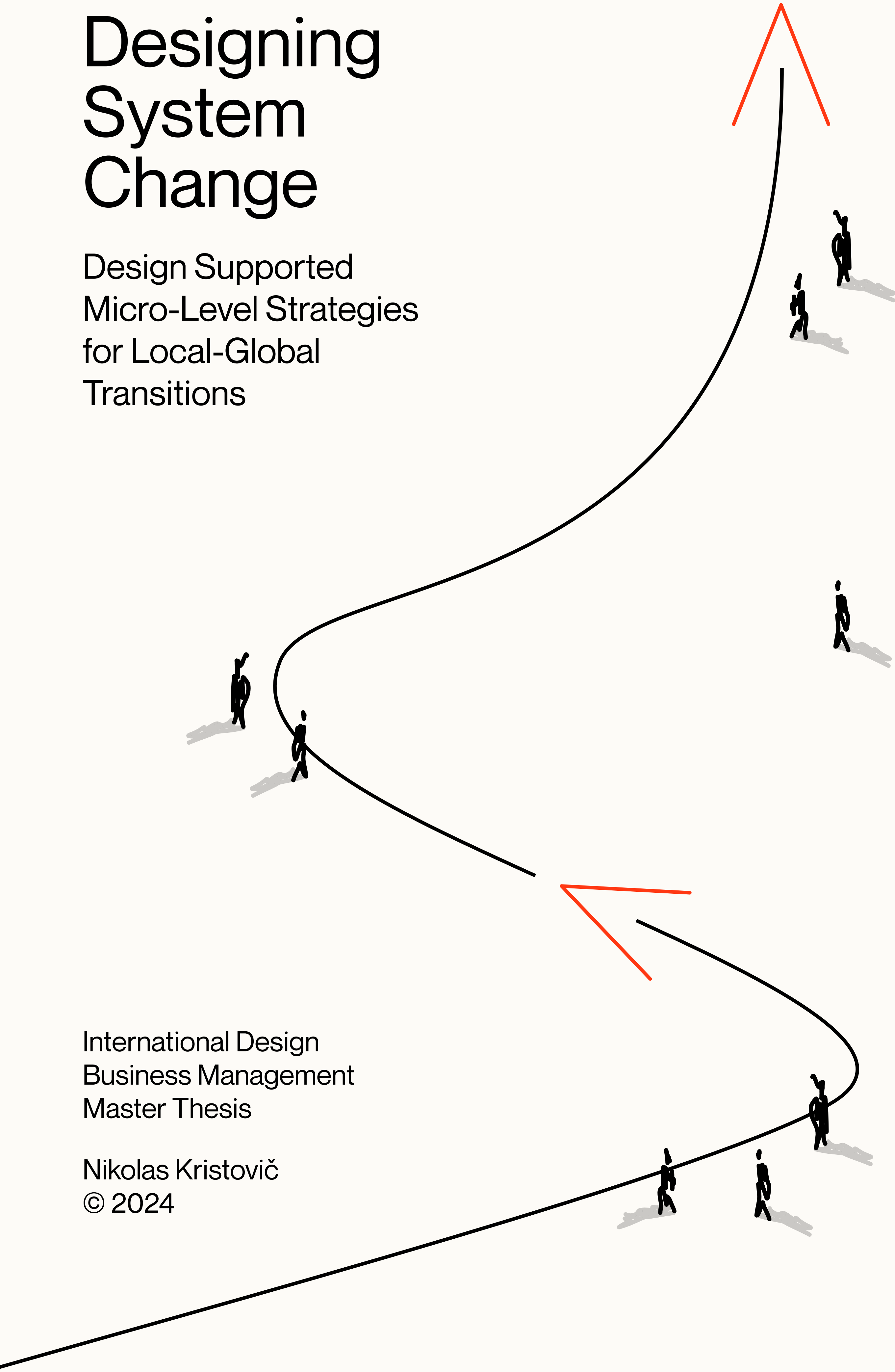
Designing System Change

Design Supported Micro-Level Strategies for Local-Global Transitions



International Design Business Management
Master Thesis

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Abstract

Implementing changes in socio-technical systems presents a prevalent challenge for society and the actors who pursue it. The system's complexity and resilience make transitioning to improved configurations, which can address its current challenges, difficult.

This study addresses this impediment by exploring the prevalent dynamics in radical multi-actor innovation efforts. It uses GLocalFlex as its focal case, covering a consortium initiative that pursues implementing a radically new energy system configuration on a Europe-wide scale. Through intensive interviews with the initiative participants and the author's observation by participation, the study provides a micro-level overview of the initiative participants' attitudes, processes, challenges, and the dynamics that link them.

Furthermore, the study analyzes strategies of two distinctive management processes, one focused on decoupled coordination while the other on design-led innovation. It highlights their value, synergies, and challenges in the initiative's context and suggests their implementation improvements.

As more resources and attention are given to international initiatives that aim to address the social and environmental sustainability challenges emerge, the study provides valuable insights on building strategies for large-scale innovation efforts.

Keywords Socio-Technical Systems (STS), Transitions, Micro-Level Dynamics, Local-Global Niches, Innovation Networks, Design Methods, Transition Intermediaries, System Resilience, Energy Systems, Multi-Stakeholder Collaboration, Strategic Niche Management, Radical Innovation, Sustainability Transitions, Consortium Initiatives, Interdisciplinary Strategies

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Preface

I extend my heartfelt thanks to my friends and family for their unwavering support throughout life's adventures. I am also grateful to my supervisor, Pauli Pakarinen, and my advisor, Prof. Peter McGrory, for their invaluable guidance during this research journey. My appreciation also goes to the GLocalFlex consortium, particularly VTT's coordination and design teams, for their mentorship throughout the initiative's processes and to the work package leads for their participation in this study. Finally, I express my gratitude to Aalto University's exceptional community of inspiring teachers and researchers, whose ideas and insights have significantly shaped the pages of this work.

Otaniemi, Espoo, 19 April 2024
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Abbreviations

STS	Socio-Technical System
MLP	Multi-Level Perspective
SNM	Strategic Niche Management
IR	Intermediary Role
WP	Work Package

Chapter 1: Introduction

Society creates and maintains socio-technical systems (STS) to fulfill its essential functions effectively. These present configurations of artifacts, actors, and processes tied together in complex interdependent webs. They are dynamic and regularly seek to adapt to the pressures of their environment (Cilliers, 2002). By learning from their failures and establishing preventive measures and rules (Burns & Flam, 1987), they continuously aim to improve their resilience.

The self-bolstering loop of an STS is typically contributive to society, as it makes the system more reliable. However, an issue emerges if the system's function stops serving society's needs or even begins to contradict them. Introducing rapid amendments, so-called band-aids, can have null effects as the system's resilience immediately ratifies them (F. W. Geels, 2004). Alternatively, it can also result in harmful outcomes, as changing one system node produces unexpected behavior in others (Saurin & Gonzalez, 2013). Thus, reconfiguring systems requires focused strategic efforts to address their complexity and resilience.

To this purpose, the research community has begun to explore the dynamics of STS and how they can be managed and changed (Köhler et al., 2019). The field diverts the focus from the then-prevalent processes of organizations to study large-scale system dynamics, producing copious approaches to address transitions. As such, the field improves the macro-level understanding of how transitions unfold STS-wide but does not provide concrete enough guidelines for transition contributors to pursue them.

Firstly, the gap exists in describing micro-level activities, where more clarity is needed in the contributor processes, roles, and strategies (Farla et al., 2012; Smith et al., 2010). Fortunately, the management approaches (Schot & Geels, 2008) suitable for niches - the local innovation environments (F. W. Geels, 2004), have begun to evolve with the conceptualization of transition intermediaries (Kivimaa, 2014). These refer to actors who carry out activities necessary for the niche's progress. By outlining their roles and corresponding activities, they present a strong baseline for further exploration of strategies that could unify them.

Secondly, most analysis within the transition field uses cases with particular national contexts and policy domains (Köhler et al., 2019). For niches to become relevant in impacting and changing the prevailing STS (Raven, 2012), they need to be successful in expanding their local networks toward global ones. As more international efforts come to life to amend the existing social and environmental sustainability crisis, the need for more exploration of micro-strategies in the context of the local-global processes becomes ever more prevalent.

Research approach and questions

This study addresses the identified gaps in the transition field by providing additional context to the micro-level local-global niche setting. It does so by analyzing the micro-level processes and structures of an international consortium initiative called GLocalFlex, which explores the implementation of a radically new energy system configuration on a European scale (GLocalFlex, 2023). Through intensive interviews with participants and observation by participation, the study documents the initiative's formation, planning, development, and outcomes, framing what micro-level dynamics exist between the initiative’s numerous diverse participants and what challenges they emerge. In doing so, it answers its first research question:

RQ1: What micro-level STS dynamics exist in local-global niches?

Further, the study contributes to the niche management practices by exploring the innovation and multi-disciplinary potential of design methods (Jones, 2018; Stickdorn & Schneider, 2012) to serve as strategies for intermediary activities. As such, it tests the value of including a design-led auxiliary effort in micro-level niche processes. By analyzing the effort’s role and outcomes, it showcases its contribution to intermediating radical, multi-stakeholder environments of local-to-global initiatives, answering its second research question:

RQ2: How do design methods intermediate micro-level STS dynamics?

Chapter 2: Socio-technical transitions and experiments

The chapter reviews existing literature and guides the reader through the study's main concepts, explaining what socio-technical systems are, how transitions within them unfold, and what micro-level processes, actors, and structures are relevant for them to do so. As such, it introduces the multi-level perspective, strategic niche management, and transition intermediaries. It concludes by drawing ties between transition's management micro-processes and the design field, highlighting its potential to unify intermediary activities under design-led strategies.

Socio-technical systems

Thinking in systems

Systems (Meadows, 1999) are created to transform a state of something into a more desirable state. Such an operation has a certain **inflow**, the resources available pre-change, and a certain **outflow**, products that emerge through the operation. What qualifies the transformation as desirable is the ability to meet the **function** or **purpose** that is given to the operation.

Since the study will later explore how to pursue change in energy systems, an energy grid is used as an example of a system. The function of the grid is to enable the use of electric appliances. The primary inflow that must be provided is energy, yet this resource isn't readily available in a state the system can use. A specialized sub-system is needed to convert thermal, solar, wind, or nuclear energy into electricity using different technologies and knowledge flows – all additional inflows. The centralized nature of the energy production system, in turn, also requires delivery to each household. The distribution sub-system takes care of that, adding to the necessary specialized inflows. Due to the nature of how electricity travels over long distances, it needs to, along the way, be converted to different voltages – a job for yet another sub-system. If all goes well, the electricity sockets in households (a component in yet another sub-system) should provide energy, which it can then be use to fulfill the desired function **-** the use of electric appliances.

What stands out is the growing number of technological processes that aid in transforming the initial inflow of energy into the final outflow, a powered appliance. These processes are enabled by various physical artifacts (such as generators, turbines, or transistors), yet the know-how in how to steer them comes from specialized knowledge and competence flows. To support these, society creates organizations (e.g., manufacturing firms, investment banks, and laboratories), scientific artifacts (e.g., books, articles), legislative artifacts (e.g., laws), and university teaching programs (Hughes, 1987). However, knowledge and competence flows not only aid the operation of the system but are also responsible for its creation. Networks of actors (that is, humans in the context of systems) use the information that these flows provide to construct, diffuse, and utilize technological processes and, in turn, create and perpetuate **technical systems** (Carlsson & Stankiewicz, 1991). The aim of which is to consistently and reliably support human needs and enhance human capabilities (Fischer & Herrmann, 2013).

Yet, what defines these human needs that technical systems should support? On their own, technical systems only describe the process responsible for transforming inflows into outflows. However, they do not address for what function or purpose the system was established in the first place. The technical systems deal with the ability to achieve the function, yet the framing of the function falls on society. It, or rather the social groups within it, decide what needs the function has to meet (F. W. Geels, 2004). They do so based on attitudes, values, knowledge, routines, relationships, rewards, and authority structures, all of which cumulate in what are known as **social systems** (F. W. Geels, 2002; Ropohl, 1999; Trancossi et al., 2021). Historically, framing of a function has been seen only in terms of selection; amongst multiple innovations, society, the users, picked and bought the innovation they preferred. However, users also play a vital role in diffusion (F. W. Geels, 2004). Through its use, users legitimize and enact technology's purpose.

Social systems also influence the structures that support the knowledge and competence flows in the technical systems. The system expresses the need for them, yet the social groups envision what organizations are created and under what principles they end up operating. It would, however, be wrong to assume that social actors ultimately govern the systems. They might be the ones who inherently (re)produce elements and linkages in the system, however, their activity is also affected by these same products (F. W. Geels, 2004). The actor's perception, behavioral patterns, and activities in (re)producing the system's structure are influenced by the existing knowledge and competence flows that support existing technical artifacts and processes. The systems in society can thus not only be framed as predominately technical or social but instead as a mutually governed combination of both - the **socio-technical system** (STS) (Fischer & Herrmann, 2013; F. W. Geels, 2004; Saurin & Gonzalez, 2013; Trancossi et al., 2021).

Characteristics and interactions

Social and technical systems are inherently different in the way they operate. Thus, when merging them, their differences' impact on STS's operations must be considered. In contrast to the consistency and reliability of technical systems, the behavior of social systems is difficult to anticipate as they are subject to constant change and evolution (Fischer & Herrmann, 2013; Mingers, 2002). This is due to their contingency towards their environment; they are not independent of external inflows, yet they are also not determined by them. While in a technical system, a well-planned algorithmically organized procedure will always turn a certain inflow into a predictable outflow, the results of social systems tend to vary. The purpose and goals they operate under tend to be mutable, making social systems prone to reconfiguring and producing results based on what the system at that point deems desired or necessary (Fischer & Herrmann, 2013; Kirkeby, 2010).

The energy grid, the example used, and most of the social substructures within society (Chaiyasoonthorn & Suksa-Ngiam, 2017) are not only seen as STSs but as **complex socio-technical systems** (Amir & Kant, 2018; Trancossi et al., 2021). They can be dubbed complex as they include numerous parameters that define time in space and time, and they possess various interactions between their components that produce unpredictable behaviors (Pringle, 1951; Saurin & Gonzalez, 2013; Siemieniuch & Sinclair, 2002).

Based on existing studies, there are four key characteristics that complex STSs share (Saurin & Gonzalez, 2013):

Large numbers of dynamically interacting components

A complex STS consists of numerous components (artifacts, organizations, etc.) that continuously change due to their influence on each other. The more components there are, the more interactions exist between them, increasing the chance of modifications (Perrow, 1999; Vesterby, 2008). Furthermore, these interactions are non-linear, meaning that even a small change can lead to dramatic effects on system behavior (Saurin & Gonzalez, 2013).

Wide diversity of elements

The complex STS's components differ in their hierarchical levels, specializations, the tasks they participate in, and the corresponding inflows and outflows they manage (Vesterby, 2008; Williams, 1999). The same also goes for their interactions (Vesterby, 2008), categorizing them in ways components cooperate, share objectives, and exchange information (Saurin & Gonzalez, 2013).

Unanticipated variability

Components in a complex STS are non-uniform and can be intentionally designed into systems or be left random (Hopp & Spearman, 2011). Even if structured, the results the system produces remain uncertain. Next to the richness of interactions, uncertainty stems from the mutability of the underlying social system, which fluctuates based on what it currently prioritizes (Fischer & Herrmann, 2013; Kirkeby, 2010). Thus, they are also time dependent (Gaziulusoy & Brezet, 2015).

Some configurations manifest by themselves, especially if components are left random. Their structures can produce unexpected and even harmful behavior. The most common system manifestations are feedback loops and emergence (Saurin & Gonzalez, 2013).

Feedback loops cause a certain action to feed back into itself, either negating it and returning the system to a state before the action (negative feedback loop) or reinforcing it and accumulating increasingly more of the same outflow (positive feedback loop) (Meadows, 1999; Saurin & Gonzalez, 2013; Stroh, 2015). Emergent are manifestations that arise from component interactions in a way that is independent of how the system was designed. Their properties are unique and not found in any of the components they emerge from (Érdi, 2008; Johnson, 2009; Sweeney, 2017). Their existence contributes to the notion that the whole is more than the sum of its parts (Checkland, 1999).

Resilience

A complex STS can adjust its operations before, during, or following changes and disruptions. This adaptability ensures that it can maintain operations even when faced with both anticipated and unforeseen conditions (Hollnagel, 2013). As such, the system can self-organize and change its configuration to spontaneously adapt to its environment (Cilliers, 2002), enduring stress and degradation (Clayton & Radcliffe, 1996). Although the extent to which it can do so is sizable, it is also not unlimited.

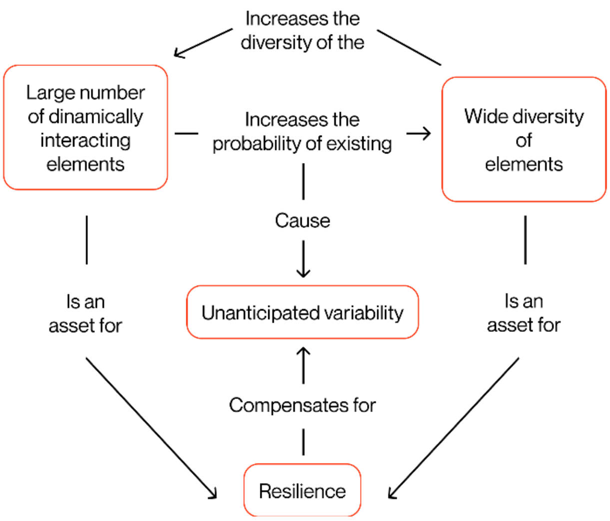

Figure 1: Characteristic relationships incomplex STS. (adapted from (Saurin & Gonzalez, 2013))

All complex STS's characteristics are interlinked (Figure 1) (Saurin & Gonzalez, 2013). The large number of dynamically interacting elements and a wide diversity of components are the elements that form a system, while resilience and unanticipated variability describe how the system functions. Quantity, dynamicity, and variety of components contribute to uncertainty and variability. On the first notion, the latter can be assumed to contradict resilience. However, diversity and dynamicity maintain a continuously changing environment, which forces the system to maintain adaptability and provides opportunities to learn from it. In turn, it gradually improves its resilience.

