e.g., government agencies, and research and technology organizations), private (e.g., consultancy firms, industry associations, and private research institutes), or non-for-profit (e.g., voluntary groups, professional associations, and labor unions)<sup>1</sup> (Bergek, 2020; De Silva et al., 2022; Intarakumnerd & Chaoroenporn, 2013). Different studies make this distinction based on the source of funding of the intermediaries in focus, their organization form, or their mode of governance (Mignon & Kanda, 2018). Public intermediaries are usually partially or fully funded by governmental budgets, which often entails a requirement to fulfil specific policy missions (Mignon & Kanda, 2018; Rossi et al., 2022). In contrast, private intermediaries are typically for-profit organizations that charge fees for their services (Klerkx & Leeuwis, 2008a; Mignon, 2017). While intermediaries usually have a dominant source of funding, there are cases of public-private hybrids, for instance public intermediaries that obtain private funding from shareholders, or private intermediaries that receive public support through e.g., subsidies (Klerkx & Leeuwis, 2008b; Mignon & Kanda, 2018). The source of funding typically aligns with the intermediaries' organizational form (e.g., public organization or limited company) and governance structure (i.e., who decides what the intermediaries should do). However, there are exceptions where for instance public intermediaries can adopt a profit-orientated approach or private intermediaries may be established by a public actor to fulfill a policy mission (Kivimaa, 2014; Mignon & Kanda, 2018). Whether an intermediary is public or private has consequences on what activities the intermediary undertakes, its role, and behaviors, e.g., regarding driving

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<sup>1</sup> Within the frame of this thesis, only the distinction between public and private intermediaries is addressed. Non-for-profit intermediaries are excluded.

forces, prioritization, neutrality, and adopter support (Glaa & Mignon, 2020; Intarakumnerd & Chaoroenporn, 2013; Klerkx & Leeuwis, 2008a).

To start with, public and private intermediaries are assumed to have different driving forces which implies that they prioritize different types of roles and activities. While public intermediaries are seen as dedicated to public interests and free from commercial interests, private intermediaries are assumed to be profit-driven and to prioritize their own survival and growth (Mignon & Broughel, 2020; Rossi et al., 2022). The policy mandate given to public intermediaries seems to allow them to play an important long-term role in laying the foundations for transitions by establishing the knowledge and financial infrastructure and providing resources and institutional support (Fukugawa, 2018; Polzin et al., 2016). In contrast, private intermediaries are considered to focus more on short-term aspects in individual innovation processes, taking on a brokering role by promoting networking, enhancing the legitimacy of renewable energy technologies, supporting sustainable projects, and providing customer-oriented support to those interested in participating in the transition (Aspeteg & Mignon, 2019; Fukugawa, 2018; Intarakumnerd & Chaoroenporn, 2013; Martiskainen & Kivimaa, 2018).

While scholars agree that public and private intermediaries exhibit differences in neutrality, there is no clear consensus on which is the more neutral (Kant & Kanda, 2019). In this thesis, neutrality is understood as independence from public administration and politics, finance, or technology (Kivimaa, 2014). For instance, private intermediaries, driven by their business model and market position, have been said to often prioritize their survival and favor specific technologies or suppliers, even if these are not the best choice for clients or the overall system (Mignon & Broughel, 2020). In contrast, public intermediaries can be mandated to remain technology or supplier neutral as part of a policy mission (Kivimaa, 2014). However, views differ on how such policy mission impacts public intermediaries' legitimacy. Some authors argue, on the one hand, that their public nature makes them appear as 'honest brokers' since they do not have commercial interests (Landoni, 2017), while, on the other hand, others argue that the reliance on public funding can be seen as limiting public intermediaries' independence, resulting in them being perceived as biased (Kant & Kanda, 2019; Klerkx & Leeuwis, 2009).

Lastly, public and private intermediaries are seen as having different roles to play when supporting the adoption of RET (Klerkx & Leeuwis, 2008a). Since adoption processes are associated with various challenges during the different phases (pre-decision, in-decision, and post-decision), intermediaries are expected to provide different support activities at different times of the adoption (Glaa & Mignon, 2020). Public intermediaries are described as better suited for more active involvement in the early adoption phases (i.e., pre- and in-decision), performing tasks like providing general information, facilitating demand articulation, and fostering networking (Klerkx & Leeuwis, 2008a). In contrast, private intermediaries are suggested to be more suited for the in- and post-decision phases, where they can support adopters in designing and implementing their investments (Glaa & Mignon, 2020; Klerkx & Leeuwis, 2008a). Due to their for-profit structure, private intermediaries typically focus on

providing services associated with the post-decision phase, where they generate their revenue through activities like project management and installation (Glaa & Mignon, 2020).

While different intermediaries play different roles in transitions, scholars emphasize how intermediaries' capacities are part of dynamic ecologies of intermediaries (Barrie & Kanda, 2020; Hyysalo et al., 2022; Kivimaa et al., 2019). An ecology of intermediaries is defined as "comprising intermediaries and other actors with different competencies, goals, and interests, who operate at different levels of the system across a broad geographical scope" (Soberón et al., 2022, p.126). By studying intermediaries from an ecology perspective, attention is brought to the relations between different intermediaries and intermediation processes in a given context, not only particularities of individual intermediary organizations (Soberón et al., 2022). Within an ecology of intermediaries, intermediaries may both complement and compete with each other (Nordt et al., 2023). While gaps should be avoided or filled, overlaps between public and private intermediaries are also unwanted as it may result in ineffective use of public funding, and risk undermining the function of public intermediaries (Glaa & Mignon, 2020; Hyysalo et al., 2022). Hence, some scholars stress the need for periodic assessment of ecologies of intermediaries to correct such gaps and overlaps (Hyysalo et al., 2022), thus ensuring sufficient support to the heterogeneous group of adopters while avoiding redundancy. Consequently, an ecology of intermediaries allowing for different intermediaries to assume distinct different roles, may contribute to more effective use of available resources, such as time and money (Fukugawa, 2018; Glaa & Mignon, 2020; Kivimaa et al., 2019).

In sum, the previous literature has contributed with a better understanding of differences between the roles and activities undertaken by public and private intermediaries, but some unclarities remain. While previous empirical research predominantly focused on private intermediaries (Aspeteg & Bergek, 2020; Mignon & Broughel, 2020), recent research on public innovation intermediaries has stressed that public intermediaries are essential in optimizing the outcomes of public missions and funding while driving transformative change (Caloffi et al., 2023; De Silva et al., 2022; Rossi et al., 2022). However, these studies mainly look at public intermediaries as knowledge integrators and network builders in the early phases of innovation, and not in the diffusion phase. Further, only a few studies address how public and private intermediaries compare in specific contexts and these emphasize that public and private intermediaries have different roles to play but as it is not evident to distinguish between them, increased coordination is needed (Glaa & Mignon, 2020; Intarakumnerd & Chaoroenporn, 2013; Klerkx & Leeuwis, 2009; Mignon & Kanda, 2018). Consequently, it is important to extend the knowledge about public and private intermediaries to ensure that they complement each other and not outcompete each other (Fukugawa, 2018). In the frame of this thesis, the spotlight is thus directed at public intermediaries supporting innovation adoption, and their characteristics in relation to private intermediaries.

### *2.2.3. AGENCY OF INDIVIDUAL INTERMEDIARIES*

In addition to the previously mentioned characteristics which focus on differences between intermediary organizations (e.g., institutes, companies, and administration), characteristics of individual intermediary actors also seem to influence roles and activities. Apart from seeing

intermediaries as entities providing certain services (Backhaus, 2010), some scholars address the variation between individual actors within intermediary organizations and call for increased attention to the role of individual actors in transitions (Bögel et al., 2022; Bögel & Upham, 2018; De Haan & Rotmans, 2018; Farla et al., 2012). As a result, there is an emerging interest in the agency of individual intermediaries (Duygan et al., 2019; Selviaridis et al., 2023; Talmar et al., 2022).

Agency refers to “the subjective experience and resulting actions of single persons” (Bögel et al., 2022, p.172). It involves the ability to act intentionally, instead of only reacting to external influences (De Haan & Rotmans, 2018, p.278). Intentional actions stem from beliefs and desires of the actors themselves (De Haan & Rotmans, 2018), resulting in the actors pursuing strategies (Farla et al., 2012). Taking an institutional logics approach, these intentional actions and strategies are referred to as institutional work, which includes activities that create, disrupt, or maintain institutions (Lawrence & Suddaby, 2006). While intermediaries are constrained by the institutional structures they are embedded in, such as systemic norms, values, rules, and networks, they are also enabled by them (Fuenfschilling & Truffer, 2014). Consequently, intermediaries still have some leeway in their decision-making to act according to their own beliefs (Farla et al., 2012).

In order to understand agency of actors in transitions, scholars turn to the literature on social psychology (Bögel & Upham, 2018). In this literature, the behaviors of individual actors are explained by elements associated with their social environment (e.g., social norms and expectations, social networks, religion, and social class) (Ajzen, 1985, 1991; Conner & Armitage, 1998) as well as elements that are intrinsic to them (e.g., knowledge, experience, beliefs, habits, cognition, norms, and values) (Wagner et al., 1999). Hence, individual decisions are influenced by both the actor’s perception of what the social environment demands (or expects) from them, and their own intentions, understanding, and expectations of the behavior resulting from the decision.

By acknowledging the fact that intermediaries have individual agency, scholars broaden the representation of intermediaries as strict policy implementers, with no or limited room for own initiatives (c.f., Parag & Janda, 2014). Instead, intermediaries have dynamic roles that change over time as a result of learning and adaptation (Selviaridis et al., 2023; Talmar et al., 2022). Consequently, individual intermediaries can drive change that is beyond the mission and objectives of their intermediary organizations (Selviaridis et al., 2023). While such changes can be beneficial for transitions, scholars also acknowledge that there are potential risks associated with intermediaries’ agency (Sovacool et al., 2020). For instance, intermediaries can cause unwanted effects by failing to perform their functions or by intentionally block processes that would be beneficial for transitions (Nordt et al., 2023; Zaunbrecher et al., 2021). Hence, intermediaries may not only facilitate transitions but they could also act as gatekeepers (Sovacool et al., 2020; Zaunbrecher et al., 2021).

In sum, it is undeniable that intermediary actors, like any other actor, have certain individual agency, which is based on different motivations and entails certain limitations (Duygan et al.,



2019; Farla et al., 2012; Selviaridis et al., 2023; Talmar et al., 2022). Therefore, understanding intermediaries' agency allows for a more nuanced perspective of how intermediaries contribute to sustainability transitions (Huttunen et al., 2021). However, given that the interest in individual agency of intermediaries is an emerging and rather understudied topic, it remains unclear how agency impacts the roles and activities of individual intermediaries, or how it shapes their roles in transitions.

### 2.3. SUMMARY OF THEORETICAL FRAMEWORK

This theoretical framework accounts for the different theoretical perspectives and definitions of intermediaries relevant in the context of energy transitions, before going deeper into key characteristics that have been, traditionally and more recently, used to differentiate intermediaries. While the main implications of these characteristics on intermediaries' activities are emphasized, there are remaining gaps that are addressed in this thesis.

First, as introduced in Section 2.2.2, public intermediaries have the potential to function as effective policy instruments in transitions. However, it is not clear how they translate their policy mission into action. While Section 2.2.1 suggests that intermediaries perform different activities at an actor versus a system level, there is no overview of what types of activities public intermediaries perform on each level to contribute to their policy mission. Without a clear understanding of what public intermediaries do, it is difficult for policymakers to assess the outcome of public intermediaries as a policy instrument.

Second, Section 2.2.3 states that public intermediaries are increasingly seen as active agents capable of driving change instead of only static policy implementers. As a result, the outcome of public intermediaries as a policy measure is not evident. However, it remains unclear why public intermediaries with a given policy mission perform certain activities and not others. While top-down and bottom-up influences are described as framing the intermediary work, the attention to middle-out factors and the role of individual agency in shaping the behaviors of intermediaries is nascent.

Third, Section 2.1 states that intermediaries have a key role to play in society and that different theoretical lenses bring attention to different aspects. However, insights from different theoretical perspectives are needed to identify particularities of public intermediaries, whose role remains unclear. In an ecology of intermediaries, as described in Section 2.2.2, the division of labor between public and private intermediaries needs to be clear to ensure that resources are used in an efficient way. Otherwise, public intermediaries may not be utilized to their full potential, which is a problem for policymakers. It is thus of interest to study how public intermediation can be improved.

To fill these gaps, this thesis focuses on how public intermediaries operationalize their policy mission, what influences this operationalization, as well as how public intermediation can be improved in relation to policy and practice. Consequently, it sheds light on the role of public intermediaries in the context of energy transitions.



### 3. METHOD

This section presents the research project within which my research is conducted, as well as the overarching research design and methods used. Lastly, I reflect on the methodological choices.

#### 3.1. RESEARCH PROJECT

During the past two and a half years, I have conducted research within the research project “Public energy advising as a policy instrument for a large-scale diffusion of solar photovoltaics – a study of the Swedish municipal energy and climate advising” which is financed by the Swedish Energy Agency [grant number 49379-1]. The project aims at adding knowledge on how public energy advising might facilitate the diffusion of solar PV. My research focuses on the first part, which is how public energy advisors function as a policy instrument, taking on the role of public intermediaries. I start with their broader role in the energy transition in paper I and II, and then zoom in on diffusion of solar PV in paper III. Another stream in the project, which I will delve deeper into in the remainder of my PhD, covers solar PV adopters’ perspective on public energy advising. This entails if and how they get in contact with public energy advisors, at what stage of their adoption process, and what they appreciate or lack in these contacts. The project started in January 2021, and I joined the project in April 2021.

The project proposal has guided my research by providing the framing and initial suggestions for studies, but the details have been modified and set along the way. While the project has a clear focus on solar PV diffusion, the first two studies have taken a broader perspective on the case of municipal energy advising in energy transitions, targeting general activities and individual agency, respectively. This has allowed for an in-depth exploration of public energy advising, thus covering the first part of the project aim. The third study returns to the context of solar PV diffusion and applies knowledge from the first two studies which is elaborated upon below.

#### 3.2. STUDY CONTEXT

The context of this thesis is the Swedish solar PV market in general and Swedish municipal energy advising in particular. In Sweden, municipal energy advisors are funded by the Swedish government, coordinated by the Swedish Energy Agency, and employed and acting at a municipal level. Sweden has a long tradition of municipal energy advising, which is a public service free of charge and commercially independent with the mission to reduce the environmental impact from energy use. The energy advising service has existed since the 1970’s and its policy mission has changed several times since then<sup>2</sup>. By providing information and advice about energy-related topics, including solar PV, to households, small and medium-sized companies, and associations, the energy advisors aim at contributing to national targets related to decreased CO<sub>2</sub> emissions and increased renewable energy investments. Since they act in-between the local and national level, broker between different actors, and operationalize national visions and policy goals of accelerating the energy transition, and since both their funding, governance, and organization form are public, they fall well within the categorization

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<sup>2</sup> See Kjeang et al. (2017) for an overview of the historical development of the service.

of public intermediaries. The Swedish municipal energy advising provides an interesting setting to study public intermediation in solar PV diffusion for four main reasons.

First, Sweden is recognized as a leading country within the energy transition (World Economic Forum, 2023). For instance, Sweden has the target of reaching 100 percent renewable energy production by 2040 (Swedish Government, 2018). While solar PV currently stands for only 0,9 percent of the electricity production, the Swedish solar PV market is rapidly expanding (IEA PVPS, 2021). Between 2010 and 2021, the total installed capacity of solar PV in Sweden grew from 10,71 MW to 1,6 GW and the number of PV system installers and retailers tripled (IEA PVPS, 2021). However, the diffusion of solar PV still needs to accelerate to meet the national targets, hence it is of interest to study how more adoption can be enabled.

Second, adopters of solar PV in Sweden have shown to be a heterogeneous group of actors (Bergek et al., 2013). The liberalization of the electricity grid in 1996 allowed for a variety of new actors to adopt renewable electricity technologies and be connected to the grid (Wang, 2006). Consequently, anyone can access the grid and become so-called prosumers (Palm, 2018). Different adopters might therefore have different motives to adopt, such as solar PV being good for the environment, interest in the technology, access to a roof suitable for solar PV production, or the potential for economic revenues or energy cost reductions (Bergek & Mignon, 2017). This implies that intermediaries need to provide a wide range of support activities to cater to the varying demands and needs of these new adopters.

Third, while all energy advising projects have the same policy mission, the energy advisors are organized and operationalize their mission in different ways. The energy advising service is organized in a project form (2-3 years) where the amount of funding depends on the population size of the municipality or municipalities in the project. Each project must have at least one half-time position to be granted funding. Hence, municipalities organize their energy advising projects in different ways, from one part-time advisor in one municipality (combined with another municipal or regional position) to a group of advisors in a cluster of municipalities, and everything in between (Eriksson & Kjeang, 2021). As of June 2023, there were 186 advisors distributed over 118 (groups of) municipalities, covering 288 out of Sweden's 290 municipalities. The advisors are given some leeway in operationalizing their mission to account for local specificities and preconditions. Moreover, the advisors collaborate on a regional basis, in networks managed by regional energy offices. Hence, the advisors can share experiences and best practices between each other, as well as support each other. Lastly, the project form of 2-3 years implies ample improvement opportunities to the energy advising service, indicating a strong empirical relevance for research on improving the service.