Regimes, niches, and landscapes

The continuous resilience loop, described in the previous chapter, actualizes the process of 'structuration.' In it, social groups, learning from earlier events (Cilliers, 2002; Johnson, 2009) ensure future coordination and stability by imposing structure to the system using rules (F. W. Geels, 2004). Rules do not exist autonomously but influence each other and combine into social rule systems. These systems do not only refer to regulative rules and prohibitions but also include cognitive routines and belief systems. To maintain their function, social groups develop social sanctions and networks of controls that create **rule regimes** (Burns & Flam, 1987). As there are various social groups, different types of regimes exist, such as technological, market, science, policy, and socio-cultural regimes. Rules are also coupled across regimes (F. W. Geels, 2004). Products that engineers produce derive from scientific research and are informed by market insights. These stem from user needs defined by socio-cultural factors and governed by policy rules. As all these social groups participate in STS, so do their rule regimes, which accumulate into **socio-technical regimes**. Nevertheless, ST regimes don't include all rules that groups have but only encompass those that link the groups together.

As rule regimes help to create a stable collaborative environment, they also cause inertia towards change. To expand on the earlier notion of an actor's perception, behavior, and action being conditioned by the existing operations of the system, it is the rule regimes that enact this. What transpires are so-called **lock-ins**, where change and innovation are unable to unfold due to the extensively stabilized system configuration (F. W. Geels, 2004). Next to rule regimes, change can also be stifled due to the system's complexity. A change of one component in the system can cause friction in how it interacts with other components (Saurin & Gonzalez, 2013). In order to achieve satisfactory operations, a completely new configuration might have to be discovered and implemented, demanding time and resources. Finally, actors and organizations can create mutual interdependencies to help build their resilience. These networks of interdependent buyers, suppliers, financial backers, and patterns of culture, norms, and ideology can actively help organizations resist disruption (Tushman & Romanelli, 1985) and oppose system change.

Optimal conditions for introducing radical innovations and change lie outside regimes in environments where there is lesser rule constriction, complexity, and actor interdependency. These spaces are referred to as **niches** (F. W. Geels, 2004). Their performance is initially low due to their novelty. Hence, they need to be protected and taken out from the mainstream market selection through subsidies, public authorities, or strategic investments within companies. The independence from regime structures allows them to pursue a process of 'mindful deviation' (Garud & Karnøe, 2001). It allows them to explore novel system configurations by selectively deviating from certain rules while keeping others. The protected space also provides niches with an opportunity to build social networks in which they are able to innovate (e.g., supply chains and user-produced relationships).

There are, however, also rules or aspects that are out of reach to niches and regimes. The spaces in which they reside are referred to as **landscapes** (F. W. Geels & Schot, 2007). These are larger external trends such as macroeconomics, deep cultural patterns, and macro-political developments, all of which are harder to deviate from. They are considerably slow to change and are thus not directly pursued by niches.

Socio-technical transitions

The Multi-Level Perspective

When talking about changing systems, researchers refer to them as transitions rather than changes. This is preferred as it emphasizes the dynamic and ongoing nature of the process rather than a one-time event (Edomah et al., 2020). The **Multi-Level Perspective** (MLP) (F. W. Geels, 2002; F. W. Geels & Schot, 2007; Rip & Kemp, 1998; Smith et al., 2010) provides a conceptual framework that describes how the interplay between regimes, niches, and landscapes contributes to transitions of socio-technical systems (Figure 2):

1. Innovations emerge in niches as alternatives to the relatively stable regime. Niches build internal momentum through price/performance improvements, learning processes, and support from powerful social groups.
2. Regime suffers pressure internally due to the misalignment of rules and expectations between the involved social groups (e.g., unmet user needs, policy changes, or friction in organizational networks) or receives pressure externally from the changes in the landscape (e.g., shifts in societal values, technological advancements, or environmental concerns).
3. The destabilization of the regime creates windows of opportunity for niche innovations to start embedding in the mainstream market. The existing structure of the regime loosens over a series of mutually influencing changes. Eventually regime either undergoes fundamental change or declines and is replaced by initial niches.

It is important to note that even though niches pursue change in the regime, they do not necessarily work in opposition to it or with an intention to overthrow it (Schot & Geels, 2008). Even more so, niche innovations are rarely able to achieve regime change without the help of broader processes and forces that reside within regimes or landscapes. The transition often transpires as **co-evolution** between these layers. This dynamic is not primarily about substitution but revolves around how niches can branch out, accumulate, and influence actors' behavior, practices, and routines within the existing regime.

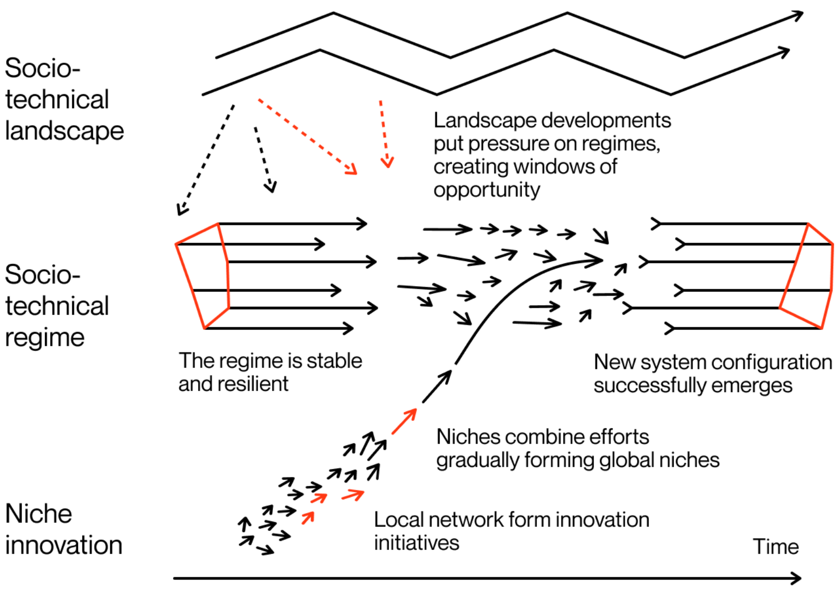

Figure 2: Transitions in the multi-level perspective (adapted from F. W. Geels, 2002)

Niche management processes

The **Strategic Niche Management** (SNM) field (Rip & Kemp, 1998; Schot & Geels, 2008) builds on the foundations of MLP and turns its focus on developing strategies that shield, nurture, and empower niches. SNM analyzes the success and failure of these experiments through the interaction between the ‘three internal niche processes (Elzen et al., 1996; Hoogma et al., 2002):

Articulation of expectations and visions

Framing and aligning expectations and visions of different participating actors is vital as it provides direction to learning processes, attracts attention, and legitimates the continuation of niche shielding and nurturing. However, articulation mustn't only pertain to pushing forward technological novelty, as is often the case (Schot & Geels, 2008). The process needs to be equally committed to discovering and representing the needs of all social groups and not be satisfied with their minimal involvement. Exploring and establishing ‘meta-visions’ can help existing institutions overcome their biases and limitations (Bos & Grin, 2008) imposed by the regime they reside in. In doing so, visions bring focus on unconsidered and unrepresented aspects that a change in the regime should address.

Ultimately, defined visions and expectations should be specific enough to provide guidance and be supported with actions in ongoing projects. Articulating them should not turn into fruitless scenarios and visioning exercises that only act as a communication tool for actors to express good intentions and improve public perception (Schot & Geels, 2008). Framing should always aim to be coupled with ‘hands-on’, real-life experiences in demonstration projects. This is especially relevant as implementing and specifying visions in experimental settings is most impactful for niche development.

Building social networks

Connections and collaborations within social networks support innovation, ensure interactions with necessary stakeholders, and draw in needed resources (money, people, expertise). Like articulating expectations and visions, networks should include a broad range of stakeholders, inside and outside actors, with numerous views and voices to grasp and pursue transition complexity successfully. Involvement of outsiders (e.g., societal pressure groups, outsider firms, scientists) is essential as they don’t act within the regime institutions and practices and can, therefore, uniquely inform the development of innovations that deviate from them (Van De Poel, 2000). Insiders (e.g., policymakers and governmental institutions) should still be present as they can support and shield innovations. In the start-up phase, they can provide their experiments legitimacy and stability and, in the subsequent phases, enable widespread support in scaling up new practices and institutions related to those experiments (Weber et al., 1999). Involved actor representatives should also have the agency to deepen the network by steering commitment and resources within their organizations and networks.

The broadening and deepening of social networks are considered vital in pursuing transitions to the extent that they call for an addition to the MLP configuration (Figure 3). Initial niche projects that reside in independent local networks are guided exclusively by specific local needs and practices (F. Geels & Raven, 2006). These are based on broad and adaptive rules, which provide ground for radical innovations but also create a highly unstable environment prone to failure (Schot & Geels, 2008). Thus, local niches can improve their success by seeking projects abiding by similar rules with which they can interchangeably collaborate on knowledge and resources (Debor, 2018). Well-defined expectations and visions, stemming from the first SNM process, can considerably aid in this, as clear articulations help the niches to quickly identify and align with suitable projects (F. Geels & Raven, 2006).

Through gradual local-to-local collaboration, global niches emerge. These are supported by 'cosmopolitan communities' (Deuten, 2003) that share the same local rules and can identify themselves as a single network that exists in multiple locations beyond the boundaries of individual projects. Gradually, the shared rules begin to guide local system practices, and become standard in new projects. Repeated implementations lead to the diffusion and stabilization of socio-technical novelties in more and more regions, emerging an 'institutional field' (Raven, 2012) and improving niche's chances to branch out into regimes.

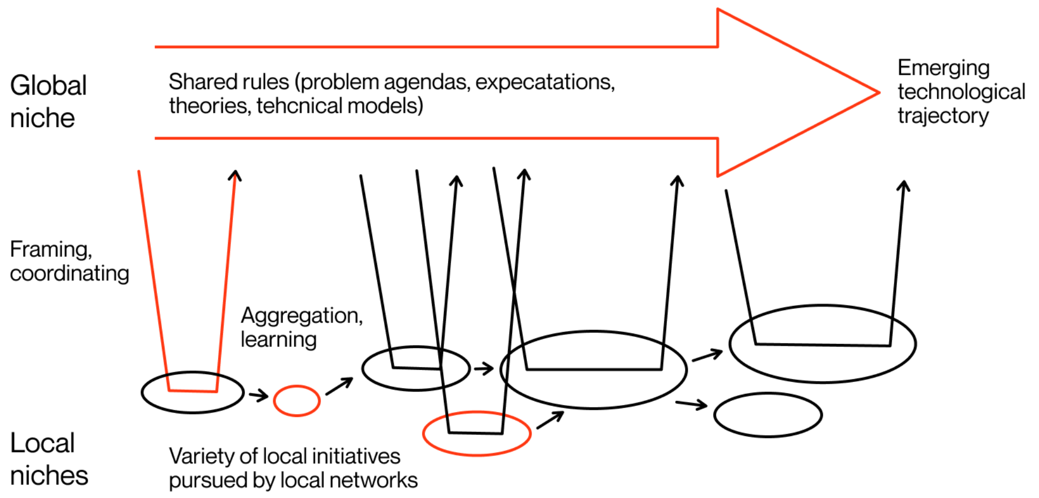

Figure 3: The transition from local to global niche (adapted from F. Geels & Raven, 2006)

Learning at multiple dimensions

Shared learning improves the technical and social aspects of the innovation and questions its underlying assumptions and values. The process should include learning technical aspects and design specifications, market and user preferences, cultural and symbolic meanings, infrastructure and maintenance networks, industry and production networks, regulations and government policy, and societal and environmental effects. Next to the accumulation and dissemination of facts and data, known as first-order learning, it is important to also promote changes in cognitive frames and assumptions, described as second-order learning (learning by doing and using) (Grin & Van de Graaf, 1996).

Transition intermediaries

The SNM guidelines covered in the previous chapter inform the requirements for a successful niche development. However, they lack ways to enact them, and, more importantly, they don't explain who should be responsible for their enacting (Kivimaa, 2014). For instance, knowledge, visions, and experiences that transpire across the local-global projects do not aggregate to general rules seamlessly and without efforts (F. Geels & Deuten, 2006). Similarly, second-order learning doesn't usually emerge without planned effort for it (Elzen et al., 2004; Harborne et al., 2007). The answer to these gaps lies in the work of intermediaries. In the context of niche processes, they take on the following vital intermediary roles (IR) (adapted on Kivimaa, 2014):

Steering expectations and visions

Intermediary work includes establishing needs, expectations, and requirements (IR1)[1,2,3,4,5] necessary for niche development and turning these into expectations and visions. Strategic work (IR2)[2,5] is needed to ensure the latter are specific enough to offer guidance. It also seeks ways to apply them. In doing so, intermediaries aim to accelerate the adoption and commercialization of emerging technologies (IR3)[1,2,6]. Lastly, they continuously review and advance the niche's sustainability aims (IR4)[6,7].

Facilitating social networks

Intermediaries take on the role of creating new social networks (IR5)[1,4,5,6,8,9] by identifying required actors and managing their engagement. This spans activity in discovering and linking actors across local niches, global niches, and regimes while shielding the network from negative pressures (IR6)[3,4,5,8]. They facilitate interests and collaboration (IR7)[2,4,6,8,9] of niche actors. Additionally, intermediaries plan for and manage the mobilization of financial resources (e.g., finding funding potential and funding activities) (IR8)[1,3,4,6,8] and human resources (e.g., ensuring representation of necessary skills) (IR9)[1,2,4,6,8].

Guiding the learning process

Intermediaries guide the process of gathering, processing, generating, and aggregating knowledge (IR10)[1,3,6,8]. They ensure communication and dissemination (IR11)[1,2,4,6,8] across the local-global perspective, contributing to the formation of shared rules. Further, intermediaries help with the assessment and evaluation of emerging technology (IR12)[2], plan its application in prototypes and pilots (IR13)[1,3,6,8] , and invest in new businesses (IR14)[1]. Supporting adequate first and second-order learning opportunities, they ensure education and training (IR15)[1,6,8], provide provision for advice and support (IR16)[4,5,6], and initiate conditions for learning by doing and using (IR17)[2,8,9].

Other

Some intermediary activities fall outside of typical niche support. Intermediaries can act as neutral and trustful arbitrators (IR18)[3] internally within the niche or externally towards the regime. They set long-term project design and its processes for management and evaluation (IR19)[1,2,3,6,9]. Intermediaries also ensure policy implementation (IR20)[3,9], accredit and set standards (IR21)[3,8], and create new jobs (IR22)[10].

1-(Bessant & Rush, 1995), 2-(Van Lente et al., 2003), 3-(Howells, 2006), 4-(Klerkx & Leeuwis, 2009), 5-(Boon et al., 2011), 6-(Hodson & Marvin, 2010), 7-(Rohracher, 2009), 8-(Stewart & Hyysalo, 2008), 9-(Backhaus, 2010), 10-(Bauknecht et al., 2007)

Design’s potential in niche management

The concepts of socio-technical transitions and transition intermediaries provide the directionality and outline the actor activities necessary to pursue transitions. However, what is still missing is an overarching strategy that actors could enact to pursue them. This is relevant, as transition processes do not emerge through the unplanned intersection of different activities carried out by actors and intermediaries (Farla et al., 2012). Instead, they often unfold under larger planned structures with different levels of predefined collaboration. While this study intends to explore what such structures might be, it also draws inspiration from a prevalent methodology known for its innovation and multi-disciplinary potential (Jones, 2018; Stickdorn & Schneider, 2012) - the field of design work.

Design in socio-technical transitions

Designs function is often seen by its outputs; the product and services it creates (Gaziulusoy & Ryan, 2017). However, through its processes it facilitates collaboration and alignment of various sets of stakeholders and in turn also generates copious amounts of knowledge. It is unique in its approach as it is human-centered and constructivist (Krippendorff, 2005); it studies humans and their interactions with contextual systems and uses that information to improve human experience through problem framing and solution ideation. Stemming from the dynamic nature of human-system interactions, design is discipline agnostic in its pursuit. It considers technical, socio-cultural, and behavioral issues, making it suitable for addressing wicked problems (Dorst, 2011; Goldschmidt, 1997; Rittel & Webber, 1973). These are ill-defined, political and systemic challenges, characteristics that all correspond with those of socio-technical system transitions.

Not all design activities coincide with intermediary work. For design to intermediate sustainable change within STS, it needs to elevate from levels of innovation (Brezet, 1997) concerned with product improvements (focusing on reducing single environmental impacts for existing products), product redesign (focusing on maintaining the existing product concept while redeveloping the product with an environmental life-cycle perspective), and product function (focusing on how a function is achieved and developing product concepts that adhere to it), and progress to the level addressing system innovation (focusing on the system as a whole). At this level design isn’t only tasked with finding ways to achieve a function of a system, but also consider what societal function does the system need to serve in the first place. Hence, if design contributes to developing the mechanism necessary to transform inflows into outflows all while also aiding in identifying the desired function of this transformation, combining the social and technical dimensions, it can then be seen as an intermediary catalyst acting on all socio-technical system layers (Gaziulusoy & Brezet, 2015).