Fourth, the municipal energy advising provides access to detailed and comprehensive data. Municipal energy advisors regularly write reports to inform the Swedish Energy Agency about their activities, and all advising projects require a final report as a prerequisite for obtaining funding for the next project period. Further, the advisors collaborate in regional networks, and they have a national channel to pose and answer questions among each other. Studying Swedish municipal energy advisors is thus facilitated by a large amount of reliable data.

While this study context is specific to Sweden, the use of public energy advising as a policy instrument is not a unique Swedish phenomenon. Indeed, following the Renewable Energy Directive (2009/28/EC) and the Energy Performance of Buildings Directive (2018/844/EU), all member states in the European Union are required to provide citizens and organizations with adequate advice on renewable, energy efficient options. While the member states may operationalize this energy advising as they want, several countries have, like Sweden, chosen to employ local energy advisors to provide such services, e.g., Austria, Belgium, Denmark, France, Germany, Greece, and Portugal. Other types of organizing include hotlines, national advising boards, and private advisors.

### 3.3. RESEARCH DESIGN

This thesis takes a mixed-methods approach, combining qualitative and quantitative methods, which provides the possibility of triangulating and elaborating findings, as well as using the results from early studies to develop later studies (Greene et al., 1989). A sequential exploratory strategy was chosen where data was first collected and analyzed qualitatively and the results were built upon by quantitative data collection and analysis (Creswell, 2003). Within the research field of sustainability transitions in general and intermediaries in particular, most empirical studies are based on qualitative methods and there is a call for diversification of methods (Köhler et al., 2019). Hence, the mixed methods approach provides the opportunity to first delve deeper into public intermediaries qualitatively and then test resulting assumptions quantitatively.

Further, this thesis can be seen as a case study, with the overarching case being municipal energy advising in Sweden (as described in Section 3.2). The case study allows for in-depth understanding of the case which is suitable for the exploratory aim of the thesis (Eisenhardt, 1989). It should be noted that the individual energy advisors are spread over municipalities and have different organizational belongings. This provides the possibility to compare and contrast individual energy advisors and hence to understand the large variation within the advisor group and to explore both the activities performed by individual advisors and their aggregated role as a policy instrument.

Based on this research design, I wrote three papers that are based on different methods. Table 2 provides an overview of which methods were used in each paper. The following sections present these different methods in more detail.

Table 2. Overview of methods used in each paper.

<b>Paper</b>	<b>Purpose of the paper</b>	<b>Method for data collection</b>	<b>Method for data analysis</b>	<b>Research questions addressed</b>
<b>I</b>	Provide an overview of the activities performed by public energy advisors in Sweden and to explore the roles that they play in the transition to a sustainable energy system.	Secondary data (advising reports)	Thematic analysis	RQ1, RQ3
<b>II</b>	Increase the understanding of what influences the behaviors of institutional intermediaries when operationalizing and translating their policy missions into action.	Semi-structured interviews with municipal energy advisors	Thematic analysis	RQ1, RQ2, RQ3
<b>III</b>	Examine similarities and differences between public and private intermediaries in their support to adopters of solar PV.	Online survey to municipal energy advisors and solar PV installers.	T-tests	RQ3

### 3.4. QUALITATIVE METHODS

In the first phase of my research, I used qualitative methods to explore the case of municipal energy advising and obtain an in-depth understanding of it. The qualitative data was collected in two ways: (i) secondary data in the form of reports, and (ii) semi-structured interviews.

The secondary data was collected in spring 2021 and consisted of 129 activity reports from the municipal energy advisors for the project period 2018-2020. The reports describe how the funding was used by describing activities and results for the project period to the Swedish Energy Agency. All reports followed the same template from the Swedish Energy Agency and handing them in is mandatory to obtain funding for the next project period. Hence, the 129 reports cover the whole cohort of energy advisors in Sweden during that period.

The semi-structured interviews were conducted between April and September 2022. 22 municipal energy advisors were interviewed, one from each region in Sweden, except the capital region where two advisors were interviewed. The advisors were purposefully selected to account for potential differences due to demographic characteristics (e.g., gender, educational background, and experience) and the geographical context of the respondents (e.g., organization form of their energy advising projects, number of municipalities in their projects, and rural or urban areas). This type of purposive sampling is common to obtain sufficient data that allows for rich descriptions of the studied phenomenon (Onwuegbuzie & Collins, 2007).

Table 3 presents an overview of the demographics and geographical context of the respondents. To ensure anonymity of the energy advisors, the regions to which they belong are not reported as some smaller regions only have a few energy advisors. Instead, the municipalities are divided into rural, urban, or metropolitan types to reflect the geographical context.

*Table 3. Demographics and geographical context of the respondents (adapted from Paper II).*

Energy advisor	Gender	Educational background	Experience as advisor (years)	Other employments within the municipality	Number of municipalities in advisory project	Type of municipality
1	Male	Energy analytics	5	-	1	Urban
2	Male	Engineering (heat and power)	12	Internal advising (10%)	3	Rural
3	Male	Biology + environment and health protection	7	-	1	Rural
4	Female	Environmental science	12	-	1	Rural
5	Male	Energy technology	7	-	1	Rural
6	Male	Engineering (power)	6	Environmental strategist (50%)	5	Rural, urban
7	Female	Energy efficiency in buildings	0,5	-	2	Rural
8	Female	Agronomy	7	Environmental strategist (50%)	4	Rural
9	Male	Electrician, environmental technology	8	Environmental inspector (50%)	2	Rural
10	Female	Environmental science	5	-	5	Metropolitan
11	Female	Environmental science	11	Sustainability coordinator (50%)	1	Urban
12	Female	Environmental science	2	Other advising-related projects (50%)	5	Urban, rural
13	Male	Energy technology	8	-	1	Urban
14	Male	Energy engineering	0,5	Consumer guidance (50%)	1	Urban
15	Male	Energy technology	15	-	1	Urban
16	Female	Engineering (energy and environment)	12	-	6	Urban, Rural
17	Male	Engineering (energy)	4,5	Municipal projects (close to energy advising) (50%)	1	Urban
18	Male	Agronomy	5	Retired (50%)	1	Urban
19	Male	Engineering (energy and industrial economy)	5	-	1	Metropolitan
20	Male	Engineering (mechanical and energy systems) + teacher (STEM)	11	-	5	Urban
21	Female	Engineering (industrial economy)	8	Sustainability strategist (50%)	1	Urban
22	Male	Engineering (energy systems)	0,5	Other energy projects (50%)	2	Urban, rural

The interview guide was based on the secondary data and contained questions about operationalization of the advisors' tasks, planning and prioritizing, municipal organization, networks, as well as drivers, barriers, and enablers in their work. The semi-structured format allows for flexibility and elaboration on topics arising during the interview while remaining

within the frame of the research topic to enable comparisons between the respondents (Bell et al., 2018). One interview was conducted face-to-face whereas the others were digital. The interviews lasted between 45 min and 2 h 45 min and were recorded and transcribed.

The main analysis method used to analyze the qualitative data was thematic analysis which was performed using the coding software NVivo. In thematic analysis, the data is categorized into themes in an inductive and iterative process (Bryman & Bell, 2015). For the document data, the analysis followed the Gioia methodology (Gioia et al., 2013), which takes a systematic approach to generating new concepts and ideas through thematic coding, thus aiming to enhance the qualitative rigor. This entails analyzing the data in three steps. First, the data was coded exploratively to generate a large number of first-order concepts based on the research question being pursued. Second, patterns were identified among these concepts by identifying contrasts and replication. This allowed for categorizing the concepts into a fewer number of second-order themes. Here, an abductive approach was used to match the themes with literature (Dubois & Gadde, 2002). Lastly, the coding was further refined to obtain aggregate dimensions of the second-order themes. The result is a data structure that graphically represents the progress of the analysis (Gioia et al., 2013).

For the interview data, a cross-case method approach was further used, using each individual advisor as a case (Eisenhardt, 1989). As a first step, the data was analyzed thematically to identify patterns in (i) the respondents' advising behaviors and (ii) influences affecting their work. In the second step, these patterns were applied to each case to identify the main behaviors and influences. This allowed for assessing the uniqueness of the different behaviors and testing the link between the behaviors and the influences, thus increasing the rigor of the method.

### 3.5. QUANTITATIVE METHODS

While the qualitative methods allowed for an increased insight into the how and why behind the operationalization of public intermediaries, quantitative methods were used to compare public and private intermediaries by testing assumptions about how they differ.