Designers as intermediaries

Literature on design provides an exhausting list of approaches designers use within various different fields. Thus, it is possible to map out how activities within design processes overlap with those of intermediaries (Table 1).

Steering expectations and visions

Designers act in response to the emerging challenges within our society and its dynamic environment (Stickdorn & Schneider, 2012). Their work informs innovation development to meet users' (stakeholders') needs. Needs are considered met if the solution addresses the stakeholder's need in a desirable way, is technically feasible, financially viable (Shapira et al., 2017) and sustainable (Buhl et al., 2019). As such, designers’ stakeholder-centricity in resolving their needs ensures that innovation aims to solve necessary social functions. They use tools such as a service blueprint (Bitner et al., 2008), to list the supporting infrastructure necessary for the fulfillment of stakeholder needs. By providing an overview of the innovation's requirements, they can inform feasibility considerations, addressing the technical expectations of the system and its applicability, and viability considerations of the innovation's cost and how it can be commercialized. Additionally, their sustainability considerations surface the complex systemic challenges. Specifically, sustainability-oriented development can be pursued through emerging design fields, such as Design for Social Innovation (Jégou & Manzini, 2008), Sustainable Product Service Systems (Ceschin, 2012) and Design for Sustainability Transitions (Irwin, 2015). Designers usually follow a planned process of 'design thinking,' which includes inspiration, ideation, and implementation of the innovation (Baughn & Suciu, 2015; Chen et al., 2018; Ribeiro et al., 2018). Doing so, they, by rule, strategize the enactment of visions and expectations through cyclical iterative prototyping until the necessary innovation needs are resolved (Stickdorn & Schneider, 2012). To support commitment, designers can produce stakeholder journey maps that, transparently inform stakeholders about their roles throughout the innovation process (Lehtinen et al., 2019).

Facilitating social networks

Designers broadly adopt co-creation (Jones, 2018) as a mindset, method, and tool for engaging users and stakeholders (Sanders & Stappers, 2012). They use it as a variety transformer (Jones, 2018), accepting the challenges of various stakeholders and, through a mutually agreeable and empathic (Stickdorn & Schneider, 2012) reduction process, converting them into an implementable set of shared agreements and design decisions. In doing so, designers are able to foster stakeholder commitment and reduce relational friction in interests (Yu & Sangiorgi, 2018). They also provide room for the surfacing of underserved stakeholder needs that might not have been discovered through common STS channels. Stemming from the concept of 'design venues' (Jones, 2018), designers pursue co-creation on various stakeholder scales: they involve users as participants in studios, the population of an organization in workshops, and contextual societal populations in labs. To adhere to the participant representation in these venues, designers can identify (Stickdorn & Schneider, 2012) and selectively engage or disengage stakeholders (Lehtinen et al., 2019; Lievens & Blažević, 2021). Thus, designers can be posed to facilitate large actor networks and align their stakeholder's interests through co-creation mindset, methods and tools. Based on the participatory requirement, designers can map out and identify necessary stakeholders (as contributors of skills, resources and vocalizers of needs) and selectively recruit or omit their participation.

Guiding the learning process

Design processes are closely aligned with methods of ethnography. These pertain to experiential, observational and explorative research where researchers are directly present in the contextual environment (Goffman, 1989). The field of design ethnography thus allows designers to innovate from the perspective of users and relevant slices of their daily lives (Stickdorn & Schneider, 2012). Throughout the process, designers generate materials that communicate the emerging insights to wide groups of stakeholders, ensuring that the foundations for the innovation's design are well understood and agreed upon. Essentially, they need to illustrate and represent the complexity of the multi-stakeholder system needs and make it comprehensible and able to be acted upon. Through information design they can convey insights to stakeholders of different backgrounds (e.g. technology, marketing, communication, management, customer services) (Lehtinen et al., 2019; Yu & Sangiorgi, 2018) and engage them in a strategic dialog (Meroni, 2008), aiding them to reflect on their current understanding of the innovation pursued. Next to accumulating and sharing insights, they, through the design thinking process of inspiration, ideation and implementation (Baughn & Suciu, 2015; Chen et al., 2018; Ribeiro et al., 2018), pursue an iterative learning approach where insights are continuously ideated on and applied to prototypes, tested and improved upon (Cross, 2011). The inspiration stage can emerge new stakeholder insights, the ideation phase highlights new innovation trajectories and business opportunities, and the implementation phase and prototyping supports second order learning. The phases also provide opportunities for co-creative assessment of technologies with involved stakeholders, addressing the technical feasibility, commercial viability, user desirability and system sustainability. Additionally, designers can support the suitable unfolding of the niche by helping the actor build organizational capabilities through teaching and coaching, thus fostering the adoption of a more human-centered mindset (Lievens & Blažević, 2021).

Other

Designers are able through co-creative methods steer strategic (Meroni, 2008) and empathetic (Stickdorn & Schneider, 2012) dialog that can help resolve friction in stakeholder interests (Yu & Sangiorgi, 2018). As such they can act as neutral actors, representing all aspects of the system as long as they align to the identified societal function to be resolved (Gaziulusoy & Brezet, 2015). Design work is also able to support long-term project planning through speculative design – imaginative discussive approach to new perspectives on what the solutions of the future could look like (Dunne & Raby, 2013), and backcasting - using explorative scenario approaches to causally link the present reality with future aspiration and conceive a path towards it (Weaver et al., 2017), which it can further translate to roadmaps (Lehtinen et al., 2019). Designer can inform policies and standards by setting design principles, which are descriptive or prescriptive statements aimed at informing stakeholders about facts or actions important to achieving a satisfactory outcome (Fu et al., 2016). Lastly, outcomes of ideation processes can identify a need for new services and skills, in turn informing new employment opportunities.

Key niche processes (Elzen et al., 1996; Hoogma et al., 2002)	**Intermediary activities** (Kivimaa, 2014)	**Design contribution**
Articulation of expectations and visions	Articulation of needs, expectations and requirements[1,2,3,4,5]	User-centered desirable, feasible, viable, sustainable approach.[11,12,13]
	Strategy development[2,5]	Design thinking plans for inspiration, ideation, and implementation of innovation. Stakeholder journey maps offer a transparent plan with all stakeholders' responsibilities.[14,15]
	Acceleration of the application and commercialization of new technologies[1,2,6]	Assessment of application through feasibility and commercialization through viability approaches.[12]
	Advancement of sustainability aims[6,7]	Advocacy for sustainability through the sustainable approach as well as specialized design sustainability fields[13,16].
Building of social networks	Creation and facilitation of new networks[1,4,5,6,8,9]	Co-creation as a mindset, method and tool in engaging users and stakeholders across broad networks.[17,18]
	Gatekeeping and brokering[3,4,5,8]	Identification and selective engagement or disengagement stakeholders throughout the process.[11,15,19]
	Configuring and aligning interests[2,4,6,8,9]	Through co-creation pursuing mutually shared agreements and decisions fostering commitment and reducing relational friction in interests.[17,18,20]
	Managing financial resources – finding potential funding and funding activities[1,3,4,6,8]	Identification and engagement of necessary stakeholders.[18]
	Identification and management of human resource needs (skills)[1,2,4,6,8]	Identification and engagement of necessary stakeholders.[18]
Learning processes and exploration at multiple dimensions	Knowledge gathering, processing, generation and combination[1,3,6,8]	Design ethnography seeks, aggregates, and provides key stakeholder insights.[11]
	Technology assessment and evaluation[3]	Iterative learning approach through continuous prototyping improvements.[21]
	Prototyping and piloting[1,3,6,8]	Iterative learning approach through continuous prototyping improvements.[21]
	Investments in new businesses[1]	Identification of new business opportunities through design thinking's phases of inspiration, ideation and implementation of innovation.[14]
	Communication and dissemination of knowledge[1,2,4,6,8]	Generation of materials that communicate the emerging insights and complexity of the multi-stakeholder system needs to stakeholders of various backgrounds.[11]
	Education and training[1,6,8]	Building organizational capabilities through teaching and coaching and fostering a more human-centered mindset.[19]
	Provision of advice and support[4,5,6]	Building organizational capabilities through teaching and coaching and fostering a more human-centered mindset.[19]
	Creating conditions for learning by doing and using[2,8,9]	Iterative learning approach through continuous prototyping improvements.[21]
Other	Arbitration based on neutrality and trust[3]	Co-creative methods steer strategic and empathetic dialog that resolves frictions in stakeholder interests. Acting as neutral actors, advocating for the societal function to be resolved.[11,20,22,23]
	(Long-term) project design, management and evaluation[1,2,3,6,9]	Speculative backcasting and further translation to roadmaps.[15,24,25]
	Policy implementation[3,9]	Using design principles as guidelines.[26]
	Accreditation and standard setting[3,8]	Using design principles as guidelines.[26]
	Creating new jobs[10]	Identification of new business opportunities through design thinking's phases of inspiration, ideation and implementation of innovation and in turn creating jobs.[14]

Table 1: Overlap between intermediary roles and design process activities

1-(Bessant & Rush, 1995), 2-(Van Lente et al., 2003), 3-(Howells, 2006), 4-(Klerkx & Leeuwis, 2009), 5-(Boon et al., 2011), 6-(Hodson & Marvin, 2010), 7-(Rohracher, 2009), 8-(Stewart & Hyysalo, 2008), 9-(Backhaus, 2010), 10-(Bauknecht et al., 2007), 11-(Stickdorn & Schneider, 2012), 12-(Shapira et al., 2017), 13-(Buhl et al., 2019), 14-(Baughn & Suciu, 2015; Chen et al., 2018; Ribeiro et al., 2018), 15-(Lehtinen et al., 2019), 16-(Ceschin, 2012; Irwin, 2015; Jégou & Manzini, 2008), 17-(Jones, 2018), 18-(Sanders & Stappers, 2012), 19-(Lievens & Blažević, 2021), 20-(Yu & Sangiorgi, 2018), 21-(Cross, 2011), 22-(Meroni, 2008), 23-(Gaziulusoy & Brezet, 2015), 24-(Dunne & Raby, 2013), 25-(Weaver et al., 2017), 26-(Fu et al., 2016)

As showcased, there is a significant overlap between key niche activities and design work. However, the fulfillment of some, perhaps even all, activities is not achieved only by designers. They ultimately act as facilitators steering inputs from technology, business, science, and social groups toward informed decisions (Gaziulusoy & Ryan, 2017). This doesn't necessarily exclude them from pursuing their implementation, but it requires them to synergize with other participants. Intermediaries were often shown to operate as part of intermediary ecologies (Kivimaa et al., 2019), which such a design-participants relation could be considered as. Nevertheless, their involvement and corresponding oversight in the proven innovation process make them suitable candidates for the ecologies management. On the one hand, they are able to use their neutral and supportive approaches (Stickdorn & Schneider, 2012) to coordinate participants. On the other hand, they can advocate for user (human) or even more-than-human needs (Giaccardi & Redström, 2020); both of which are regularly underrepresented in innovation pursuits (Schot & Geels, 2008). Thus, giving designers high levels of agency and oversight could prove highly beneficial when pursuing niche developments that aim to configure greater societal function while involving many diverse actors.

Additionally, it is important to note that the comparison did not include all the activities and concepts the design field encompasses. Yet, the aim was not to provide a complete evaluation of design practice and its ties with transition studies but to see if a connection can be made between the activities pursued by design and those pursued by intermediaries. The comparison proved this, supporting the potential of using design work in niche management as an intermediary strategy.

Chapter 3: Case and setting

This chapter provides a context to the study by introducing its focal case - GLocalFlex. It describes the initiaitve's goal, how it emerged, who its participants were, and how its management structure was organized. Additionally, it expands on the design effort within the initiative, covering its purpose and the plan to pursue it.

Goal

GLocalFlex initiative was run as an innovation action supported by the European Union's (EU) Horizon Europe call (GLocalFlex, 2023). Its objective was to catalyze the adoption of demand-response solutions and services that would support the scaling of flexible local energy systems (LES). It pursued the concept of energy flexibility, where power systems can become more resilient to changes in demand and production by intelligently steering energy assets (Chandler, 2008; Cochran et al., 2014). The need for this function began to increasingly emerge since the broader introduction of renewable sources to energy grids (Brunner et al., 2020; Kara et al., 2021). As these are predominantly weather-dependent, their power contribution is uncertain, requiring the grid to 'flexibly' respond in a way it manages power. Thus, if disruptive renewable technologies aim to be implemented, the stability of the energy grid must also be enhanced. Demand response services are seen as a viable way to address this complexity. Many concepts for these have already been proposed and tested; however, a broader system adoption is yet to be seen.

GLocalFlex's (2023) goal was to contribute to these pursuits by conceptualizing an energy flexibility marketplace that would provide consumers across all energy sectors a low-barrier way to participate. At the same time, it would also need to offer a convincing incentive for them to do so. Furthermore, it aimed to achieve broad adaptability through flexibilities 'own evolution'; that is, the marketplace concept would allow changes, upgrades, and integration of various appliances, consumer profiles, and microgrid configurations and, in turn, support a varied and widely accessible energy ecosystem. The concept would be able to adapt to different energy system sizes and the availability of local resources and regulations. To ensure the applicability of research, GLocalFlex involved six country-distinct European pilot sites, where it planned to in real time demonstrate the flexibility marketplace concept.

Background

GLocalFlex's project coordinator developed the initiative's topic based on his previous experience within the field. While working under the VTT Technical Research Centre of Finland, he, in early 2010, took on the task of establishing a laboratory that would study renewable energy sources. Having completed a previous project that successfully streamlined the adoption of wireless sensors, he was keen on exploring a newly emergent field of renewables that was then catalyzed by the increased adoption of photovoltaics.

> *"Photovoltaics were just coming into the market, and they were very expensive, but there was an opportunity, and I thought, OK, why not go for this? ... Several times, I misunderstood the time scale of how fast this technology would penetrate the market as there was nothing like that in Northern Finland, nothing at all. So, by studying it and multiple times starting from scratch, I have eventually created this research facility. I was happy with it as I could finally see, OK, this going to be the future." – project coordinator*

Throughout the laboratory's operation, the team explored the field of self-sustainable energy production and capacities. At the same, they learned about the grid fluctuation problems and the concept of flexibility through collaborations with external research and business partners in Finland and abroad. Initially, these topics didn't pose much relevance. Yet, as the adoption of renewable energy sources grew and the fluctuations increased, the team ultimately created a research project within VTT and began exploring the flexibility marketplace concept that would increase flexibility adoption and address these issues.

> *"I came back with the product idea; OK, let's bring together some experts and start the project in which we will study different opportunities how to create flexibility and how to use the flexibility in a reasonable manner … So the issue was that flexibility presented tiny amounts of money as the fluctuations were small and the line of stock market prices for energy was flat and not jagged. It was a steady business with no surprises. For a long time, nothing changed, but after things changed rapidly. So what today seems very obvious, a no-brainer, wasn't a no-brainer 10 years ago." – project coordinator*

To scale the project's efforts, the team applied to the Horizon Europe call, a research and innovation program that the EU erected to tackle climate change, achieve the United Nations's sustainability goals, and boost the EU's competitiveness and growth (Directorate-General for Research and Innovation, 2024). The team reframed their current research efforts to fit the call's Climate, Energy and Mobility, and Energy Systems and Grids programs and presented a concept note and, later, a project proposal. This meant defining key project topics, their contribution to the call, and the plan to carry them out. The initial founding project team, representing VTT, became the leading coordinating body of the initiative.

Participants

The founding team needed enough researchers and specialists to support the initiative, along with leads to coordinate work package (WP) teams. Next, the consortium required at least three partner organizations from different countries to qualify for the Horizon Europe call. What transpired was an ensemble of diverse organizations (Table 2): technical universities (2), institutes/centers (7), municipality offices (2), a housing company (1), energy utilities (3), specialized energy sector actors (3), IT firms (2), housing/construction actors (2), an architecture firm (1), and a privacy compliance consultancy (1). Most were privately owned (14), with the rest publicly owned (8), except for 2 hybrid cases. Non-profits comprised the majority (14), while the rest were for-profit (10). The coordinator and seven WP leads came from five organizations. Contributions included researchers (10), pilot coordinators/owners (9), domain experts (6), developers (6), infrastructure providers (1), and designers (1).

The coordinator and WP leads interviewed* came from diverse professional and academic backgrounds, including smart renewable energy systems (6), electrical engineering (5), wireless communications (3), mechanical engineering (2), stochastics (2), database management (2), mechatronics (1), machine intelligence (1), and technical physics (1). Some also had expertise in business analysis, customer behavior research, or operations research (1 each). All had experience with large, interdisciplinary, and international projects. However, only 4 held managerial roles coordinating teams of 5–30 participants, while the rest (3) focused on specific tasks within their teams.

*Leads of WP6 and WP7 were not included in the study as it was not possible to arrange an interview with them

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Name	Type	Ownership	Orientation	Participants' role in the initiative
Technische Universitat Dortmund	Technical university	Public	Non-profit	WP lead (I), researchers, developers, pilot owners
Ceske Vysoke Uceni Technicke V Praze	Technical university	Public	Non-profit	Domain experts, developers
Teknologian Tutkimuskeskus Vtt Oy	Technical institute	Public	Non-profit	Coordinator (I), 2 WP leads (I), researchers, developers, designers (I)
Csem Centre Suisse D'electronique Et De Microtechnique Sa - Recherche Et Developpement	Technical institute	Public-private	Non-profit	WP lead, researchers, domain experts
Fundacion Tecnalia Research & Innovation	Technical center	Private	Non-profit	WP lead (I), researchers
Fundacion Ctic Centro Tecnologico Para El Desarrollo En Asturias De Las Tecnologias De La Informacion	Technical center	Private	Non-profit	Researchers
Fundacion Circe Centro De Investigacion De Recursos Y Consumos Energeticos	Energy research center	Private	Non-profit	Researchers
Fundacion Asturiana De La Energia	Energy research center	Private	Non-profit	Researchers
Centre Scientifique Et Technique Du Batiment	Technical center for buildings	Public	Non-profit	Researchers
Statutarni Mesto Kladno	Municipality office	Public	Non-profit	Pilot coordinators/owners
Utajarven Kunta	Municipality office	Public	Non-profit	Pilot coordinators/owners
Office Public De L'habitat Vallee Sud Habitat	Housing company	Public	Non-profit	Pilot coordinators/owners
Electricite De France	Multinational energy utility company	Public	For-profit	WP lead (I), researchers, pilot coordinators/owners
Edp Espana Sa	National energy utility company	Private	For-profit	Domain experts
Sww Wunsiedel Gmbh	Multi-utility company	Municipality-owned	Non-profit	Pilot coordinators/owners
Nano Green S.r.o.	Energy supply and purchasing firm	Private	For-profit	Domain experts
Skarta Energy Oy	Energy infrastructure firm	Private	For-profit	Pilot coordinators/owners
EF.ruhr Gmbh	Energy sector consultancy	Private	Non-profit	Researchers
Mainflux Labs Doo Beograd Zvezdara	IoT technology firm	Private	For-profit	Domain experts, developers
Canary Bit	Cybersecurity firm	Private	For-profit	Developers
System Evergreen	Engineering, procurement & construction firm	Private	For-profit	Pilot coordinators/owners
Construcciones Garcia Rama Sl	Architecture firm	Private	For-profit	WP lead, communication, and dissemination activities, pilot coordinators/owners
Privanova Sas	Privacy compliance and risk management consultancy	Private	For-profit	Domain experts
V-zug Ag	Household appliance firm	Private	For-profit	Developers, pilot infrastructure provider

Table 2: Details about the organizations who participated in the GLocaFlex initiative

Participants included in the study's interviews are marked with (I).

Process

The initiative consisted of two distinctive processes: WP management and the design effort. The WP management processes existed since the initiative's formation and encompassed management activities of segmented work packages, carried out by WP leads. The design effort was introduced to the initiative as an auxiliary activity, aiming to bolster its understanding of concept users. However, its enactors, the design team, posed and proved that the effort also contributed to other initiative domains.

WP managment

According to the initiative's aim, all participants in the initiative were split into seven work packages: WP1 - Management & coordination, WP2 - South-Western Pilot Group, WP3 - North-Eastern Pilot Group, WP4 - Development of low-barrier flexibility trading marketplaces, WP5 - Catalogue of services and business models, WP6 - Replication and verification, and WP7 - Exploitation, dissemination and promotion.

Each work package consisted of a team lead and multiple contributors deemed experts on the topic pursued. The initiative plan covered the responsibilities of each work package and outlined their tasks (Table 3), deliverables, and milestones. They were defined together with corresponding WP leads during initiative formation. This process proved exceptionally smooth and well accepted as partner organizations were already asked about their contributions in the selection process.

> *"Once it (the partner consortium) was built, it was pretty easy to divide the job, the tasks, and the management into different work packages. We didn't ask who was willing we were proposing: 'Would you take care of this?' But it wasn't difficult since we already had this plan on the paper (topic representation for each topic). We just showed them the work package we were planning for them and asked them if they could take care of it. We gave them the topic and what was expected in the call application and asked them to elaborate on this. They were very happy to create the contents of the WP." – project coordinator*

Yet, the coordinator didn't decide on such a democratic approach only for good spirits. By allowing participants to formulate their tasks, he counted on them to surface aspects that needed to be addressed to create a solution that would be valuable not only for the confines of the initiative but also for the organizations. Only as such could the work be truly applied, allowing the concept to showcase its full potential.

> *"So I want to avoid this feeling that we are doing this just because the grant agreement says we need to do it. We tried to make a meaningful combination so that people are well motivated to do things because they see that OK, this is belonging to this and this, this is necessary, and this is needed. Because if you don't find a business use cases that are, let's say feasible, then I think we don't manage, we don't succeed, and nobody takes this research seriously." – project coordinator*

Progress on deliverables and milestones was regularly reported to the EU representative assigned to the initiative. In addition, KPIs were established during the initiative, which further communicated initiative developments. A project coordinator led the overall initiative. Additionally, GLocalFlex had a designated ethics and advisory board, which provided insights into the concept's ethics compliance and technological and market relevance.

Work package	Task
WP1 - Management & coordination	Financial and administrative management
	Coordination and project management
	Ethics compliance Management and Ethics Advisory Board
	Data Protection Compliance and Data Management Plan
WP2 - South-Western Pilot Group	Describe pilot site testing objectives
	Develop specific services to meet the testing objectives
	Recruit and engage the participants, and deploy the services on the pilot sites
	Execute the test scenarios, evaluate the KPIs and verify the results
WP3 - North-Eastern Pilot Group	Definition & Description of pilot site testing objectives
	Development of Flexibility Services and Support Tools
	Deployment, configuration and commissioning of the hardware-software tool chain on each pilot sites to meet the testing objectives
	Execution of pilot operability verification
	Execution of service analysis and replication studies across the pilots
WP4 - Development of low-barrier flexibility trading marketplaces	Design & Development of extended technical architecture of GLocalFlex marketplace, general terms, conditions & flexibility protocol specification
	DID integration mechanisms design & development
	Development of smart contract-based payment rule base & recurring trade use cases
	Cybersecurity and data privacy scenarios from GLocalFlex Platform and pilot-platform integrations cybersecurity scenarios
	Marketplace-pilot integration, testing, verification & evaluation
WP5 - Catalogue of services and business models	Definition of overarching Business Use Cases
	Definition of Key Performance Indicators
	Creation and population of the catalogue of services
	Evaluation of the GLocalFlex business models
WP6 - Replication and verification	Review of applicable standards and recommendations
	Preparation of flexibility road mapping methodology
	Verification of flexibility roadmaps: cross pilot replication evaluation
	Flexibility services impact evaluation tool
	Impact assessment in replication sites
WP7 - Exploitation, dissemination and promotion	Communication and Dissemination
	Exploring synergies and clustering with relevant Horizon 2020 and HEU projects
	Exploitation and evaluation of project results and IPR management
	Standardization Activities

Table 3: The initiative's work packages and their assigned tasks.

To ensure progress in delegated work package responsibilities, WP leads highlighted 7 processes they managed during the initiative's runtime.

(P1) **Work coordination**

WP leads needed to coordinate activities within their work package and synergize efforts with other work packages. They had to manage effective communication and facilitate collaboration between participants. Organizing meetings helped with this, allowing them to align on initiative goals and track progress.

(P2) **Task prioritization**

WP leads had to ensure the initiative goals were met within set deadlines and with available resources. For this purpose, they formulated roadmaps to help direct the work of their work package and inform task prioritization.

(P3) **Upper-lower management synchronization**

WP leads conveyed the initiative's high-level decisions, which were made in general assembly meetings and monthly management committee meetings (consisting of the founding team and all WP leads) to their work package members and supported their enactments. This was most prominent in work packages that included pilot sites, as their developments had to be kept synchronized with initiative efforts.

(P4) **Challenge surfacing**

Building on the previous task of synchronization, WP leads had to incentivize participants to surface their challenges as they emerged. This was vital, as it informed the initiative's concept evolution, ensuring that its outcome would be applicable to specific case constraints.

(P5) **Cross-partner learning**

As competencies and experiences were widespread across the initiative teams, WP leads had to maintain consistent knowledge flows among initiative participants to provide timely and relevant insights while their teams pursued their tasks.

(P6) **Testing and experimentation**

The developed platform needed to be tested and evolved through experiments to ensure the concept would function in real-life scenarios. The project coordinator initiated this process, so the WP leads acted as messengers to pilot owners, who were encouraged to participate in experiments. A working group consisting of WP4 and WP6 leads, and members orchestrated the practicalities of the experiments. These were arranged on a case-to-case basis due to the diversity of pilot sites.

(P7) **Data work**

WP5's efforts involved considerable data work to provide an economic analysis of the marketplace concept. Fees, costs, and corresponding benefits, as well as the overall availability of flexibility, needed to be calculated to determine the concept's feasibility. The lack of necessary data in specific pilot sites was addressed by extrapolating insights from the experiments that were available.

Design effort

The design team was onboarded into the initiative after the consortium agreement and the project proposal had already been accepted, and the overall initiative plan had been solidified. The project coordinator invited them to ensure that the final concept produced by the initiative would be valuable not only to the initiative but also to the would-be users. The motivation for such an approach came from experience in a past initiative, where his team struggled to convince users to use the concept they had developed, as they mainly focused only on its technical feasibility. As such, the coordinator wished to ensure that users would be sufficiently educated and ready to use the concept during and after the initiative.

> *"My understanding, based on experience, is that if found that you can do technically very advanced solutions, very neat solutions, which you think are beneficial for the end user. But if the end user doesn't understand these solutions, if they are not getting the point, then your work has been wasted. Because I think it is very easy to go the very advanced technical development and … come up with a solution that … could be beautiful, technically very advanced, like a dream solution, but it doesn't motivate (the user)." – project coordinator*

The design team accepted these goals yet saw their contribution as more significant than just user research. Their team lead pointed to the design's ability to achieve alignment. He believed that their design effort achieved a common understanding of the initiative's concept and its pursuit. Thus, design through its activities and frameworks, next to providing user insights and addressing the solution's desirability, helped build more effective work processes.

> *"The most obvious answer is to represent the users, but it's more than that … It is about, hopefully, bringing direct user insights into the process and making things as user-centered as we can. But it's also about bringing those multidisciplinary different perspectives onto the same conversation and giving them frameworks that they can all work on together … So, the user focus actually means that the service will be more desirable. The alignment hopefully means that the project work will be more efficient in creating the policy implementations and will line up better with the user's needs … We wouldn't have been able to do it without the multidisciplinary team, but also, the multidisciplinary team would have had no effective way to do this without the service design framework bringing them together … If they can use journey maps and blueprints as tools through the project and iterate them, they'll provide great ways for people to just stay literally on the same boat." – design team lead*

The design team consisted of two members of VTT's internal design department: the department's vice president (VP) and a designer, and one coordinating team member (the author of this work). The VP took on the role of a team leader, and the coordinating team member served as a bridge between the initiative and the design team. However, all members also contributed equally to the design process's realization.

To pursue the initiative aims, the design team devised a service design plan and familiarized the consortium with it. Within it, they outlined the necessary steps, including their purpose, and listed the participants and external actors to be involved in each.

(DS1) **Preparation and mobilization**

Establish a solid informational baseline by reviewing current knowledge on the topic through desk research of similar projects, business intelligence reports, and conversations with experts from the consortium and internal organizational network. Coordinate logistics with consortium partners and devise a plan for carrying out qualitative studies.

(DS2) **Qualitative studies**

Visit two consortium pilot sites with the most developed local networks in the context of energy flexibility. Gather first-hand insights into user needs, challenges, and opportunities by conducting in situ interviews with potential users and stakeholders in the local energy service system. In the process, local partners are consistently included to ensure a successful interpretation of language and culture. Carry out daily debriefs with the whole design team.

(DS3) **Research report**

Structure insights from qualitative studies into a research report. Include suitable frameworks, e.g., archetypes, personas, etc., providing value to the initiative and the research community. Prepare these insights to be further iterated in the next steps of the process.

(DS4) **General case co-creation**

Bring together the cross-functional initiative team (consisting of all WP leads and counting around 15 to 20 people) and conduct a 2-day face-to-face workshop, empathizing with user needs and ideating solutions to ensure a desirable, viable, feasible, and responsible concept. Do so by facilitating the creation of a vision for future service experience and generating a list of solution ideas in a problem-solution pattern. Conclude with a systematic prioritization of these ideas. After completing the workshop, synthesize the emerging outputs and familiarize the consortium with them.

(DS5) **Pilot-specific co-creation**

Expand on insights from the initial workshop by engaging pilot-specific teams (representatives, owners, and users) in dedicated follow-up workshops. Facilitate co-creation and alignment of emerged ideas with pilot-specific needs and capabilities. Structure and synthesize outputs, identifying overlaps and informing efficiency of concept development.

(DS6) **To-be service experiences**

Create a coherent view of future service experience by synthesizing "to be" service experience user journeys and selecting the most important features and value hypotheses to be embodied in low-fi prototypes and tested with users. Through short remote tests, validate with the users' input if the concept development is heading in the right direction.

(DS7) **Responsibility workshop**

Using a series of 'tarot cards' to present unintended consequences technologies can bring to society, prompt dialogue with the cross-functional initiative team about the responsible development of the initiative's concept.

(DS8) **Service Blueprinting**

With the cross-functional initiative team, facilitate a remote workshop and co-create a service blueprint to understand future technology architecture for the concept's service catalog. Uncover how the platform's backstage will support the front-end user journeys designed and validated in the previous steps.

(DS9) **Mapping platform flows**

With a domain expert, map out critical platform processes, including user actions and technical functions, to increase understanding of the intended platform behavior.

(DS10) **HiFi Prototyping**

Create fully interactive prototypes outfitted with user flows that represent the future of GlocalFlex's service experience to support further, more detailed validation of iterated concept hypotheses.

The design team adapted the plan throughout its execution to accommodate requirements and work around emerging challenges (section 'Design challenges' includes more on the latter, p. 52). The Responsibility workshop (DS7) was introduced later to address the responsibility implications of the concept, as it became more apparent that its enactment could have further-reaching effects on society. Similarly, mapping platform flows (DS9) was added later to help guide the increasingly complex dialog about platform specifications. Pilot-specific co-creation (DS5) and To-be service experiences (DS6) were skipped due to time constraints and coordination problems. They were planned to be pursued later with HiFi Prototyping (DS10); thus, their analysis could not be included in this work.

Chapter 4: Research design and methods

This chapter describes the study's grounded theory method. It showcases its application and the rationale behind it.

The process of this study

The study used the grounded theory as its method, as its focus on uncovering management trends within the GLocalFlex setting corresponded with the method's ability to generate insights rooted in systematically collected and analyzed data (Charmaz, 2014). The approach allowed consideration of various data sources the research had access to and their analysis to construct theoretical conclusions that could serve as guidelines.

Defining research questions

The study's research questions were defined in line with a preliminary literature review of the explored topic. This was done to ensure their relevancy, as lacking familiarity with the studied phenomenon would run the risk of 'reinventing the wheel,' lowering the value and argumentation of the study's contributions (Charmaz, 2014). More traditional grounded theory recommendations contrast this approach, as familiarizing with literature at the start of the process could lead to pre-conceived notions in the theory's construction (Glaser & Strauss, 2009), losing its theoretical sensitivity (Glaser & Holton, 2004). Yet even this consideration has recently been challenged as it is improbable for a researcher to be completely unaware of existing research, posing that a purely untainted theoretical sensitivity is practically unachievable.

Keeping the comments from the grounded theory field in mind, the concepts of socio-technical transitions were studied to an extent that allowed the study to focus on existing concepts while still omitting deep analysis to preserve theoretic sensitivity. Thus, a general understanding of the key transition processes was obtained, covering the MLP model (F. W. Geels, 2002), strategic niche management guidelines (Schot & Geels, 2008), and the conceptualization of intermediaries (Kivimaa, 2014). With the practical requirements fulfilled and a study plan possible to pursue, the research topic was solidified, and the research questions were established.

Data collection

To feasibly acquire insights on all GLocalFlex management operations, actors with the most oversight of the initiative's activities were engaged. These included all work package leads, where WP1, WP2, WP3, WP4, and WP5 leads were interviewed, and the remaining two, WP6 and WP7, were not, as a meeting with them was not possible to arrange. In addition to the WP4 lead (who was also the project manager), two coordination team members, the project coordinator, the domain researcher, and the design team lead, were also included.

Next to intensive interviews, which are deemed particularly valuable in grounded theory due to the rigor of participants' inputs (Charmaz, 2014), evidence was also collected through the study's author's own observations. His role as a designer and product strategist enabled him to gather contextual insights into the initiative's processes and structure. This proved especially valuable as the interviews took place during a limited time window within the initiative's complete timeline. Thus, the context of what preceded and followed them provided additional clarity to their statements. Combining methods aligned with grounded theory's constructivist beliefs, stating that knowledge is constructed socially from interactions, sharing viewpoints, and interpretive understandings (Guba Egon & Lincoln, 2013; Vygotsky et al., 1962). As the data does not emerge from these by any specific method, the latter had been chosen in context of the research question (Charmaz, 2014). The exploration of the ongoing management dynamics within the STE thus warranted this combination.

Intensive interviews

Intensive interviews, being longer structured or unstructured conversations with participants that dive deep into their experience about the studied topic (Charmaz, 2014) were carried out in parallel to the design team's process, more specifically after the series of co-creative workshop and during the formulation of service concepts. The conversations were semi-structured and aimed to explore interviewee's background, view on the initiative, role in the initiative, challenges in their work, their familiarity with design processes, and the impact that the design team's efforts had on the operations. During the documentation of interviews' evidence, most sources were fully anonymized, as they included statements that have been deemed sensitive and potentially harmful to initiative's future dynamics.

Participant observer

The main operations the author was involved in throughout the course of the initiative were coordination processes and design activities. In the coordination team, the author was given continuous oversight on how the initiative was evolving, yet acted fully as an observer, as he had limited agency in imposing decisions.

In contrast, he was fully involved in and contributed to the design team's efforts. The team was tasked with devising and carrying out a set of service design activities that would provide a deeper understanding of users and stakeholders regarding the socio-technical change of introducing energy flexibility. As such, the author was able to continuously reflect with the team on and evaluate the design effort's contribution and observed how their adjustments reflected in the initiative's improvement.