The quantitative data was collected through an online survey to (i) municipal energy advisors and (ii) solar PV installers at Swedish solar firms that support adopters in their investment processes. In order to construct the survey, previous empirical research on intermediaries in innovation and transitions was reviewed to identify common assumptions about similarities and differences between public and private intermediaries (see Section 0 and Paper III). The identified assumptions were operationalized into four categories of items: driving forces, neutrality, perceived strengths, and scope. The items were five-point rating scales of unipolar types, ranging from "To a low extent" to "To a high extent" (or similar wording, depending on the question). To reduce the risk of common method bias, some items were reverse-scored (Podsakoff et al., 2003). Table 4 presents an overview of the survey items.



Table 4. Item structure for the survey to public and private intermediaries (adapted from Paper III).

#	Theoretical concept	Item	Adapted from references
1	Driving forces	Maximize tailored advise	Mignon & Broughel (2020)
		Maximize client satisfaction	
		Maximize number of clients	
		Maximize number of installations	
		Maximize profitability	
2	Neutrality	Maximize own learning and development	Bankel & Mignon (2022)
		Degree of influence on client's choice of technical solution	
		Degree of influence on client's choice of solar PV product	
		Degree of influence on client's choice of service provider	
3	Perceived strengths	Commercially independence	Aspeteg & Mignon (2019)
		Price competitiveness	
		Process rapidity	
		Content of the service package	
		Location	
		Relevant expertise and experience	
		Legitimacy and recommendations	
4a	Scope: Adopters' decision process	Commitment	Glaa & Mignon (2020)
		Service quality	
		Clients without previous intention to adopt	
		Clients considering adoption of	
		Clients with intention to adopt	
		Clients that have decided to adopt	
4b	Scope: Adoption support	Clients that have adopted and need further support	Aspeteg & Mignon (2019), Bergek (2020)
		Clients that have adopted and want to make a new investment	
		Provide general information and education	
		Provide design and installation support	
		Provide investment support	
		Provide technological support	
4c	Scope: breadth	Provide administrative support	Bergek (2020)
		Provide behavioral support	
		Perceived capability to answer clients' questions	
		Also provide support about energy efficiency	
		Also provide support about EV and charging	
		Also provide support about energy storage and batteries	
		Also provide support about heating systems and ventilation	
Also provide support about buildings, insulation, and renovation			
Also provide support about lighting			
Also provide support about steering electricity consumption			

In addition to the theoretically driven items in Table 4, the survey also included background questions pertaining to the respondents' position, experience, and adopter contact. Furthermore, it incorporated some open-ended follow-up questions to provide opportunities for respondents to clarify or elaborate on their responses. All in all, the survey covered 20 questions. Two versions of the survey were created to match the terminology for the public and private intermediaries of our sample.

Given that the survey was based on qualitative assumptions rather than previously validated constructs and items, pretesting of the survey was done in iterations to increase the validity and reliability (Hox, 2008). First, the face validity, i.e., whether the survey measures what it is supposed to measure, was assessed using input from a small group of academics and professionals with expertise in the area. Second, a pilot testing of the survey was conducted with five representative respondents, belonging to either respondent group. They were professionals with great insight into the topic but not part of any of the sample frames, as to not waste potential respondents. Focus was on the test respondents' understanding of the questions to improve them before the final version (Hox, 2008).

The survey was sent out to the two respondent groups in June-November 2023. For the public intermediaries, the total sample was 186 municipal energy advisors distributed over 118 (groups of) municipalities in Sweden, covering 288 out of 290 municipalities in Sweden. The municipal energy advisors were accessed via regional development managers at the fifteen regional energy offices in Sweden. The regional development managers coordinate regional networks of energy advisors and keep up-to-date mailing lists of the advisors. The survey to the municipal energy advisors was available for responses in June-July 2023 with one reminder in the middle, and the response rate was 49% (91 out of 186). For the private intermediaries, the sample size was less defined as there was no evident way of accessing all solar PV installers in Sweden. The survey was first sent in June via a weekly newsletter from the Swedish Solar Energy Association, reaching 2700 people employed at member companies. The introduction to the survey was adapted to attract interest from solar PV installers. With the number of responses after a month including one reminder was very low, a second round was performed in August-September 2023 using a Facebook group dedicated to solar PV installers, with the hope that the low response rate in June was due to pre-vacation workload. However, even after one reminder, this second round only attracted a few more respondents. A third try was done in October 2023, again via the Swedish Solar Energy Association's newsletter but with a revised introduction to the survey. After these three rounds, only sixteen responses were collected. Therefore, a fourth round is currently undergoing (November 2023) where we create a sample frame by directly contacting relevant firms from Swedish Solar Energy Associations' member list.

Nonresponse bias will be assessed by doing a comparison between early and late respondents. Such extrapolation methods are based on the assumption that late respondents are more like non-respondents than early respondents (Armstrong & Overton, 1977).

As the quantitative data collection is still ongoing, no quantitative analyses have been performed. When the data is complete, the individual items of the two respondent groups will be compared by using independent samples t-tests.

### 3.6. REFLECTION ON METHODOLOGICAL CHOICES

As both qualitative and quantitative methods were new to me when starting my PhD, I have spent a lot of time reflecting on my (methodological) choices while learning more about them. In this section, I first reflect on my view on ontology and epistemology as this has been highly prevalent during my first years as a PhD student. Thereafter, I address the research quality as well as impacts from being in a normative research field.

Having a chemical engineering background, I have been imposed a positivistic view of knowledge where research is objective and aims to find the current version of truth. Since this research project belongs to social sciences, I struggled in the beginning to grasp how research is done in that field. PhD courses on theory of science helped me understand that the view in which I was trained was only one way of viewing research, and that there are other ways that are more suitable when studying social phenomena, such as socio-technical transitions. Hence, I have adopted a more interpretivist approach, looking at how individuals make sense of the world around them. While positivism aims for objectivity and generalizability, interpretivism takes a more subjective approach by taking social action into account (Bell et al., 2018). In my research, I assume that adopters are strongly affected by their surroundings and that it is of importance to acknowledge their individual needs and motives when assessing the impact of intermediation directed towards them. I also assume that the intermediaries are individuals that are influenced by the environment in which they work and that their motives and foci vary.

Further, I have reflected on the quality of the research I have conducted so far, which has mainly been qualitative as the quantitative data collection is still ongoing. Assessing the quality of qualitative research is important, but not always evident (Grodal et al., 2021). One common way of assessing quality in qualitative research is to address its trustworthiness in terms of credibility, transferability, dependability, and confirmability (Lincoln & Guba, 1985).

*Credibility* refers to how believable the findings are, i.e., that the research is trustworthy and results in a reliable account of the studied phenomenon (Bryman & Bell, 2015). In this thesis, this was addressed through the different qualitative methods, enabling triangulation between data obtained from them. With the 129 activity reports and 22 interviews, many perspectives were obtained, enabling a more robust understanding of the various aspects of public intermediation. Moreover, the credibility in the document analysis was enhanced by the use of the Gioia methodology (Gioia et al., 2013) that was specifically developed to enhance the rigor of (grounded) qualitative analysis.

*Transferability* relates to the degree of generalizability of the findings. This is a balancing act for all qualitative research, where the aim most often is to obtain depth at the expense of generalizability (Lincoln & Guba, 1985). Given that my research strives for an in-depth understanding of the various aspects of public intermediation in the context of Sweden, the

transferability will inevitably be lower than if I covered multiple contexts. However, insights from my research can still be useful for public intermediation in similar settings.

*Dependability* refers to the consistency between data, analysis, and conclusions. This is addressed through systematically describing all parts of the research methodology as well as testing my research output on academic conferences and seminars. Further, the dependability is highly stress tested in the publication process and its peer reviews.

Lastly, *confirmability* concerns the objectivity of the researcher in conducting research and interpreting the data (Bryman & Bell, 2015). The confirmability is strengthened by close collaboration with my co-author, especially in the coding processes where we started to code individually and thereafter compared and aligned the coding strategies to reduce individual biases.

A last reflection is that my research is of a rather normative character, and this influences what methods I use and which conclusions I draw. The sustainability transitions field has the underlying normativity of viewing the current energy system as unsustainable and that there is a need to change modes of production from fossil to renewable resources. This sense of directionality is being increasingly integrated in both the transitions literature and policy-making, not the least through mission-oriented innovation policies that aim at achieving specific objectives and to respond to grand challenges in society (Mazzucato, 2018). However, I do not engage in academic discussions on directionality. Instead, I only acknowledge that my research is normative and based on the assumptions that an increased diffusion of solar PV is desirable for a more sustainable energy system, that there is a possibility to increase the adoption of solar PV in society, and that adoption can be facilitated and enabled by improving public intermediation.