Initial coding

A characteristic process of grounded theory is coding. It encompasses segmenting concrete statements in data into analyzable fragments and making analytical sense of them by giving them labels or 'codes' that categorize, summarize, and account for all collected data (Charmaz, 2014). By doing so, stories, statements, and observations can gradually be transformed into generalizable theoretical statements by interpretation.

In the manner described, the notes taken during data collection were transformed into codes, encompassing initiative evolution, coordination, the design team's challenges and decisions, and reflections from interviewees on the initiative's intention, their role in the initiative, challenges in their work, their familiarity with design processes, and the impact that the design team's efforts had. Following best practice (Charmaz, 2014), the codes were kept short, simple, precise, and close to the data, allowing them to be scrutinized and changed later in the process. The coding of interviews took place shortly after they were carried out and additional codes were added through reflection. In the end, the coding process returned 168 codes.

Focused coding and categorizing

As data aggregation and analysis progressed, a second (focused) round of coding followed. With the intent of directing efforts in potent domains that could build toward theory (Charmaz, 2014) initial codes are assessed and prioritized to determine a more focused direction of research. Further, codes were combined into 57 second-order codes. 8 of them were labeled as the initiative's management processes, 10 as the design effort's steps, and the remaining 39 as the initiative's micro-level characteristics, further categorized into agendas, drivers, challenges, design aims, design impacts, and design challenges.

The emerged codes and categories were framed and compared to the intermediary roles defined by existing research (Kivimaa, 2014), to reevaluate and connect them to the socio-technical transition domain. Aiming to observe how different themes contributed to the roles, the code co-occurrences in service to each intermediary role and between each other were documented. High co-occurrences were noted, along with possible explanations for them. These produced memos (Tweed & Charmaz, 2011), iterative drafts of what later became chapters and sub-chapters in results and theoretical conclusions.

Theory building

The comparisons of codes and intermediary roles accumulated in an all-encompassing relational network explained the micro-level dynamics within GLocalFlex, categorizing them into 4 activity domains: strategy, network, research, and piloting. Next, the study observed how distinctive strategies of WP management and the design effort synergized and contributed to micro-level dynamics, returning 3 contribution domains: insights, alignment, and foundations. As such, it showcased how the design effort aided in the management dynamics present in the initiative.

Chapter 5: Findings

This chapter presents the study's findings by overviewing the micro-level characteristics that surfaced in interviews with GLocalFlex's participants. Next, the study draws links between these micro-level characteristics and adds WP management processes, design steps, and intermediary roles (as defined by (Kivimaa, 2014)) to contextualize and outline the overall initiative process and showcase all micro-level dynamics that emerged within it, answering RQ1: What micro-level STS dynamics exist in local-global niches?

Building upon them, it observes patterns in WP leads' and design team's contributions to intermediary roles. It highlights their distinctive intermediary strategies and synergies in the context of insight formation and managing participant alignment, while also considering remaining roles taken on by the founding team. As such, it evaluates the design counterpart in the initiative's pursuit, answering RQ2: How do design methods intermediate micro-level STS dynamics?

Micro-level characteristics

Using the themes identified through interviews, the study frames 39 micro-level characteristics, explaining prevalent trends in the management of the initiative. These are grouped into 3 domains related to WP management: drivers – approaches participants emphasized as contributive; agendas - participants' main motivations; and challenges – turmoils that emerged in the initiative's pursuits. Further, 3 domains related to the design effort are also established: design aims – the intended contribution of the design team; design impacts – actualized outcomes of the effort; and design challenges – turmoils that the design team faced in their process.

Related to WP management

Drivers

During the interviews, the included initiative participants surfaced certain views and approaches pivotal to the initiative's development. These insights were dubbed drivers and split into three domains: approaches diversity, unified concept, and partner selection.

Approaches to Diversity (D1)

Interviewees agreed that having diverse approaches within the initiative contributes to the overall research. Even if their goals differed, they saw benefits in their collaboration, as it provided participants with new points of view on the topic they were pursuing.

> *"I'm trying to bring in the people which I know are … let's say, having fresh ideas, fresh viewpoints, fresh angles to approach the problems. These people I know are older researchers, but for some reason, I evaluate they are good, fast thinking, and they are capable of thinking out of the box, and that is why they are there. And then I have these young researchers which are just starting their career. I hope that bringing together all researchers, who got the attitude and respect in the discipline they're doing and also the world we are living in, will be helpful." – interviewee E*

Diversity was pursued through the inclusion of various backgrounds in the initiative. Their variety was important as it further fueled the emergence of novel perspectives, making the research more interesting and innovative.

> *"If the people come from the same background with the same knowledge and expertise, then it's not that good. Of course, they can do wonderful things if it's about software development and such. Yeah, but that's only one dimension … I'm not happy with just one dimension, with just going to this way. I want to study the problem from different angles. You know, because usually when you are doing that then you can see something different and you may find something new, something very interesting. That is why it's so good to have different people from different backgrounds in the product because they can bring out different perspectives." – interviewee E*

Some deemed maintaining diverse, decoupled, streams of development necessary to allow each partner to approach the problem from their own perspective. At the same time, a degree of synchronization, coupling, was also needed to ensure relevance and applicability of the outcomes.

> *"Like last year, the corporation was much closer because it was planning, and we all had to get an answer on how we deal with the smarter platform, and we got it together. The coordination was much more coupled for four months and once we submitted the document it was more decoupled for three months. And I think over the next phase, it will get more coupled once again … It has to be decoupled to the right degree, and I think it's the right way. I think in the upcoming months when we get more to the technical development, every partner will have problems and it shouldn't be the case that every partner keeps their problems to themselves … so we have to ensure that we stay on the right degree over time." – interviewee F*

They expanded on the decoupling-coupling requirement further in context of pilot sites. As sites faced specific technical challenges best understood by their owners, it was deemed best to maintain a management approach with limited involvement in execution of their tasks. The leads saw themselves more as observers of the pilots' processes; monitoring their progress and informing them of possible synergistic opportunities as they surfaced. This decoupled way of working was supported as long as pilots had a plan to connect to the general platform concept the initiative was pursuing. The diversity in how they would go about this was seen as beneficial as it provided further insights and inspiration on how a flexibility marketplace service could work.

> *"In the coordinating role we are like the bridge between the project lead, the work package and the pilot … While we are all working on integrating the GLocalFlex marketplace platform, the pilots themselves are very different from a technical point of view … I think in our case … it will not be too efficient if we do some micromanagement and would attempt to understand every single detail of all of the pilots and then discuss with them on how they should do it. At the end of they, they are responsible for their own pilot site ... the biggest expert in their field … So, our coordination is not in the titles, because the pilots are way too decoupled for that … Shared dynamic ownership, something like that - each of the partners is the main executing entity of their own pilot site. We use the synergies available, but also make sure that we have a decoupled structure for those topics where we do not really have synergies that are applicable … We are there to monitor the progress and in case we see that the progress doesn't really fit, we are there to intervene … If there's some things that are being discussed and we know about our pilots, how things are handled there, we can put our opinion into the project management discussion as well.." – interviewee F*

Unified Concept (D2)

Some participants considered the initiative's key goal was to create a single scalable solution that would unify the efforts of all initiative pursuits. WP5's role in defining business models was seen as pivotal contribution towards unification. It was anticipated that providing a business context to the initiative processes could surface a common understanding platform's purpose and real-life applicability.

> *"We have work package five just dedicated to business models and flexibility services where essentially the target is to get everybody on the same page and deliver the one solution on how the system should look like … Of course, the most important thing is that you have your plan made up. You know how to integrate the platform and you know how to realize it, but still, it's not good if all the six pilots have their own impression of the platform." – interviewee F*

On the other hand, technical unification was to be pursued through iterative testing on the core platform. Participants were encouraged to prioritize establishing a connection to the platform and use the opportunity to test their local technical concepts in a wider market setting.

> *"I was telling them that: 'OK, we provide you the platform and against the platform test your strategies. You can test your modeling, you can test everything, but you have to build the communication. Without the communication and this kind of dialog you cannot test anything against the platform, so you will lose the biggest benefit of the product, which is testing your tools against a developing platform, which needed in order to exchange energy flexibility. So, we are trying to provide a tool for that, and also more understanding about what it takes." – interviewee E*

The highest perceived achievement for the initiative was ensuring the replication of the developed concept. The aforementioned continuous business case exploration and technical tests aimed to bolster the concept's wider application and established greater initiative interest and relevance.

> *"What is nice is that some other product, our sister project, is also willing to make some trials against the platform. If you can bring it out to wider publicity with a wider audience, with some other products, then it will have a bigger impact than it was originally planned, or there emerges a plan on how we can open the platform up for wider testing and evaluation. That would be a dream. If you can replicate something, really replicate something, then you have gained something. You have created a principle that can be copy pasted or can be replicated, so that is a good thing." – interviewee E*

Partner Selection (D3)

Lastly, the success of the initiative's progress was ascribed to the effectiveness of the initial partner selection process. Consortium participants were deemed to have all necessary competences and could successfully pursue the initiative's set-out tasks.

> *"It's very important to have partners that are capable of taking care of the tasks … I've been involved in several products in which there have been, let's say, problems with the timetables and the contents of the deliverables … We are extremely lucky in this way because we would very likely spend some time on this. But we were going through several partner candidates, both looking at their experiences and research background … and using their network … I think we have been, so far, able to cover all deliverables' deadlines. I think the people have done a great job." – interviewee E*

Additionally, participants showcased a sufficient level of commitment to the initiative's aim and were willing to collaborate and proactively solve emerging problems.

> *"You need a full commitment from different partners, which in the case of GLocalFlex, I see very good collaboration in that sense." – interviewee A*

Agendas

The diversity in the consortium's organizations corresponded with various initiative agendas that participants followed or perceived. The analysis of the interviews conducted with the project coordinator, five work package leads, and a domain expert revealed five overarching themes: progressing research, ensuring continuity, benefiting business, aiding system transition, and responsibility.

Progressing Research (Ag1)

All interviewees agreed that one of the initiative's aspects was exploring ways to implement flexibility in the energy grid. They saw the importance of taking advantage of current technologies' possibilities and exploring ways these can be configured to help solve grid challenges. The initiative aided this by creating a cross-organizational and cross-discipline environment where existing knowledge could be challenged and new perspectives could emerge.

> *"Every product is a learning opportunity, not only for your own, let's say, area of research, but it's always about everything else. And for me, it's always like I want to understand better ... what is going on here ... what is happening outside because the focal point of innovation is that you understand the whole scope, not only deeply inside your own things. That way you lose perspective." – interviewee E*

Some continued the notion of technological development. They saw the purpose in creating concepts that could be scaled to cover multiple grid scenarios and introduce standards in the flexibility domain.

> *"In theory, it would be the case that we have one solution that deals with all difficulties we have, and it works everywhere - this is the way it should be done ... and we are able to make a profit by implementing this platform and practice everywhere. I think that's the ideal scenario on the bigger picture; that's the benchmark." – interviewee F*

Some emphasized specifically exploring the concepts of platforms and marketplaces. They deemed these approaches enticing as they worked in other domains, such as e-commerce and stock trading platforms, and could impose rules and, at the same time, offer value for their users, both of which were deemed necessary for a successful implementation of an energy flexibility service.

> *"I like the idea of a marketplace ... there would be some kind of restrictions, some firm rules or a firm thinks for everybody, and GLocalFlex allows that" – interviewee B*

Additionally, some were glad about the applied nature of GLocalFlex's research, as they could put their theoretical knowledge to the test. They explained that this was not often the case for projects they have been part of, so the initiative presented a unique opportunity.

> *"... not just that we discussed about the concept, but we actually have a practical realization that works in practice with actual flexible units that are trading with the platform" – interviewee F*

Ensuring Continuity (Ag2)

Some interviewees saw GLocalFlex as an opportunity to ensure further continuity of their organization's work. The initiative provided the necessary resources to continue their research effort and secured further buy-in and support from their organization.

> *"For us as an organization, it was like quite a good thing to continue the topic of flexibility markets because we do not have many other projects in this area … and now we were able to continue it. (His two colleagues) have now slipped into the topic as well. For us, it has been really good to have GLocalFlex as a project, to continue with this topic of flexibility markets." – interviewee F*

As some of the participants had already developed their own flexibility approaches in previous projects, they wished to evolve them further and connect them to novel, more impactful concepts.

> *"In our organization, we have some people in charge who help us find European projects … they present them to us, and we say: 'Yes, this topic is interesting for us' … Glocalflex was one principal topic for our activity … we were already involved in energy services and also decarbonized services and so on … so we were interested to answer and to participate to this project." – interviewee C*

Benefiting Business (Ag3)

Even though none of the interviewees mentioned a business incentive as one of the reasons for their organization's commitment to the initiative, they did perceive this could have been the case for the for-profit partners. They presumed their need to make a profit caused them to possibly push for more business-viable solutions and stem away from radical concepts.

> *"We are an institute and a university; we do not aim to make a profit, but other companies aim to make a profit. They want to use the project to advance their product and then sell it afterward … Let's say we are a private company and are about making a profit afterward. We have to really 100% ensure that what we're doing is being used afterward. In these research projects, for them, maybe the incentive is more limited because of the profit-making component. It is not an incentive for every single partner." – interviewee F*

Some implied that it is beneficial for for-profit partners to participate in the research initiative as they can become familiar with developing concepts early on and are thus more prepared once they become the norm. As such, they avoid being surprised by possible legislative changes. Further, they can also achieve a competitive advantage as they are the first to offer a more valuable service to the market.

> *"If they understand this is a huge opportunity, to build from scratch something that you can actually use to make a big impact for your own business, they offer something that nobody else offers to the market." – interviewee E*

Lastly, it was also assumed that one of the reasons some partners joined the initiative was to find resources to sustain their operations.

> *"For some partners, the purpose can be quite different. I think for some partners, it's about at the end of the day getting the funding and then having the money available to pay the personnel." – interviewee F*

Aiding the System Transition (Ag4)

Almost all interviewees, in some way, implied that GLocalFlex pursued a system transition. The aim was to contribute to the gradual overhaul of the grid with technically advanced flexible distribution systems that could support the ongoing shift towards renewable energy sources.

> *"GLocalFlex wants to create, wants to facilitate the participation of small-scale units in providing flexibility for the system … so that the energy transition can be accomplished, let's say." – interviewee A*

The initiative's potential to pursue the transition was ascribed to its applied approach. It allowed it to serve as a showcase for a novel, radical energy system concept. Through its application, GLocalFlex aimed to prove that such a system is possible and valuable for society to commit to.

> *"… we want to show that it's possible. We want to show the way it should be done. Does this mean that the GLocalFlex system is the one that's going to be used everywhere in the world? I maybe doubt that, but on the other hand, if you show the way it should be done, then this could be the way for politics." - interviewee F*

Some referenced legislative changes that would be necessary if the adoption of flexibility were to happen at scale. They saw the initiative contributing to this cause by surfacing knowledge and public sentiment around the topic and, in turn, prompting legislators to act. It was suggested that this was even intended by the found providers - the EU. As mentioned in the previous paragraph, by showcasing the concept, the legislative bodies could gather the needed support to progress the system's transition.

> *"It's one thing to realize what you promised and the proposal. That's one of the purposes and, of course, to develop an interesting system. But I think if you look at it from a bigger picture from, maybe, a political point of view, the purpose of research is always to advance the knowledge into some topic and then maybe at some point be the base for regulatory changes … That's why we have regulation changes, and that's why we allow these systems to be operational … then such a system can be used in practice." – interviewee F*

Responsibility (Ag5)

When explaining the purpose of the marketplace concept GLocalFlex was pursuing, interviewees revealed two domains in which the initiative wanted to leave a grander social impact. The first was to secure a consistent and affordable supply of renewable energy by contributing to better grid stability. As already described in the initiative's aim, the ongoing introduction of renewable sources created higher fluctuations in the energy supply, making consumption more expensive during declines. The marketplace concept aimed to balance demand and reward cooperation by offering consumers economic incentives, consequently increasing availability and lowering net energy costs.

> *"The fact that there are certain times when there's plenty of energy and certain times when there isn't enough energy, or that is too expensive, in those times, if we wish to have a lot of energy, we will have to produce energy with fossil sources, which isn't good."– interviewee B*

The second domain built on the first as it covered the overall empowerment of consumers in the energy system. Consumer collaboration was considered as a means to achieve a balanced grid. As such, one-sided benefits of companies had to be prevented, and consumers needed to be fairly compensated for their efforts. Furthermore, consumers' willingness and ability also had to be respected. Consumers were to be given the power to choose how they wished to participate, what consumption deficit they felt comfortable with, and what time was suitable for them, avoiding the scenario where all these decisions would be made by energy companies alone. For all of this to be possible, consumers also needed to be made aware of the grid mechanisms, allowing them to make informed decisions.

> *"... finding new ways to keep the energy system in balance ... Consumer side has been forgotten ... they can also participate in the balancing, and the project aims to change this ... make consumers more aware of the mechanism in the gird so they can participate in the marketplace" – interviewee G*

Challanges

Change of Commitment (C1)

The leadership of one of the participating organizations changed during the initiative. This shifted their commitment to the initiative's tasks and raised concerns amongst the leads about whether the developments in the organization's segment of the initiative would be able to be successfully addressed.

> *"They are not providing things they (the partner) were hyping us about ... We should have anticipated the risk already when they joined in, and they pitched because they wanted to do this and this and this ... They got acquired, and the vision of the company changed. The now new parent company is a publicly-traded company and thus has to look at profits due to the legal responsibility to their shareholders" – interviewee D*

Diverging Priorities (C2)

As already hinted in the section 'Agendas' (p. 37), the diversity in participating organizations resulted in varying priorities amongst participants. Interviewees saw these as barriers to pursuing a unified marketplace concept. On the one hand, the concept itself wasn't the focal point of their pursuit but rather a more general exploration of energy flexibility that could be applicable to their situation. On the other hand, their organization's priorities influenced specific requirements in adapting the concept to their case.

> *"Most likely, each partner will have its own idea of what GlocalFlex is about, especially in the pilots. I have the impression that each of them more or less has its own objective, which might not always be the use of the GLocalFlex market but to increase the level of monitoring capabilities or to start them." – interviewee A*

Agendas also differed in terms of participants' personal motivations. This was most prominent among researchers who wished to pursue complex academic topics and methodologies that weren't necessarily applicable to the initial initiative intentions.

> *"Because people want to publish things about complex modeling problems, they create themselves a complex modeling problem, so that they can strain to provide a solution to a problem that doesn't exist in the real world, something that people can really use in their normal life - we are not clear there. So, once we get closer to the user perspective and understanding: 'OK, how should it look for users, or how should it be brought to users? So, you should discover something that is beneficial for the people that they find useful.'" – interviewee E*

When asked about approaches to ensuring alignment in agendas during the initiative formation, the project coordinator confessed that this wasn't a priority due to the limited time the founding team had in assembling the consortium.

"It is a tricky thing because of the limited time you can spend with each partner discussing. We had roughly 20 partners to talk with. In the second and third year, we will see actually what their real objectives are and how they're supporting the product." – project coordinator

Experts with Strong Opinions (C3)

Interviewees expressed concerns about experienced researchers who tended to promote their own perspectives and methodologies. This behavior sometimes hindered the initiative's explorative nature and knowledge evolution.

"You can see that happening to very good engineers and professionals, that they think that the work they are doing is the most important work in the whole world. They master their discipline, so they don't make any mistakes, that they are invincible." – interviewee E

Knowledge Management (C4)

The initiative's broad ambitions required participants to draw knowledge from numerous domains. Despite having sufficient expertise, identifying and converging insights proved challenging while also committing time and resources to platform development.

"The biggest challenge is still that we have a really big and ambitious project. There are a lot of question marks, and I think if we get all of us to a table, we could discuss for hours and not really come up with a solution but just name problems." – interviewee F

Certain interviewees expanded on this, by explaining the difficulties of conveying knowledge to others. Due to their variety in backgrounds, coordination proved difficult as some participants didn't have sufficient depth in the topic to formulate answers and requests others could pursue. Some also expressed concerns about participants' ability to pursue certain initiative's tasks. As work was organized with a fair degree of participants' autonomy, it depended on each to be able to take responsibility for their local pilot developments.

"Most partners don't really know what they want. It's difficult to ask questions and get answers. If I get too technical, I lose them … I don't need to talk to high level people in the company … You need to find the right people for the right problem." – interviewee G

Language Barriers (C5)

An interviewee highlighted occasional difficulties in understanding other initiative participants due to their diverse nationalities and accents, which influenced their communication in English.

"It's not often easy to understand even English, the same English from all the countries, with all the accents." – interviewee C

Local Pilot Context (C6)

Pilots operated in diverse local contexts with specific systemic and legislative hurdles that required unique approaches to the concept's application and testing.

"Energy markets is such a complex topic in itself. There are some national differences … the way these things are handled, especially on the distribution system, so the lower level of the energy system, that's very different in like the national systems. I mean, there are things that are the same, but there are also some national differences. So, everybody has their own

understanding of the flexibility marketplace. Everybody has their own national legislation. Not fully decoupled, but there are some differences. I think the technology is actually not the deal breaker here, but more the regulation and the way that things need to be done" – interviewee F

User preferences varied between and within pilots as well. Interviewees mentioned doubts about finding universal business models and service concepts that would be accepted by all local users. During the initiative, some general user groups were identified and were expected to overlap among pilots. However, uncertainty remained about their size and corresponding market relevance in each of the pilot sites.

> *"The solution for sure will not be the same for Finland and for Spain because we don't have the same kind of motivations … There might be some general trends that can be applied for all of Europe, but then also some other details that will make that business model work in one place and not in another. You may find consumers with the same interests all across Europe, but the share of them will be different." – interviewee A*

Meeting Objectives (C7)

The complexity emerging from diverse pilot and organizational requirements caused strain on resources needed to address them. This situation left participants concerned whether the initiative had sufficient capabilities to meet its expectations. At the same time, some remained confident in its pursuit. An interviewee explained that the emerging managerial task was to showcase initiative's successes and replicate their morale across the consortium.

> *"And then there are people that are, let's say, feeling that now the challenges are really … big for them, but overwhelmingly big. They are, let's say, having this kind of issues: 'OK, how can we actually possibly do what is expected?' So now, the challenge for me is to try to motivate these people. To go ahead and say: 'OK, see this, other guys are also doing it, and then we can help you. So, it's not that bad. You can manage,' and so on. So, to get the people to do and get more motivated about doing the challenges … It's about the motivation; how to keep the ambition level high and how to get people to resolve practical problems which they will face." – interviewee E*

On the other hand, some questioned if the initiative's scale was viable and whether a different concept scope would make complexities in real-life applications more manageable. An interviewee mentioned energy communities as a more feasible starting ground for flexible marketplaces. The communities' secluded stance meant greater freedom from dependencies on the surrounding system structure regarding technology, market, and legislation.

> *"Let's argue the bigger challenge; in my personal opinion, there are some more promising approaches. For example, some energy communities are regulatorily more acceptable and feasible than some local flexibility markets that are working on top of what we have at the moment. We want to address the local user-level flexibility utilization. In my opinion, there are better concepts to do it. For example, energy communities that are fully decoupled from the current structures and are a bit more radical and leveled system." – interviewee F*

Alternatively, an interviewee expressed the need to refocus efforts on developing the marketplace platform, specifically the matching agent. By focusing purely on the concept of flexibility exchange, the broader initiative complexities would not need to be addressed right away but rather later once part of the initiative has already materialized.

"We could have started to create very complex systems on how to combine these assets together. Instead of that, we created the most simple system we could think of … the matching engine, but when you go inside that thing, it is complex. You have gotten the perspective of the work itself. You know what you're doing. But if you are opening up a complex structure, you lose insight into the whole thing. You don't understand anymore what you should be doing, and then you will run into complex loops in which you are solving all kinds of problems that are not necessary … it is something that needs to be solved, but not today." – interviewee E

Path Uncertainty (C8)

Interviewees expressed uncertainty about how the concept's development should proceed. Even if its structure was clear in theory, the radicalness and novelty of an energy flexibility marketplace meant that there was no clear path toward its implementation. Any approach to changing the existing system to accommodate concept requirements had to be newly envisioned and tested. This left researchers and pilot site representatives questioning which of the plethora of unproven methods would be most suitable to pursue.

"That's probably one of the limitations we have: working in practice with the people from the field in energy systems where some novel concepts, like flexibility markets, are probably still way ahead of what we are able to do on a big scale now …" – interviewee F

Pilot Preparedness (C9)

Pilots differed in technological and economic preparedness. Interviewees pointed out that some pilots didn't possess the technology necessary to participate in flexibility training, which prevented them from participating in the initiative's platform tests. Pilots did commit to developing the missing required systems, yet this caused some to overly divert their focus and hamper the pursuit of the initiative's core platform initiative.

"People are jumping into this technical solution right away like: 'OK, how do we control devices?' This is not the core; it doesn't make any sense to solve this problem prior to having this (platform) communication." – interviewee E

In addition to technical shortcomings, some pilots lacked financial planning to inform their investments and business planning to inform their service requirements. Both reflected in their uncertainty in expressing the technological needs they would expect from the concept's platform.

"Feedback from (one of the pilots) is useful. They have domain knowledge, they know how the grid works, and they know what they want. They are responsible for balancing so they can have accurate projections for investments. Other research companies don't have a business model. They are uncertain of what they want to pursue because they have the freedom to be creative with no pressure to make revenue. They have assets, and they want to utilize them – to develop a business case, they want to calculate investment but don't have the feeling yet." – interviewee G

The challenge was even more prominent among pilots who didn't receive any resources from the initiative, as that meant they had to cover all the necessary investments themselves.

"There is a big delay and uncertainties about the pilot. There are lots of companies that are not actually in the pilot; they don't have any budget. Still, they need to deliver something in order to get things done." – interviewee E

Process Alignment (C10)

Participants pursued multiple diverse approaches, which made it difficult to steer and align initiative processes. Interviewees expressed concerns that the initiative's aim might have been too complex and set too broadly to support a unified initiative.

"I think the project is really, really big and maybe even too big to get everybody on the same page." – interviewee F

Even though interviewees didn't provide any specific examples of diverging processes, as they believed the initiative still maintained a sufficient level of alignment, they did share their experiences of this happening in past projects. To a varying degree, this influenced their concerns of this process materializing in GLocalFlex as well.

"Let's say I can always see in any big product, there are always pilots which are, let's say, in line with what is the expectation, and then they are pilot sites which are not that well in line … They are doing quite a lot of things, and some of these are not even in the product. So, they are developing this kind of system. (Developing) the biggest, tallest system in a big company is slow in many ways because they have got like 3000 engineers on the development side, and that slows them down because they have too much everything to meet the company requirements and so on." – interviewee E

One of the efforts within the initiative dealt with the analysis of flexibility potential amongst participating pilot sites. Per the initiative plan, the analysis took place at the start of the initiative, before proper mechanisms were developed. This required a theoretical approach, which aimed to predict actual flexibility potential. Some interviewees were unsure how sensible this approach was as it provided less reliable data that anyhow had to be verified again later in the initiative.

"Honestly, some of the deliverables we should have timed better … For example, this June … we have a catalog of services, flexibility potential of appliances, and business use cases. Everything else in that deliverable is fine except the flexibility potential part … we are not flexing, we are not using the flexibility yet ... So why are we talking about flexibility potential at this time of the project? … once we have done some tests, maybe then we can do some (flexibility analysis) … It can be referenced with theoretical studies, but that's bullshit. Of course, it's true in a sense, but nothing is better than measured data." – interviewee D

System Resilience (C11)

Some interviewees linked the difficulties in implementing concepts to the contradictory interests and actions of existing system incumbents. As wide-scale adoption of energy flexibility would force the existing markets and infrastructure to adapt, the currently established actors were less likely to support such change. Moreover, it was suggested that they might be using their current standing to influence legislation in an attempt to block novel market arrangements. In contrast, one of the interviewees implied that the current actor structure should be respected to a certain degree, although he did agree that change is still possible and necessary.

"There are these companies that are not willing to accept new ways of doing business. I think the biggest problem is that the DSOs think that they are, let's say, invincible. They're

protected by the markets, laws, and regulations, and they can modify and regulate the loss so that they will be forever protected by these …" – interviewee E

Translating Theory to Real-World Scenarios (C12)

Interviewees pointed out the difficulty in bridging theory with concepts that would be valid for real-world scenarios. Theoretical estimates typically seem sound, however challenges arise once economic interests and user preferences are added to the mix. As such, specific approaches, enabled by added technical capabilities, are needed to mediate and motivate technology's use. For these to be possible, next to technological development, changes in legislation might be necessary.

> *"There are some things that you think about when you try to make a bridge from the perfect algorithm to some actual practical implementation. You can make a perfect optimization modeling that does some mathematical optimization for the entire community, and that's economically the best way that you can get to it. But I mean, even before that, you knew that this was not practical, and there are practical limitations because you have individual economic interests of users."* – interviewee F

Some interviewees expended on the topic of user needs. They highlighted how extensive, ingenuity-driven research often results in solutions users don't use. Thus, it was important for them to learn more about how users want to use technologies and how they can be engaged to do so.

> *Coming from the academic world, you say: 'OK, I think that this is a very good solution, why won't you go for this? OK, let's make a project to prove that this can be done on technical terms and see whether it's economically feasible, and you forget about the social part. And then, yeah, you create a good technical solution. You say: 'OK, under these conditions, it will be economically sound,' but since you forgot the third one, then it doesn't work." – interviewee A*

A system that would support the concept's and the user's needs would require relatively extensive technological infrastructure. Hence, concerns were also raised about the economic feasibility, questioning whether the user would be able and willing to make the initial investment in the set-up.

> *"It's difficult for them to implement a device in a private home that controls private storage. It's still too expensive to implement such systems that would be used on a wide scale. These costs need to be cheaper than the cost you would have beforehand, so you would need to somehow minimize all of this." – interviewee F*

Related to the design effort

Design aims

Throughout the interview, the design team lead explained his outlook on how the design effort contributed to the initiative. This led to the outline of seven aims, which the design team expected to reach through their process: providing user perspective, increasing clarity, collecting and sharing knowledge, converging perspectives, outlining implementation, raising research questions, experimenting towards system transition, informing responsibility, and offering neutral and advocative advice

Providing User Perspective (A1)

Corresponding to project coordinator's initial task, the design team's main contribution revolved around collecting, sharing, and actualizing user insights within the concept's development. As such, most of the design steps in some form added to this domain. The Qualitative studies (DS2) provided a baseline for introducing a user perspective to the research. Despite the study's smaller size, the design team lead argued it still returned significant insights. He explained that often, a relatively small number of user interviews is sufficient if another user class doesn't emerge. Rather than statistical significance, its main value stemmed from gathering data directly through interfacing with users.

> *"Even though it was quite a small study, I think there are quite compelling arguments for why even quite a small study if you're actually interfacing with potential users, is valuable … you learned most in the earliest interviews and only by moving to a very different type of user class, do you typically learn more after you go beyond five? Of course, there's no statistical significance to that, and it's not scientifically robust. But as a qualitative study, to help the team start understanding the issues from a user perspective." – design team lead*

Through the synthesis of the Qualitative studies (DS2), as part of the Research report (DS3), the design team created user archetypes and, from them, also user personas. These materials embodied hypotheses about users and helped others engage in user-empathic concept development. Afterward, during the General case co-creation (DS4), using the voice of the user exercise, the team aimed to further elevate user empathy among participants.

> *"So, the archetypes contain our hypotheses of what kinds of users are out there, and the personas are then sort of tying down the archetypes to specific fictional characters. The objective of the persona is to challenge or give a basis upon which to decide if a solution is valuable or not … to engender using empathy. Because one of the things you should not do is design things for yourself. … What that means is that you just start thinking: 'OK, what could those problems be? Not my problems, but the real user problems. And what could the valuable solutions be? Not valuable to me, but valuable to the people we're trying to design for.'" – design team lead*

The user hypotheses would then be validated through user testing in To-be service experiences (DS6) and HiFi Prototyping (DS10). The design team lead reasoned that through testing the prototype and engaging with open-ended interpretation, users would be able to inform developments to further improve the service's experience.

> *"The logical next step is to validate those problem solution hypotheses with users. You show them the storyboards, and you start to get those reactions. The way to do that is to initially show them (the storyboards) and say: 'Hey, what do you think of this?' They're quite open-ended, so see how they interpret them and then be more guiding. Again, this will not be statistically significant or scientifically rigorous, but it is the way your UX (user experience)*

gets designed, which is to chat in a very pragmatic and quick way about how users react to your designs and then iterate your designs accordingly." – design team lead

Increasing Clarity (A2)

The frameworks used in the design plan helped collect user and concept data and surfaced the relations between them. The user journey, the result of the General case co-creation (DS4), helped clarify the user's perspective in the initiative's service context. The journey served as a focal point for all relevant user information and informed each part of the concept's use. From it, the cross-functional initiative team was able to ideate and construct a suitable user experience for the concept.

"As one of the standard frameworks, after (a complete) journey map, there are many different things you can do … You can essentially hang many different types of information on it. You can use it to start your UX design because it is a high-level description of how the UX is gonna work. You can start working out how this will be translated into user flows, which is what we did to build out the blueprint … (Also), the user journey was sort of the spine along which we hung ideation." – design team lead

During Service Blueprinting (DS8), the design team struggled to maintain participants' focus on generating a full-service view of the concept. Participants got stuck in concept specifics, as they were either too complex or unique to only one pilot. By collaborating with a domain expert in Mapping platform flows (DS9), the team managed to present a general perspective on the service's behavior and contributed to a better understanding concept's functionality.

"When we had the workshop to try to co-create the blueprint, it just didn't work. We didn't manage to co-create the blueprints because every team got bogged down in those phases … what we ran into was that, actually, the functionality of the service was a lot more complex than I think we really understood. It became clear, I think, to all of us that we had to go into these in more detail and get these right before we could really, really understand what the service was … That's why I think it was actually a really good move to cross-help with (the domain expert) and dive into those specific phases related to energy optimization and trading.

Sharing Design Insights (A3)

All materials the design team produced were made with tools that were accessible to participants and allowed their further iteration. This made it possible for participants to maintain an updated shared source of knowledge about users and the concept's design.

"I'm very much in favor of making sure that when you create artifacts like this, they're in tools that are editable by people who aren't designers … They would now use these frameworks for the rest of the project to collect hypotheses and help each other understand what they're trying to create. They would just keep iterating these frameworks based on their learnings and actions in the project. In the ideal case, that would be how the frameworks would be used going forward." – design team lead

Converging Perspectives (A4)

The activities within the design effort created settings for dialog about the initiative's aims and how to achieve and converge them. The General case co-creation (DS4) allowed participants with different backgrounds to share their varying perspectives and begin uncovering overlaps.