## 4. SUMMARY OF APPENDED PAPERS

This section summarizes the three papers included in this thesis that are all co-authored with my main supervisor, Ingrid Mignon. Paper I was published in *Energy Policy* in March 2023 after two rounds of revision. Ingrid is the first author and took the lead in problematization and conceptualization as well as driving the process. I did the main data collection and analysis and took the lead in the presentation of the data. We wrote the discussion and answers to reviewers together. Paper II was submitted to *Technological Forecasting and Social Change* in June 2023, and as we contributed equally, the author list is in alphabetical order. I took the lead in problematization, data collection, and presentation of the data. Ingrid was in charge of the conceptualization, and we collaborated in data analysis and discussion. Paper III is a work in progress, where I am the first author of paper III, taking the lead in developing the paper. While Ingrid stands for problematization, I have taken the lead in conceptualization, data collection, and preliminary analysis. The data collection is not yet finalized, as presented in Section 3.5. Nevertheless, an early draft was presented at the IST conference in Utrecht, Netherlands, in August 2023. Table 5 provides an overview of the papers as well as their current publication status.

*Table 5. Overview of appended papers.*

<b>Paper</b>	<b>Title</b>	<b>Status</b>
<b>I</b>	The role of public energy advising in sustainability transitions – empirical evidence from Sweden	Published in <i>Energy Policy</i> , March 2023.
<b>II</b>	Institutional intermediaries in transitions – neutral policy implementers or self-driven change agents?	Submitted to <i>Technological Forecasting and Social Change</i> in June 2023 and currently under revision.
<b>III</b>	Similarities and differences between public and private intermediaries supporting the adoption of solar photovoltaics in Sweden.	Presented at the International Sustainability Transitions Conference, 30 August - 1 September 2023, Utrecht, Netherlands.

### 4.1. PAPER I

Paper I examines the activities of public energy advisors in Sweden and their roles in the transition to a sustainable energy system. It is positioned within the energy policy literature, where public energy advising is recognized as a powerful policy instrument. However, the energy advising landscape is undergoing a shift due to evolving client demands and increasing competition from alternative advisory services. To shed light on these dynamics, we used a document analysis of municipal energy advisors in Sweden.

Our findings reveal that municipal energy advisors perform a wide range of activities that contribute in different ways to the goal of energy advising – to facilitate and stimulate actions from energy users that contribute to reduced energy consumption or increased adoption of renewable energy technologies. In the paper, we suggest a conceptualization of these activities as a multilevel sphere of influence, shown in Figure 1.

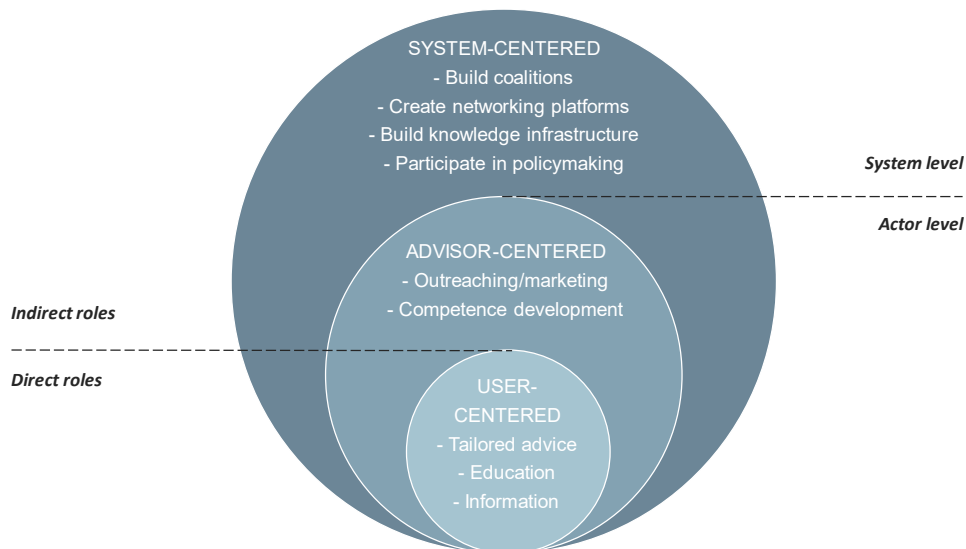


Figure 1. The multilevel sphere of influence of public energy advising activities (illustration taken from Paper I).

This multilevel sphere of influence of energy advising activities consists of three categories, i.e., user-centered, advisor-centered, and system-centered, depending on the target recipients of the activities, i.e., energy users, the advisors themselves, or the overarching energy system. The closer to the middle, the more the activities are likely to result in concrete actions from energy users. Thus, we make a distinction between direct roles, that target energy users specifically, and indirect roles, that rather increase the quality of advising or raise awareness to a broader public. Lastly, we draw a line between the actor and the system levels based on if these roles are aimed at (groups of) individual actors (e.g., energy users or advisors) or to system functions (e.g., networks and institutions).

*User-centered activities* include providing information, education, and tailored advice to the different target groups. This implies a direct role of the energy advisors as they provide the energy users with information and advice necessary for them to take action.

*Advisor-centered activities* aim to enhance the quality and legitimacy of the advising service, e.g., by outreaching and competence development. By performing these activities, the advisors can expand their impact to more energy users as well as providing them with up-to-date information and advice. These activities are performed on an actor level, with the advisors themselves as actors, and they result in an indirect role of the advisors.

*System-centered activities* connect various actors in the energy system through creation of coalitions and network platforms, building knowledge infrastructure, and participating in policymaking. This reflects an intermediary role of the energy advisors. These activities do not target individual users but instead contribute to reduced system challenges to adoption. Therefore, advisors performing system-centered activities take on an indirect advisory role.

Interestingly, these findings highlight that public energy advisors do not only perform activities targeting energy users, even though it is their main mission. Instead, they also perform activities

that are beneficial for the system, thus acting as intermediaries with the possibility to translate between the local level and policymakers.

In sum, this paper highlights the diversity in advisors' roles and activities which constitutes an important potential for policies aimed at accelerating the energy transition.

#### 4.2. PAPER II

In paper II, the Swedish municipal energy advisors are studied as cases of institutional intermediaries, i.e., actors with a formal role of implementing policies in local settings. The paper aims to understand what influences the behaviors of institutional intermediaries when they operationalize and translate their policy missions into actions. By integrating insights from literature on intermediaries, social psychology, and agency in transitions, the paper proposes an analytical framework highlighting three levels of influence on intermediary activities: top-down, middle-out, and bottom-up influences. Figure 2 summarizes this analytical framework.

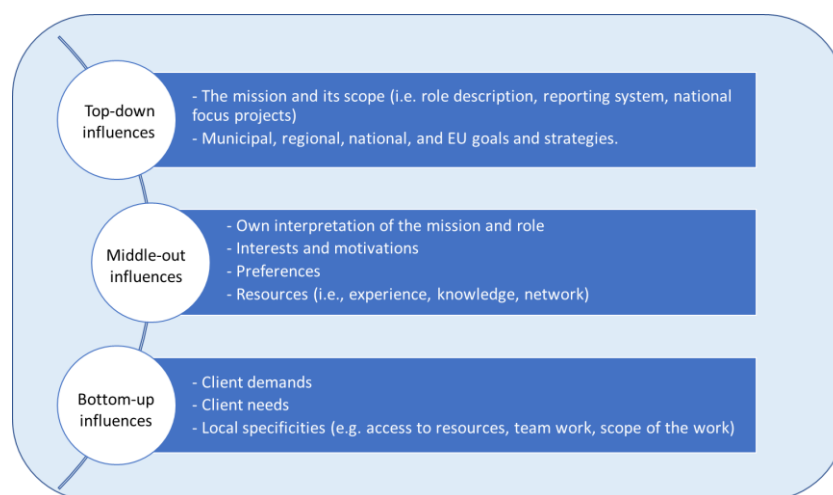


Figure 2. Top-down, middle-out, and bottom-up influences of intermediary activities (illustration taken from Paper II).

Through a cross-case analysis of 22 municipal energy advisors from across Sweden, the study identifies six distinct intermediary behaviors that represent various approaches to operationalizing policy missions. The concept of behaviors is borrowed from the literature on social psychology in transitions (Bögel & Upham, 2018; Upham et al., 2019), which emphasizes strategies and actions of individual actors in transitions. The behaviors are categorized as client-oriented, goal-oriented, expertise-oriented, experimenting, learning, and holistic behaviors. By applying our analytical framework to the different cases, we show that top-down, middle-out, and bottom-up influences have difference relevance for the different behaviors.

*Client-oriented behaviors* are expressed through personalized advice and tailored information, with a strong focus on meeting client needs and demands, primarily influenced by bottom-up factors.

*Goal-oriented behaviors* revolve around fulfilling predefined goals from stakeholders and aligning activities with top-down influences, such as rules and regulations.

*Expertise-oriented behaviors* are displayed by advisors that prioritize technical knowledge and are influenced by middle-out factors, including personal interests and preferences as well as interpreting their role as being a provider of detailed technical knowledge.

*Experimenting behaviors* involve proactive, creative approaches, with influences stemming from middle-out factors like personal interests and the interpretation of the advisors' role to continuously expand the advising impact.

*Learning behaviors* are exhibited as knowledge enhancement and legitimacy building through networking and participation in events, primarily influenced by middle-out factors, especially related to knowledge or network capital.

*Holistic behaviors* are displayed by advisors adopting a long-term perspective, seeking substantial impact on energy savings and environmental goals. The main influences are middle-out factors like interests and motivations, such as a desire to contribute to a better world.

Importantly, while advisors often tend to have one main behavior, they sometimes combine these behaviors in specific situations. For instance, being client-oriented can result in experimenting or expertise-oriented behaviors depending on which clients the advisors target. While top-down and bottom-up influences frame the municipal energy advisors' roles, it is the middle-out influences that play a significant role in shaping how they operationalize their policy missions.

In summary, paper II contributes to a better understanding of intermediaries' agency and the impact of middle-out influences. Hence, it sheds light on the varying operationalization of policy missions given to public intermediaries.

#### 4.3. PAPER III

While paper I and II focus on public intermediation in the context of the energy transition in general, paper III zooms in on the diffusion of solar PV in Sweden. It aims to examine similarities and differences between public and private intermediaries in their support to adopters of solar PV. To this end, a quantitative approach was used. A survey was constructed based on previous qualitative research on intermediaries, as well as insights from paper I and II. This survey was then sent to municipal energy advisors and solar PV installers in Sweden, as cases of public and private intermediaries. However, getting solar PV installers to respond to this survey has proven challenging, and a fourth round of reaching out is currently underway. Hence, no quantitative analyses and comparisons between the two respondent groups have been possible at this stage.

Instead, what is interesting to raise in this thesis is the development of the survey itself. While previous research on intermediaries have been mainly qualitative, scholars have encouraged other methods, not the least quantitative methods, to be able to draw more general conclusions



about differences between public and private intermediaries in their support to adopters of solar PV (e.g., Caloffi et al., 2023; Kivimaa et al., 2019; Köhler et al., 2019). From previous literature, we identified four main factors where public and private intermediaries are assumed to differ: driving forces, neutrality, perceived strength, and scope. These factors were operationalized into survey questions that were subsequently validated through expert assessment and pilot testing.

The factor *driving forces* relates to what public and private intermediaries are assumed to value the most when providing adoption support. Public intermediaries are described as being driven to contribute to the common good of society, whereas private intermediaries are assumed to strive for profitability, thus ensuring their survival and growth.

The factor *neutrality* involves how biased the information coming from the intermediaries is perceived, as one of their key functions is to filter information to make it more available to their clients. While public intermediaries can be required by their policy mission to remain commercially independent, the fact that they receive public funding may be perceived as running errands for public institutions. In contrast, the market position of private intermediaries may result in them prioritizing short-term profits at the cost of their clients' interests.

The factor *perceived strengths* involves which tangible or intangible attributes the intermediaries identify with and what they believe are important when clients choose their services. These include e.g., price competitiveness, relevant expertise and experience, and service quality.

Finally, the factor *scope* relates to where in the adoption process the intermediaries are most likely to be active and where their competences are. Public intermediaries have been described as better suited in the early phases of adoption, providing general information, creating networks, and articulating needs on behalf of adopters. In contrast, private intermediaries are suggested to be suitable for the later phases, given their capability to support adopters through designing and implementing their investments.

When finalized, it is expected that paper III will contribute with empirical insights into the differences between public and private intermediaries active in solar PV diffusion, hence answering a need in the intermediary literature. It is anticipated that this will result in an increased understanding about how to best allocate public and private resources and in more informed decisions about the design and implementation of public intermediaries as a policy instrument as well as for the business models of private intermediaries, hence contributing to more effective allocation of resources.



## 5. DISCUSSION

To better understand the role of public intermediaries in the energy transition, this thesis addressed three research questions: (1) how do public intermediaries operationalize their policy mission, (2) what influences the way public intermediaries operationalize their policy mission, and (3) how can public intermediation be improved? This section highlights important findings from the three appended papers and shows how these compare or contrast with previous literature.

### 5.1. OPERATIONALIZATING POLICY MISSIONS

First, the findings show that public intermediaries' operationalization of their policy mission differs between individual intermediaries. This is highlighted by the large variety of activities presented in Paper I, where municipal energy advisors were shown to perform both user-centered, advisor-centered, and system-centered activities, including advice, education, or information to individual energy users; outreaching or competence developing activities to strengthen the advisors themselves; and creating network platforms or participating in policymaking to reduce system-level challenges in the energy system. While the energy advising literature acknowledges user- and advisor-centered activities as direct and indirect ways of stimulating energy actions among users (Darby, 1999), the system-centered activities indicate that energy advisors also has a role to play as systemic intermediaries (van Lente et al., 2003). Altogether, these three types of activities imply that the municipal energy advisors link different levels of the energy system and contribute to changes in energy behavior among the public, resulting in their potential role as transition intermediaries (Kivimaa et al., 2019).

One surprising finding in Paper I is that many municipal energy advisors in our study devote much effort to advisor-centered activities, i.e., activities that aim to strengthen the advisory role. While continuous competence development is important to remain up to date, many also expressed a need to perform a large number of outreaching activities to make their services visible and hence increase the demand for their services. This indicates, in line with Mahapatra et al. (2011a), that the awareness of the municipal energy advising service is in general low and it varies across the country. With a low demand, the question thus arises whether the government should finance municipal energy advising at all. There are several perspectives to this question. Is the demand low because citizens do not know that they can obtain energy advising services from municipal energy advisors? Is it because the required services from the citizens are obtained from actors on the market, e.g., private intermediaries? Or is it because the services are not required, i.e., that citizens are not interested in receiving advice to change their energy behaviors and contribute to the energy transition? If the municipal energy advising fulfills a key role for citizens, but is not sufficiently known in society, increased measures are needed at a system level to raise awareness of the service. Moreover, if the lack of demand is due to competition with other actors, this indicates that there are no market failures that require the government to intervene with publicly funded advisors. Lastly, if the lack of demand is due to a lack of interest in society to engage in the energy transition, the outreaching activities of municipal energy advisors can instead be seen as a policy measure to raise the awareness of energy issues in society. For example, Palm and Lantz (2020) showed that a national information campaign about solar PV had a positive impact on solar PV adoption. To

summarize, a large number of outreaching activities does not necessarily have to indicate a failure of municipal energy advising as a policy instrument. Instead, the raised awareness of municipal energy advising can lead indirectly to an increased awareness of, and interest in, the energy transition.

Moreover, Paper II highlights that the combination of different activities result in the municipal energy advisors displaying six distinct types of behaviors: client-oriented, goal-oriented, expertise-oriented, experimenting, learning, and holistic behaviors. The concept of behaviors is borrowed from the literature on social psychology in transitions (Bögel & Upham, 2018; Upham et al., 2019), which emphasizes strategies and actions of individual actors in transitions. Hence, the behaviors are seen as an aggregation of intermediary activities. For instance, client-oriented and expertise-oriented behaviors entail a substantial extent of user-centered activities, such as tailored advising. Moreover, experimenting and learning behaviors are more associated with advisor-centered activities, with outreaching efforts to increase their legitimacy and impact. Holistic behaviors include more of the system-centered activities, such as facilitating network-building, whereas goal-oriented behaviors involve activities based on the goals to be fulfilled, such as performing a pre-determined number of seminars and advising sessions with the different target groups. While some advisors showed a clear preference for one of the behaviors, others displayed different behaviors in different situations. This goes in line with previous literature that stress the importance of considering individual actors, not just organizations, in transitions (Duygan et al., 2019; Farla et al., 2012).

The results further draw attention to both opportunities and risks connected to the different operationalization of individual public intermediaries. Starting with opportunities, the heterogeneity of public intermediaries indicates that they, through their different activities and behaviors, have the potential to cater to a varying demand from their target groups. This tailoring of their behaviors to specific situations was visible in the interviews, where some municipal energy advisors expressed the need for adapting their behaviors to suit their local context. This strengthens previous research of the importance of local energy advisors that provide tailored advice adapted to the clients (Darby, 1999; Kjeang et al., 2017). However, our results also suggest that a consequence of individual operationalizations is that not all activities and behaviors are performed in all municipalities. This entails the risk that clients may experience inequalities or lack of transparency in what services they should expect in their municipalities. As scholars have shown that there is a spatial variation in the willingness of households to engage in energy action, in particular between urban and rural areas (Halleck Vega et al., 2022), this indicates that the demand for different types of activities and behaviors in one municipality may not match with the advising services provided in that municipality. It is therefore important for intermediaries to have an up to date understanding of their clients' expectations and demands, as suggested by Aspeteg and Mignon (2019).