"The advantages of cocreation are: firstly, you get diverse perspectives, but secondly, you start to get everybody on the same page. People start to understand each other, not just the

problems and solutions … they start to understand different perspectives. These perspectives can spark off each other. It's a very efficient way to not just extract knowledge from people but to get them to form this sort of common vision … It's a multidisciplinary effort, but design is absolutely one of those disciplines. It just so happens that we can also run this process that can bring people together" – design team lead

Even though the workshop through ideation introduced divergence, the storyboard, and future ad exercises later in the process converged the participants' understanding of the concept. By prompting participants to envision a fully-fledged user experience within the setting of each journey phase, participants needed to make decisions on what functionalities were most vital and how they aided the tasks the user needed to fulfill.

"The co-creation workshop starts very divergent, so you need to get people to open up to get ideas out. But then it sort of switches to convergent … You've got all these ideas from the journey map, and you have to exclude some in order to form a narrative. It's a way to understand what people think are the most powerful and valuable ideas - what they think are the most valuable solutions for the personas." – design team lead

Overall, the process's intent was not to produce an ideal solution but to guide iteration toward a concept that could converge users' and pilots' perspectives.

"It's not about discovering the perfect solution, but it's about gradually converging on a good solution." – design team lead

Outlining Implementation (A5)

The HiFi prototyping (DS10) that the design team planned would help participants reevaluate their approach to the solution. In contrast to typical waterfall ways of development, prototyping would, throughout the process, inform participants of how suitable their concept is in real-world scenarios.

"One of the benefits of prototyping is that it forces people to think through the solution in more detail … when you make a prototype, you have to very specifically say: 'Ok, how's this gonna work.' And then you realize: 'OK, this actually doesn't fit.' You don't get that when you break things down in this (waterfall) hierarchy." – design team lead

The presumed most optimal way the implementation of the initiative's concept would commence was based on lean start-up principles. This required organizations to build a minimum viable product (MVP) that would support the most critical functions of the service. Service Blueprinting (DS8) tied user needs with necessary roles and platform functionalities to fulfill them, helping to create precise specifications of the platform. Looking at these would allow participants to estimate costs and development time for each of the functionalities and, based on their organization's capabilities, decide which functions should be prioritized in their MVP.

"People, I think, had technology in mind before the project even started … OK, we could build everything at once. But if we want to follow lean start-up principles, we should find what is the MVP (minimum viable product) … So now it's a question of saying: 'OK, how do you best utilize the technology you've already made? OK, what's gonna be the MVP for the (partner's pilot site)?' … Once you start to understand what the specification is for the platform, you can start to estimate what the cost is gonna be. You can estimate how long it's gonna take to build … to help them work out what is the version-one of their implementation gonna be."

The pilot-side team could advance the implementation with the help of UX design sprints. Being structured as an interchanging tandem between designers and developers, they would allow user testing feedback to be incorporated into the backlog for the next sprint, guiding the development process.

> *"The way the pilot-side people could progress now is to do these UX design sprints … you have one front-end team with developers and designers, but the designers are sort of running ahead of the developers. So then, when you do your user test, you type that into the backlog meeting for the next sprint, and you use that to set the design. You're always one sprint ahead of the developers, feeding information into the development so that you know the development is progressing in the best way possible." – design team lead*

Raising Research Questions (A6)

The design process outcomes were to extant different to a consulting project, where the process would be typically applied. Normally the process would focus on identifying and also closing open questions. Questions that weren't able to be addressed were seen as indicators of unviable services and which would lead to efforts discontinuation. Yet, as the initiative's aim was to produce research, it naturally welcomed the formation of new hypotheses. Because clients were researchers, they accepted the presence of open questions as part of the process of advancing knowledge and understanding in the pursued field.

> *"If I compare this to a consulting project, then the big thing is that we actually dealt with identifying open questions. Because it's a research project, and that's natural."* – design team lead

Experimenting Toward System Transition (A7)

The role that the design team ascribed to the design effort in GLocalFlex was to test the initiative's hypothesis that trading consumer energy flexibility can reduce carbon emissions. The team would not do this through rigorous techno-economic analysis but by facilitating pilot site experiments and evidence gathering as a part of To-be service experiences (DS6) and HiFi prototyping (DS10). In turn, researchers could use the emerging data to help determine if the initiative's concept is beneficial; if it's reducing CO2 emissions or grid congestion. These findings could then inform policy, funding, and regulations to support similar initiatives in the future.

> *"It's more to try and gather evidence. It's an experiment. If you see people trade flexibility, that people are receiving benefits, leading to a more favorable CO2 footprint, or it's leading to less grid congestion, which is also eventually gonna enable more renewable and make the transition, then this will be valuable in producing evidence that these could be good things to do."* – design team lead

Informing Responsibility (A8)

Service design inherently addressed user desirability, technical feasibility, and business viability. However, it through the Responsibility workshop (DS7) also introduced the dimension of responsibility, encompassing environmental sustainability, societal impact, and ethical considerations. This added focus ensured that the design process not only met traditional criteria but also aligned with broader values, promoting practices that are beneficial for the environment and society at large.

> *"I think service design sort of natively hits on the other three things (user desirability, technical feasibility, and business viability), but then what's a little bit new is how you deal*

with that responsibility angle, which includes what's good for the environment, what's good for society, what's ethical, etc." – design team lead

Offering Neutral and Advocative Advice (A9)

From the design team lead's perspective, designers must act in balance with neutrality and advocacy. The team aimed to be objective and followed user research and co-creation insights without attachment to specific outcomes. However, they also had to bring their skills, experiences, and opinions to the table. They needed to advocate for users, especially since they were the only ones in the initiative who had direct user interactions during the Qualitative studies (DS2). The lead added that designers gather experience across various projects they work on, which helps them propose better solutions. However, he emphasized that they should share their opinions in a respectful and constructive manner and recognize the expertise of others involved in the process. Taking firm stances is, in general, not advised since all work is based on hypothesis. Nevertheless, he supported the idea that designers should have a more active stance in their facilitation.

> *"Designers need to be opinionated. So, for example, you and I met the users; most people in the project have not and will never meet a user. So, there needs to be an element of user advocacy."* – design team lead.

Design impacts

During interviews, interviewees, in several instances, voiced how they perceived the design effort impacted the initiative. These were then grouped into the five following impact domains: supporting learning about users, guiding real-world viability, pursuing system change, clarifying concepts, and steering for focus and alignment.

Supporting Learning About Users (I1)

Interviewees voiced that the framework that the design effort included, such as user archetypes, personas, and user journey, provided them with an intuitive grasp of user needs. They saw workshops as games and role-playing exercises that deepened their understanding of different user perspectives and revealed their varied motivations and behaviors. The insights helped them shift focus from technical solutions to user-centered designs, emphasizing the importance of addressing real-world user needs.

> *"Several different insights, different ways I could expand my knowledge about the user and user behavior in many modern ways. That was very good because, working with these different user archetypes, you could actually see that they're completely different motivations for people." – interviewee E*

> *"You had the personas, and what we provided was the input for the life cycle of the service for a specific persona. So, therefore, we already had our intuition of the user and of their needs, and then I think it was basically what we feel like what was needed to start." – interviewee B*

> *"I was very impressed by the workshop … When you give this broad range of people templates; it opens up much more … We were thinking about how different types of people interact with the platform … That was kind of a game we were playing to see how they think and what would be the best way to incentivize them" – interviewee D*

> *"Roleplay to imagine how it is to be a different person." – interviewee G*

"... where you think: 'OK, that's a cool idea, but this would not work in practice because the people would not actually use it. That's one of the first things we had as part of the service design activities in this project. That's the impact in the head for me personally; you think about these topics. Beforehand, you would have thought, OK, yeah, that's technically the good solution, and that was it. These are some thoughts that I would have never had before that, and especially with the personas we had in the workshop in September." – interviewee F

The design process motivated one of the interviewees to explore the initiative's impact on users further. He proposed that the initiative conclude with a feedback survey that would evaluate the initiative's hypotheses about users and evaluate their eagerness to use the completed solution.

"... somehow get the feedback: 'Now we have got the system up and running. You think this is something you would use in the future? Or is it just something that you will stop using after the project ends?' ... Collecting information about what happened: Did our survey about user profiling work? Did it have an impact, and if it did, how was it impacting the work? To think about if there is something in the process that could be developed further?" – interviewee E

Guiding Real-World Viability (I2)

An interviewee explained that typically, business cases for projects within his organization remain underdeveloped and are only worked on when they are planned to become spin-off companies. This made GLocalFlex unique, as the design effort helped guide interviewees towards real-world feasible solutions early on. By providing a practical user-focused concept vision, participants were given a strong baseline on which they would create their business use cases and models. As consumer appeal was addressed from the start, interviewees perceived that this would help avoid the common issue of technically sound solutions that end up lacking user engagement.

"At least for me that's the highest value that you will provide to the project, that the business model will be defined in a way that we will not again be in that situation where we have a very good technical solution, which can work on economic terms, but no one is using it." – interviewee A

Pursuing System Change (I3)

One of the interviewees explained that he initially saw design as a challenge but later became aware of its potential in guiding system changes. The insights helped him identify the impact and purpose of each partner, enabling a mediation process on how a system can evolve and what is necessary for it to do so.

"For now, I've been mostly using it (design insights) as like a challenge, but actually, it's like the position on how you should actually then change your system design. Like in the bigger picture, you have impact and purpose from each partner. There at some point, you'll maybe mediate what's practically possible. Let's say you have your pilot site, and you know the way things work there and you know where the limit would be to actually implement something. But then, it could be the case that you know such a system that would be perfect if you have this system and this support." – interviewee F

Another interviewee was pleased with the systemic implications the responsibility workshop raised. Despite some being uncomfortable to discuss, she saw the importance and value in addressing them.

"I think what was very good was about these tarot cards. There were quite nasty questions. They were good questions and actually good answers." – interviewee B

Mapping Systems (I4)

An interviewee explained that collaborating with the design team helped her achieve greater clarity. While discussing the dynamics of flexibility logic and user needs, the interviewee gained a better understanding of how the system works. She found the diagrams that were produced in the process particularly useful, as she was able to look around and iterate on emerging insights.

"The way I've benefited from it was that I was actually in these three hours with (the design team) when we circled around the logic, what is happening, what is needed and what is actually flexibility because that is a very complex thing. When I started to explain it to (designers) then, it crystallized to me ... how it works. And then (a designer) was making this sequence where I was able to iterate and look around." – interviewee B

Steering Focus and Alignment (I5)

The design effort's workshops brought initiative participants together and, as interviewees recalled, helped surface different disciplinary and organizational perspectives. Participants were able to be inspired by others' efforts and see where they overlapped and diverged. By doing so, they were able to identify their focus areas and coordinate tasks with others accordingly.

"It was at the general level, which was very interesting ... to share the concepts to think about user journeys from one end to the other ... to understand the meaning and the goal of the services we have to develop. A common overview and common directions between different partners ... to help the exchange between partners when we collaborate ... to share another view of the goals of the project to the service library. With your help make the link more directly to apply it to a specific use case ... to understand that some partners will focus on one part and others on the other parings, on other kinds of services ... To be able to decide and to choose which part we are going to work on ... to make, to sell, to engage." – interviewee C

Furthermore, one interviewee equated design to planning, as its process was perceived to help identify key problems and areas to focus on before the intensive work on the initiative started. As such, it optimized initiative efforts around complexity and supported its success.

"It's always good to have a plan, a design first ... Design and planning I would use in the same way ... You need to identify key problems and how design can speed up key areas ... You see the problem, complexity and the issues and what will work or not." – interviewee G

Design challenges

The conversations held with interviewees revealed several challenges that hampered the progress and impact of the design effort. These were then grouped into the five following domains: slowness in coordination, trouble understanding the design process, unclear utilization of design, poor design reputation, and considerable commitment of resources.

Slowness in Coordination (DC1)

The design team lead saw the slow progression of the process as one of the main challenges in the effort. It was particularly difficult to schedule and coordinate the plan's steps, especially on-site visits, with organizational representatives. This led to delays and postponement of some steps (5, 6, and 10) to a later stage in the initiative's process, in which they were less relevant and thus had lesser impact. The lead saw cause for this in participants' unfamiliarity with the process (covered in the next point) and the research nature of the initiative, as the focus was more on exploring new theories rather than rapidly applying them.

> *"It was so damn slow to get things agreed and scheduled ... Trying to get everybody to come to calls and explain to them about the support we needed to get the workshop organized ... Context is an issue as well. So we're all working in a research context, and research just doesn't fit with agile or lean."* – design team lead

Trouble Understanding the Design Processes (DC2)

The design team lead posed that even though the initiative's participants might have understood the planned exercises and frameworks, they had trouble seeing their relevance and place within the initiative. The momentum and support improved once the co-creation workshops were carried out, as participants noticed applicable benefits to their work.

> *"Service design is tricky to understand. It's tricky to understand the value of it. Until you actually experience it. So I think it's something service design as a whole has a problem with. The process is not opaque. I think everybody understood the frameworks we're gonna use, but they didn't understand why they would be so useful until they were in the process."* – design team lead

An interviewee further expanded on the perception of design as someone from a different domain. She was eager to understand the complexity of user needs but had trouble applying the insights the design effort produced. Posing her colleagues had similar issues in utilizing the research and conversely seeing its value and being more engaged, she suggested that the insights should be presented in a framework and context more akin to engineering. Instead of user journeys and service blueprints, she suggested using UML (unified modeling language) based sequence diagrams and business use cases. She explained that the initiative's participants were already using them and could thus, based on newly provided knowledge, evolve them.

> *"If people go to the workshops and they get also the feeling that they are not benefiting from it then they are there but their mind is somewhere elsewhere and that is not productive. It may be oriented in such a way that they get the feeling that they will in the end benefit from it and then therefore they would be willing to contribute ... So therefore, when service design is presenting something, if they can translate it or present it by using tools and frameworks and stuff that is very similar... then engineers go like: 'Huh? OK, I have seen this before now. This is relevant now. This is relevant for me ... Now we are in business, now we are doing something serious, and there is this UML (Unified Modeling Language) and then there are these use cases ...' 'this is from the service point of view, and this is my engineering point of view,' and now if you have two hands and you can start to compare." – interviewee B*

Other interviewees confirmed the notion, as they also struggled to digest the insights provided and hoped for additional adjustments in the way they were communicated.

> *"This is the most challenging, I think, that you now have these massive boards ... There's too much information. I get bored ... Things should be very simple. Making things not simple prevents you from using the results ... But then you sometimes need complicated stuff. Oversimplifying is not the right way either." – interviewee D*

Familiarity with design

Based on the carried out conversations, interviewees' familiarity with design work was somewhat limited. Two interviewees mentioned that they worked on projects where design played an important role and were thus somewhat acquainted with it. However, they still posed that the methods they used were less advanced than those in the GLocalFlex initiative. In this regard, some interviewees mentioned that they were more familiar with design in terms of user interfaces, brainstorming, and business and value analysis. As such, the conducted design effort, with its more systemic approach to service creation, ended up being a noticeable upgrade in methodology for participants with backgrounds rooted in engineering.

> *"Maybe the kind of activities that I have been involved are more old fashioned than the service design activity that you are carrying out in GLocalFlex. So, trying to think out of the box but not so oriented to defining what kind of personas and the stories that come from each of them. Most likely I'm familiar with a apart of the methods, but not the combination of them and the whole process." – interviewee A*

Unclear Utilization of Design (DC3)

Most interviewees did not recognize ways in which they could directly apply the design effort's insights to their work and thus did not perceive any obvious impact on the Initiative's developments other than the conversations they sparked. They suggested that design materials would become more relevant once the concept is developed, and user engagement begins.

> *"The impact in our case maybe has been limited, because we're probably not at that point yet. We're still a bit early in the project. There is a user recruitment which is done by our partner mostly in the systems are not yet implemented and not yet in place."* – interviewee F

Poor Design Reputation (DC4)

The design team lead suggested that the lack of participant engagement might also be due to the poor reputation of design services. He explained that design services became rapidly popular before 2020, and many failed to deliver on their promises afterward, leading to distrust in the industry.

> *"Sometimes, I think you bump into the problem where there are some really bad service designers out there who have kind of ruined the brand of it. So, there are people who are just not very good either, I think. Pre-pandemic (service design) was very hot, and it attracted a lot of people, and not all of them were very good at it."* – design team lead

Considerable Commitment of Resources (DC5)

Some interviewees voiced concern that the design process demanded considerable resources in terms of personnel and time. Even though they recognized the value of co-creation work, they saw the multi-day commitment of multiple participants as slightly disproportionate.

> *"Big problem, regarding service design work, is that it's co-creation actually takes a lot of resources. What are we getting out of this? Think about this workshop, where you have a room full of people and you try to get them to work on some problem and to get something out of that. And if you count like how many working hours it is."* – interviewee B

Management dynamics

Contextually linking identified micro-level characteristics and intermediary roles (Kivimaa, 2014) within the WP management and design effort processes, returns 4 activity domains, showcasing micro-level management dynamics within the initiative. The strategy domain describes the initiative's planning and higher-level coordination. The network domain showcases efforts in creating and managing a network that was necessary for the initiative's pursuit. The research domain outlines the knowledge flows that provide insights into the concept's development. Lastly, the pilots domain explains the concept's evolution towards experimentation.

Strategy

The initiative's founding team coordinated with the participants and gradually formulated a suitable plan, aligning with the Strategy development (IR2) role. To pursue their primary aim of conceptualizing an energy flexibility marketplace that would be able to engage actors across all energy sectors in a low-barrier way, various use scenarios would need to be studied to achieve the concept's broad adaptability.

To support this, participants, as covered in the driver Approaches diversity (D1), believed that broad representation of expertise and environments in the initiative's consortium network would generate numerous points of view, thus ensuring all stakeholders are heard, and each systemic aspect of the concept is addressed, effectively fulfilling the role of Articulation of needs, expectations, and requirements (IR1).