Finally, the preliminary results from Paper III indicate that while public intermediaries perform a wide range of activities to support adopters of solar PV, there are some activities that they might be more suited for than private intermediaries and thus should prioritize. For instance, the municipal energy advisors in the study indicated a high extent of support through general

information and support with tenders, which is connected to their commercially independent situation. This is in line with previous literature that highlight the role of public intermediaries in the pre-decision and decision-making phases of adoption (Glaa & Mignon, 2020; Klerkx & Leeuwis, 2008a). Moreover, the division of labor between public and private that Paper III addresses is in line with the emerging literature on ecologies of intermediaries (Hyysalo et al., 2022; Kivimaa et al., 2019; Soberón et al., 2022). Instead of designing the policy mission to public intermediaries for them to provide all the required support for solar PV adoption, they should be seen as one important part in a wider ecology of intermediaries. Instead, the accumulated activities of both public and private intermediaries together provide the support needed to accelerate diffusion of solar PV. Consequently, their respective roles need further attention to ensure efficient use of resources.

In sum, the results emphasize that public intermediaries do not only implement policy missions (cf. Backhaus, 2010; Parag & Janda, 2014). Instead, individual intermediaries perform different activities and display different behaviors when operationalizing their mission. The next step is thus to explain what influences this varying operationalization.

## 5.2. INFLUENCES ON POLICY OPERATIONALIZATION

This thesis highlights that there are several different influences on how public intermediaries operationalize their policy mission. Paper II shows that the activities and behaviors chosen by municipal energy advisors are impacted by top-down (e.g., policy missions, goals, and strategies), middle-out (e.g., interpretation of their mission, interest, preferences, and resources) and bottom-up influences (e.g., client demands and needs, and local specificities). For instance, top-down influences lead to goal-oriented behaviors, bottom-up influences encourage client-oriented or expertise-oriented behaviors, and middle-out influences guide the use of the other behaviors, i.e., experimenting, learning, and holistic behaviors. While previous intermediary literature has mainly focused on the importance of top-down influences (Backhaus, 2010; Gustafsson & Mignon, 2019; Kivimaa, 2014) and bottom-up influences (Aspeteg & Mignon, 2019; Heiskanen et al., 2013) in shaping the role of intermediaries, this thesis stresses the need for a broader perspective on influences. While top-down and bottom-up influences are associated with the intermediaries social environment, as suggested by e.g., Wagner et al. (1999), the findings shows that there are also intrinsic, middle-out, factors that have seemingly large impact on the policy operationalization. We therefore acknowledge the need for using social psychology and its intrinsic aspects to agency in transitions context, as advocated by Bögel and Upham (2018) and Upham et al. (2019).

The findings illustrate that middle-out influences, such as interests, preferences, resources, and interpretation of their mission, result in public intermediaries showing individual agency when operationalizing their policy mission. This adds to the emerging literature stressing the importance of agency of individual intermediaries in shaping the role of intermediaries (Duygan et al., 2019; Selviaridis et al., 2023; Talmar et al., 2022). Indeed, the results show that public intermediaries, thanks to their agency, perform activities and display behaviors that go beyond their policy mission. Several respondents expressed that their main driving force was to “contribute to a better world”, which is in line with the stream of intermediary literature

highlighting the role of intermediaries as change agents in socio-technical transitions (Gliedt et al., 2018; Huttunen et al., 2021; Kivimaa et al., 2019). However, while previous intermediary literature has mainly focused on private intermediaries and the agency they show through different business strategies (e.g., Aspeteg & Bergek, 2020), this thesis stresses that also public intermediaries are to be seen as active agents, capable of pursuing strategies.

Moreover, the thesis integrates the concepts of “agency” and “middle-out.” In their work on the middle-out perspective, Janda and Parag (2013) define middle actors as acting from the middle out with a certain degree of agency. In their definition, they see middle actors acting from the middle out as distinctly different from intermediaries, with the main difference that middle actors are supposed to have agency whereas intermediaries are suggested to only implement policies (Parag & Janda, 2014). In contrast, our results demonstrate that while municipal energy advisors do indeed act from the middle out, they are also guided by middle-out influences and thus show clear individual agency in the operationalization of their policy mission. Consequently, the findings stress that public intermediaries do not only implement their policy mission reactively, as argued by e.g., Parag and Janda (2014) and (Backhaus, 2010), but instead are active in their operationalization, influenced by both top-down, middle-out, and bottom-up factors. Hence, this contrasts with the assumption often made in the innovation policy literature that the outcome of a policy measure follows the intentions of the policymakers, i.e., only influenced by top-down factors (e.g., Haddad et al., 2022).

Finally, the results emphasize the need for further attention to the agency of public intermediaries. While top-down and bottom-up factors have indeed been shown to be important to set the frame for public intermediation, the most determining factor to the choice of behaviors and activities was shown to be middle-out influences. Consequently, it is crucial for policymakers and transition scholars to acknowledge, not only bottom-up and top-down influences on public intermediaries, but also middle-out influences, such as intrinsic motivations, experiences, norms, and values as determining for shaping their roles. Therefore, the next section deals with how public intermediation can be improved.

### 5.3. IMPROVING PUBLIC INTERMEDIATION

The findings suggest that there are several ways in which public intermediation can be improved. To start with, increased coordination within public intermediary organizations constitutes a potential way of improving public intermediation, in order to capture the opportunities resulting from a large heterogeneity within public intermediary organizations. As the different behaviors represent different strengths (e.g., expertise, knowledge, service-mindedness), all municipalities would benefit from having advisors capable of displaying the different behaviors. Hence, an increased learning between municipal energy advisors is needed to strengthen the competencies and skills of the municipal energy advising as a whole. Paper I shows that the municipal energy advisors in this thesis have regional networks where they collaborate and exchange experiences, as well as a national platform to ask each other questions, which streamlines the activities and behaviors to some extent. However, Paper II indicates that there are differences in how the municipal energy advisors interpret their role, and some advisors even express that their behaviors are the only right ones. Therefore, they may not want

to learn from their colleagues, even though there are collaboration platforms in place. Consequently, the municipal energy advising would benefit from increased coordination, with a focus on valuing heterogeneity in behaviors and learning from each other's strengths. In contrast to intermediary literature stressing the role of intermediaries in coordinating other actors (e.g., Bergek, 2020; Spiro et al., 2013), we thus argue that the intermediary actors themselves are part of what needs to be coordinated. Moreover, as introduced in Section 5.1, coordination is also needed within ecologies of intermediaries to ensure efficient use of resources from both public and private intermediaries.

Further, the policy mission to public intermediaries provides another opportunity for improvement of public intermediation. The results highlight that the policy mission of public intermediaries sets the frames within which they should operate. However, Paper II suggests that the policy mission can sometimes be limiting, such as when the municipal energy advisors are imposed activities on specific topics or target groups. While the policy mission to municipal energy advisors indeed contains a certain degree of freedom in the operationalization, some advisors express a feeling of being hindered by their mandate, for instance by having too much steering on which activities to perform (that may not be equally suitable for all municipalities) or by not being allowed to do certain things, such as recommending suppliers or solving technical issues. Moreover, other advisors voice a concern that the mandatory activities do not leave room for other activities that the advisors believe could be of significant impact, e.g., targeting groups that seldom seek advice or launch campaigns about behavioral changes. Thus, this thesis aligns with Talmar et al. (2022) who suggest that the choice of support activities should be delegated from policymakers to the intermediaries themselves. As shown in Paper II, some advisors go beyond their policy mission of providing support mainly on a project level and instead also contribute to system-level changes. To conclude, on the one hand, nation-wide advising efforts are important to improve the national coherence of the municipal energy advising services. On the other hand, these efforts should not be at the expense of individual adaptations to local conditions. Consequently, the policy missions assigned to public intermediaries should both steer towards a wanted direction and ensure sufficient freedom in operationalizing, to not miss potential benefits resulting from individual agency.

Lastly, public intermediation can be improved by regular assessment of their role to ensure that their mission, mandate, and competences are up to date. Following the historical account of municipal energy advising in Sweden by Kjeang et al. (2017), our findings show that not only does the policy mission change, but also the way advisors operationalize it. This adds to the acknowledgement in the literature of the dynamics of public intermediaries (Kivimaa et al., 2019; Talmar et al., 2022). While the results indeed show differences in activities, influences, and behaviors, these are not fixed over time. The municipal energy advisors express how they must constantly adapt to new policy missions, changes in client demands, as well as changing political landscapes, nationally and locally. This is especially visible through the holistic and experimenting behaviors presented in Paper II, that are forward-looking and proactive. However, data from both Paper I and II highlights that it can be difficult to be proactive when the project funding only covers two to three years, requiring both reporting and writing new applications between each project which takes up a lot of time. Consequently, many advisors

express difficulties in taking a long-term role, even though they would have wanted to. This nuances the assumption in the literature that public funding allows intermediaries to take on a long-term role (e.g., Mignon & Kanda, 2018). By regularly assessing the mission of public intermediaries in relation to changes in society, their role can be even more valuable in involving more actors in the energy transition, which, as stated in Section 1.1, is crucial in mitigating climate change.



## 6. CONCLUDING REMARKS

This section provides conclusions of the thesis as well as implications for policy, theory, and practice.

### 6.1. CONCLUSIONS

The aim of this thesis was to increase the understanding of the role of public intermediaries in the energy transition. This was done by addressing three research questions: (1) how do public intermediaries operationalize their policy mission, (2) what influences the way public intermediaries operationalize their policy mission, and (3) how can public intermediation be improved? Through a mixed-method approach, including data from 129 activity reports and 22 interviews with Swedish municipal energy advisors, as well as a survey to these municipal energy advisors and solar PV installers in Sweden, this thesis reached a number of results with implications for the understanding of public intermediation in the energy transition.

Regarding the operationalization of policy missions, this thesis shows that public intermediaries do this in diverse ways, which is reflected in them performing different activities and displaying different behaviors. Three types of activities were identified, namely user-centered, advisor-centered, and system-centered. These are differentiated based on their target recipients and whether they lead directly or indirectly to energy user actions. Through combinations of the performed activities, the intermediaries display different behaviors: client-oriented, goal-oriented, expertise-oriented, experimenting, learning, and holistic. Consequently, this thesis highlights that there is a large heterogeneity within the same intermediary organization.

Moreover, the thesis suggests that the heterogeneity within public intermediaries is a result of top-down, bottom-up, and middle-out influences. While top-down and bottom-up influences were indeed important for providing a frame of the advisory function, the main finding is that middle-out influences were identified as determinant for shaping the role of intermediaries. Consequently, public intermediaries do not only implement policies imposed on them, but they also show individual agency in driving the energy transition forward.

Finally, this thesis identifies three main improvement areas for public intermediation. First, increased coordination among individual public intermediaries can strengthen knowledge and experience exchange, thus making the most out of the large heterogeneity among individual public intermediaries. Further, the policy mission to public intermediaries should be designed taking the agency of individual intermediaries into account and delegate the choice of the most suitable activities and behaviors to the intermediaries themselves. Lastly, the role of public intermediaries should be regularly assessed to ensure that their policy mission, mandate, and competencies are up to date and relevant, following the inherent dynamics of the energy transition.

## 6.2. IMPLICATIONS

This thesis has implications for both policy, theory, and practice, which are elaborated upon below.

For policymakers, this thesis shows that public intermediation can indeed be an effective policy instrument in reaching current energy and climate goals and accelerating the energy transition. However, our findings highlight that public intermediaries do not only implement policies, but also drive further efforts beyond what is expected of them, due to middle-out influences. Even with a mission to act on an actor level, the public intermediaries in our case study performed activities on a system level. Policymakers need to acknowledge that public intermediaries may indeed be driven by middle-out influences, and not only top-down and bottom-up influences. Hence, the outcome of a policy mission might be different from what was initially intended by the policymakers. Moreover, the thesis suggests three areas where public intermediation can be improved in relation to policy. First, policymakers should ensure sufficient coordination within public intermediation services to maximize the benefits from a heterogeneous group of intermediaries. Second, policy missions should be designed to capture the agency of individual intermediaries, as there might be situations where the public intermediaries are more suitable for determining where to focus than the policymakers. Thus, policymakers can make the most out of the different behaviors and strategies. Lastly, policymakers should regularly assess the role of public intermediaries to ensure that the policy mission, mandate, and competencies are up to date and relevant for the current state of transitions. If not, policymakers should adjust the mission and provide competence development accordingly, to give public intermediaries the optimal prerequisites to deliver their policy mission and contribute to the energy transition.

Moreover, by understanding the intermediary activities performed by public actors, these can be compared with private intermediaries to identify gaps and overlaps in intermediation solar PV diffusion. Hence, policymakers can ensure that resources are allocated in an optimal way. If, on the one hand, public advising is shown to enhance adoption of solar PV, policymakers need to be aware of that and assure that the funding continues and is effectively used. If, on the other hand, public advising turns out to be redundant in solar PV intermediation as compared to private advisors, policymakers need to rethink the role of public advising to contribute to energy and climate goals more effectively.

For theory, this research draws attention to the role of public intermediaries in energy transitions. Above all, it emphasizes the importance of considering agency when studying public intermediaries, thus contributing to the emerging attention to agency in the intermediary literature. Through our case study on municipal energy advisors in Sweden, we provide empirical evidence on the large variation in public intermediaries' operationalization of their policy instrument. This is illustrated through a comprehensive overview of public intermediary activities, categorized into user-centered, advisors-centered, and system-centered, and a typology of public intermediary behaviors, comprised of client-oriented, goal-oriented, expertise-oriented, experimenting, learning, and holistic behaviors. Moreover, by integrating insights from social psychology and transitions, we present an analytical framework that explains how the variation in operationalization is the result of top-down, middle-out, and

bottom-up influences. This framework can be used to study intermediaries in other contexts to further extend the understanding of public intermediaries. Moreover, while the findings of Paper III are still preliminary, this research contributes methodologically to the intermediary literature by quantitatively testing assumptions of public and private intermediaries. Lastly, we stress that public intermediaries should be seen as active change agents and not static policy implementers in the energy transition.

For practice, this research highlights the intermediary role played by municipal energy advising in Sweden as well as the large variety of activities and behaviors that are performed. The categorization of user-, advisor-, and system-centered activities as well as the six different behaviors provide new ways for public intermediaries to discuss their work in relation to others. Furthermore, this heterogeneity among public intermediaries is to be considered as a strength and learning opportunity for the public intermediaries. Consequently, having this common language may facilitate coordination and increase knowledge and experience sharing. Moreover, the findings can be used to improve the ecology of intermediaries in the context of energy advising and solar PV support. For instance, the results highlight that public intermediaries have a key role to play in raising awareness of energy issues and stimulating change on a system level. To avoid gaps and overlaps, public and private intermediaries need to collaborate to ensure that they together provide sufficient support to adopters. Having a clearer labor division will also benefit potential adopters as they can more easily know who to address to get access to relevant information and advice concerning solar PV adoption. Consequently, with sufficient support services available, intermediaries may indeed contribute to an increased awareness and willingness in society to engage in the energy transition.



## 7. FUTURE RESEARCH AVENUES

As this thesis approaches its end, it is appropriate to look out for what lies ahead. With more than two years to go, there are several avenues I could take on my journey of becoming a doctor, after finishing paper III. The three main ones, that I will discuss here, are (i) taking an adopter perspective on intermediation, (ii) looking at public intermediaries in empirical contexts, and (iii) looking at other public intermediaries in Sweden.

The first research avenue is to take an adopter perspective on intermediation. While this thesis has addressed the role of public intermediaries, it has only seen it from the intermediaries' point of view. There is a lot to learn from changing viewpoints from the intermediaries to the ones receiving their services. By taking this path, I can compare my findings about intermediaries with how adopters perceive them and see whether there is a match between services provided and the demand for them. This provides even deeper knowledge about the specific case of Sweden.

A second research avenue is to apply the insights from this thesis to another empirical context with other conditions than Sweden. Given that members of the European Union are required to provide energy advising in some form, as per the Renewable Energy Directive (2009/28/EC) and the Energy Performance of Buildings Directive (2018/844/EU), it would be interesting to study another European country that has chosen a similar form of advising, such as France, Belgium, or Denmark. By applying the analytical frameworks developed in the appended papers, comparisons can be done with the Swedish case to generate further understanding of intermediary activities and behaviors. It would be interesting to see if another way of organizing the advising service affects the undertaken activities or the displayed behaviors. This avenue would contribute to strengthening the generalizability of the analytical frameworks.

A third path is to keep the context of the Swedish energy system but instead focus on other public intermediaries. One example is to study the regional development officers at the regional energy offices in Sweden, who (among other things) coordinate their regional networks of energy advisors. Hence, they have the possibility to enhance collaboration between advisors and generate further benefits for the transition of the energy system. Another example is to take an even broader perspective and look at the ecology of intermediaries active in the diffusion of clean energy technologies. Here, it is of interest to study which actors constitute the ecology, and how they are interrelated. Overall, this path can lead to new insights and other policy implications concerning public intermediation.

To conclude, there are several possible paths to take which would take my research in different directions. As an imminent next step, I will walk down the first path and explore the adopter perspective of intermediation, as this is a working package within my research project. But who knows, I might have the opportunity to pursue other avenues further ahead on my research journey.



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