The insights would be pursued through knowledge circulation and, akin to the agenda of Progressing research (Ag1) and the challenge of Translating theory to real-world scenarios (C12), actualized in real-life pilot settings, adding to the role of Creating conditions for learning by doing and using (IR17). Gradually, as expressed in the driver Unified concept (D2), the insights would be used to inform the development of a standardizable concept capable of integrating into pilots' energy systems, fulfilling the role of Acceleration of the application and commercialization of new technologies (IR3) and the agenda of Aiding the system transition (Ag4).

Supporting this strategy, the network and the role of Creation and facilitation of new networks (IR5), research and the role of Knowledge gathering, processing, generation, and combination (IR10), and piloting and the role of Prototyping and piloting (IR12), required coordination efforts to effectively inform IR1 and its utilization towards the development of a valid energy flexibility marketplace concept. To keep track of progress, the founding team also defined KPIs and milestones, addressing the role of (Long-term) project design, management and evaluation (IR19).

Network

The founding team, led by the project coordinator, took on the role of Creation and facilitation of new networks (IR5). The project coordinator shared the sentiment covered in the driver Approaches diversity (D1) and thus pursued participant diversity in the consortium since the founding of the initiative. With its aims spanning various disciplines, the coordinator needed to gather the right partner competencies to ensure success, requiring the role of Identification and management of human resource needs (skills) (IR9) and the role of Gatekeeping and brokering (IR6) to assemble a sufficient consortium. He first searched for fitting actors within the network of his organization's previous collaborations. Later, these invitees referred additional partners to fill out the remainder of the disciplines sought.

> *"We built it gradually; we wanted to put together the pieces as we found … specialized people who had good experience in different places of the product ... We were throwing out people who were overlapping too much with some other partners and also identified things that were clearly missing … So, we gradually put together a product group that was able to cover all the topics." – project coordinator*

Next to competencies, the selection process also depended on the potential partner's perception of how they could contribute. The initiative's founding team aimed to convince partners to join primarily based on their interest in contributing to developing the marketplace concept and its corresponding topics.

> *"We said to them: 'This is the goal we are pursuing,' and then we also sold them the product idea ... 'We are putting together ... let's say a product call consortium, which is interested in these kinds of topics, right?' We introduced them to the marketplace scenario: 'This is what we are willing to bring to the product. Do you want to work with this?' So, to those who said yes, we said: 'OK, so what is your contribution? How do you relate to this? What is your perspective?' – project coordinator*

Since the created consortium consisted only of research and industrial partners, the design team added a vital contribution to this role, as they, through their aim of Providing User Perspective (A1) and specifically the design step Qualitative studies (DS2), established a presence of users in the initiative's network. In the end, in the driver Partner selection (D3), participants expressed confidence that the initiative sufficiently covered all domains and expertise needed for its realization.

Next to the agendas Aiding the System Transition (Ag4) and Progressing research (Ag1) that directly formulated the initiative's strategy, the consortium participants brought various own agendas to the initiative, impacting the requirements and expectations of its activities. A commonly shared agenda amongst participants was Ensuring Continuity (Ag2), as they saw the initiative as an opportunity to secure the commitment and resources necessary to continue their organization's research projects. Within the agenda Benefiting Business (Ag3), some also suggested that some organizations would use the concept that the initiative would produce to bolster their or their clients' commercial businesses. By being successfully accepted in the EU call, the founding team fulfilled the role of Managing financial resources – finding potential funding and funding activities (IR8), ensuring substantial resources to address these two agendas. Doing so, they indirectly also contributed to the roles of Investments in new businesses (IR13) and Creating new jobs (IR22).

Perhaps most in line with the initiative's plan was the agenda of Responsibility (Ag5), as participants had an interest in pursuing the concept to help the system achieve a more stable grid and more empowered consumers, all of which translated to sustainable aims and thus the role Advancement of sustainability aims (IR4).

Fulfilling the facilitation part of the role Creation and facilitation of new networks (IR5), WP leads carried out the Work coordination (P1) processes, holding monthly work package meetings to coordinate activities and requirements. They ensured these were in sync with the rest of the initiative through the Upper-lower management synchronization (P3) process.

Research

The WP leads through their process of Cross-partner learning (P5), aided in familiarizing participants with the collective knowledge of the consortium, and supported the creation of new knowledge, contributing to the role of Knowledge gathering, processing, generation, and combination (IR10). Stemming for the challenge of Translating theory to real-world scenarios (C12), participants were concerned about the relevancy of the research as they worried that the produced flexibility marketplace concept would not see actual use.

Through their impact in Supporting learning about users (I1), the design team amended this. By collecting user insights and introducing them into the concept's development in an accessible manner, as covered in their design aim Sharing design insights (A3), they balanced technological focus with user needs, allowing the role of Technology assessment and evaluation (IR11) to be addressed holistically. As user needs also served as a baseline for formulating business cases and models, the impact Guiding real-world viability (I2) further clarified requirements for the concept's relevancy. Some participants did, however, identify shortcomings. As the insights primarily stemmed from the Qualitative studies (DS2) conducted only at one pilot site, participants within the challenge Local pilot context (C6) expressed doubts that they also applied to other pilot sites.

The design team also contributed to the role of Advancement of sustainability aims (IR4). Even though the role was somewhat already addressed by the overall nature of the initiative, the team, as covered in their design aim Informing responsibility (A8), made a specific effort to identify unintended consequences an energy flexibility marketplace could bring to society and through the design step Responsibility workshop (DS7), prompted its participants to consider 'nasty questions' in concept's and its system's long-term development, as covered in the impact Pursuing system change (I5).

Throughout the initiative, participants contributed to the role of Communication and dissemination of knowledge (IR14). They shared and published two reports and six deliverables on use cases, technical standards, replication, and user needs. However, the participants did face the challenge of Knowledge management (C4). Firstly, participants had difficulties finding time to learn about the initiative's multiple topics that corresponded with its broad scope. Secondly, information had to be often adapted to differing participant's backgrounds, which required additional time and effort.

Pilots

During the Testing and experimentation (P6) process, WP leads fulfilled the role of Prototyping and piloting (IR12) in coordination with the pilot sites in a decoupled manner. As such, the leads, through the process of Upper-lower management synchronization (P3), conveyed the initiative's piloting requirements and expectations to pilot representatives, through the Task prioritization (P2) process prioritized them, and then left it up to the pilot sites to decide how to best address them. The reasoning behind such an approach can be found in the driver Approaches diversity (D1), as participants advocated for the pilot's autonomy in management as they were the ones who best understood their local systems.

However, within the challenge of Pilot preparedness (C9), some sites showed limited capabilities in supporting planned tests and required help to evolve their technical capabilities and use case definitions. On the other hand, even if a pilot did possess a suitable infrastructure, its set-up varied. As per challenge Path uncertainty (C8), the radical nature of the flexibility marketplaces meant limited proven standards, leaving researchers to pursue multiple paths to uncover one suitable for the concept. Pilots also functioned in different regulative and market environments, some more supportive of flexibility developments than others, as covered by the challenge Local pilot context (C6) and System resilience (C11). Prompted by their organization's needs, sites within the challenge of Diverging priorities (C2) varied in commitment to solving these constraints, leaving WP leads uncertain about what to commit initiative's resources to best serve all participants. The drastic change in the agendas of one of the participating organizations resulted in the challenge of Change of commitment (C1), which further increased the complexity of addressing pilot site needs.

The heterogeneity in cases and their issues led to the challenge of Process alignment (C10) as WP leads struggled to address separate cases while still maintaining the cohesion of the whole initiative. In the challenge of Meeting objectives (C7), some participants expressed uncertainty about the initiative's broad scope and proposed refocusing on specific aspects, which also varied. To amend this situation, WP leads, with the process of Challenge surfacing (P4), emphasized encouraging participating pilots to share their constraints as they arose, giving the initiative time to react and fulfill the role of Configuring and aligning interests (IR7), where they would negotiate and adapt to new requirements through the processes of Work coordination (P1) and Upper-lower management synchronization (P3) taking place in monthly work package meetings.

In cases where pilots possessed the required resources and commitment, WP leads expanded their Cross-partner learning (P5) efforts and provided relevant knowledge to pursue experiment implementation, contributing to the roles of Education and training (IR15) and Provision of advice and support (IR16). On the other hand, some testing limitations caused by pilot constraints were addressed through the Data work (P8) process, as the participants aimed to extrapolate the data available in some pilot sites to those without such access.

These approaches also presented specific challenges, such as Language barriers (C5), where different spoken languages and accents in the initiative caused misalignment due to miscommunications, and Experts with strong opinions (C3), where some participants held strong stances on specific approaches, making alignment difficult to achieve. In more dire cases such as C1 and C11, the founding team aided the WP leads in networking and arbitration, fulfilling the roles of Gatekeeping and brokering (IR6) and Arbitration based on neutrality and trust (IR18). The team was more suitable for these situations as they were the main representatives and had already taken on these responsibilities when forming the initiative.

The design team contributed to the role of Prototyping and piloting (IR12) as they, through their aim of Experimenting towards system transition (A7), saw themselves as facilitators of experiments that would put the initiative's theoretical work to the test and provide researchers with data that they could use to evaluate and possibly argue for further system transition towards flexibility. However, in contrast to the WP leads' approach, the designers used their user research as a baseline for concept definition. Instead of keeping requirements decoupled and dependent on the capabilities and priorities of pilots, they worked towards a general concept that would adapt purely to user needs.

Their approach allowed them to sideline system constraints momentarily to evolve a more detailed concept definition that helped participants distill the requirements they should pursue. In pursuit of the design aim of Increasing clarity (A2), they, in steps General case co-creation (DS4) and Service Blueprinting (DS8), facilitated the application of user needs across the service flow, allowing participants to envision a corresponding structure that would support the service. With the design aim of Converging perspectives (A4), activities were facilitated in a co-creative workshop that encouraged participants to discuss concrete user expectations and problems and address them. Mirroring the emergence of needs, participants identified how the concept should contribute to each step, gradually building out the network of actors and technologies and fulfilling the role of Technology assessment and evaluation (IR11). Participation in the workshops also equipped participants with new knowledge on how to consider user needs in their development, posing that the design team also aligned with the role of Education and training (IR15).

Through the team's design aim of Offering neutral and advocative advice (A9), no other interests were prioritized other than the user's participants, and in a manner of the role Arbitration based on neutrality and trust (IR18) empowered participants to surface varied and ambitious perspectives that focused on concept's success and not their organizational requirements. Instead, once a suitable structure was envisioned, participants could identify how they could aid in its fulfillment. They shared the aspects they intended to focus on, achieving the design impact of Steering focus and alignment (I3) and contributing to the role of Configuring and aligning interests (IR7).

Under their design aim of Outlining implementation (A5) and corresponding impact Mapping systems (I4) supported by step Mapping platform flows (DS9), they, together with the participants, identified critical functions within these concept definitions, advising prioritization and development of prototypes in the step HiFi Prototyping (DS10), akin to the role Provision of advice and support (IR16). The completed service maps and prototypes holistically addressed the concept of an energy flexibility marketplace service and, as such, aligned with the driver Unified concept (D2) and set the ground for Accreditation and standard setting (IR21), which would be further pursued by WP7 (unfortunately, an interview with its lead was not conducted; thus, insight into this domain is limited).

However, as covered in the design challenge Unclear utilization of design (DC3), most participants did not perceive these insights on implementation to apply to their current processes. Some of this uncertainty can be ascribed to the challenge of Trouble understanding the design process (DC2), as participants were generally unfamiliar with design methods and thus had no experience utilizing them. Yet, possibly the more prominent issue was the over-general nature of the concept. Since it and its corresponding prototypes were generalized for all pilot sites but not adapted to any specific case system present in the initiative, the participants were likely unsure of how to implement the insights in their pilot environments, as they were considerably varied as covered in the challenge Local pilot context (C6).

The Pilot-specific co-creation (DS5) was aimed at addressing these issues by facilitating adaptations to local cases, but it had to be postponed due to the challenge of Slowness in coordination (CD1). The reasons for the latter could be seen in the initiative's more relaxed research culture, in the challenge of Poor design reputation (DC4), or, as before, in the overall approach. Because the latter was impartial to specific pilot environments and emphasized users, it did not cater to the priorities and organizational agendas stemming from the challenge Diverging priorities (C2), making pilot representatives less motivated to participate.

Nevertheless, some participants did see value in the design effort. Even if its insights were not directly utilizable in their cases, as covered in the impact of Pursuing system change (I3), the ideal service structure the effort produced helped participants surface systemic conditions and open questions that would need to be addressed if the solution were ever to be scaled to cover all system's needs effectively. As such, the design activity again circled to research contributions within the design aim of Raising research questions (A6)

Intermediary strategies

Observing the fulfillment of intermediary roles in GLocaFlex's coordination dynamics (Figure 4), showcases noticeable overlap between the WP management and the design effort. However, despite the shared contribution, both adopted distinctive intermediary strategies. While WP leads prioritized contributing to technical implementation and economic analysis through a decoupled manner, the design team focused on fulfilling user needs by informing development through a general service concept. To contextualize their impacts and synergies further, their shared roles can be separated into those contributing to concept insights and those aligning participants in its development. Additionally, roles outside their direct overlap showed considerable, or in some cases, complete involvement of the founding team and were thus seen as specific to the initiative's founding process. What follows is an analysis of contributors' intermediary strategies pursued in the identified three contribution domains: insights, alignment, and foundations.

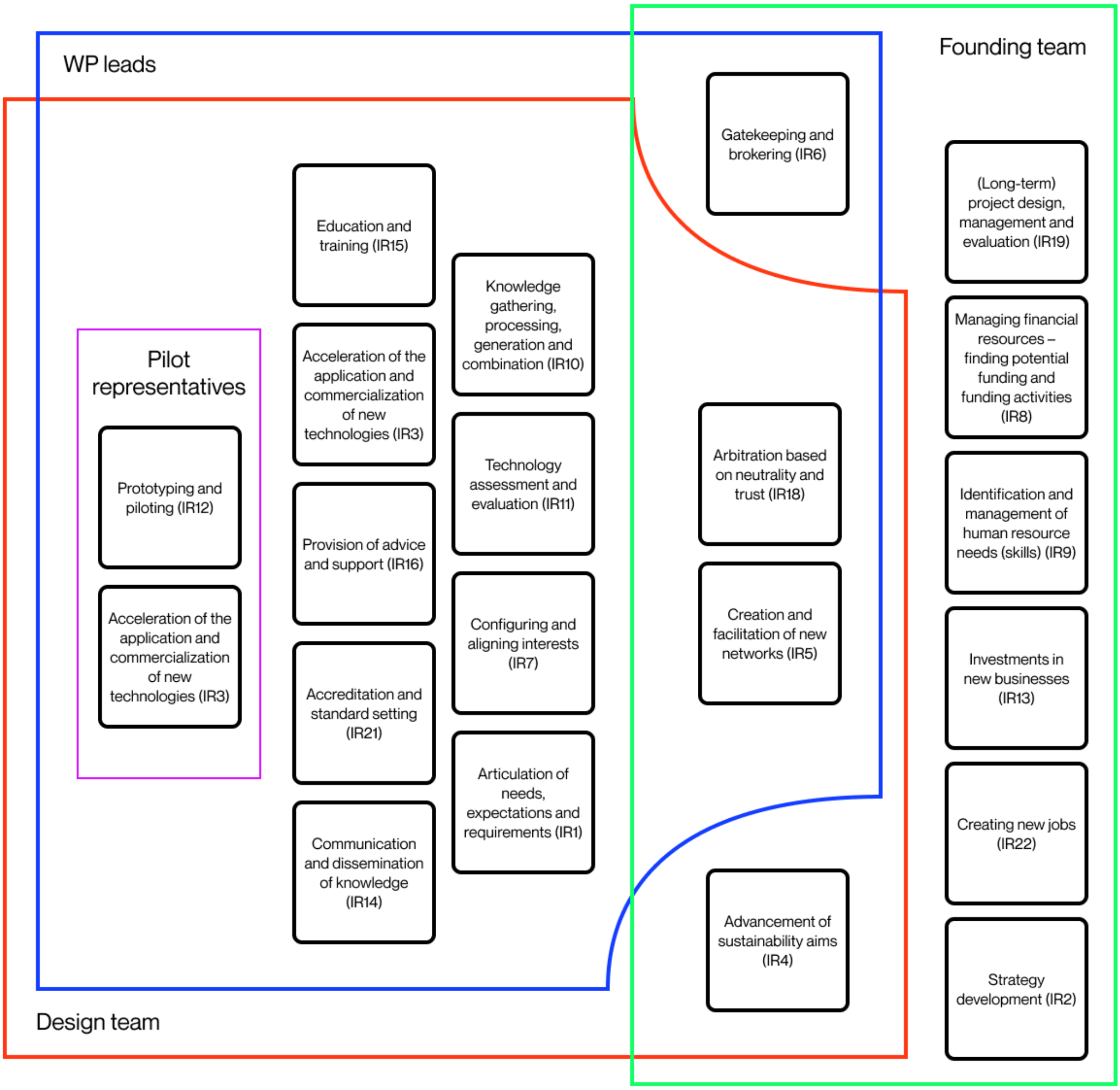

Figure 4: Overlaps of intermediary roles between contributors

Insights

Both WP leads, and the design team contributed to the formation of insights under the role of Knowledge gathering, processing, generation, and combination (IR10) and, in turn, impacted the roles of Articulation of needs, expectations, and requirements (IR1), Technology assessment and evaluation (IR11). WP leads focused on circulating knowledge amongst the initiative participants, primarily from organizations with a technical and economic focus, providing insights mainly in these domains.

As participants feared that the eventual technically feasible and economically viable solution would miss addressing a real-world need and thus see poor adoption, the design team addressed this blind spot through their qualitative studies, which involved users directly and thus produced new first-hand insights on the service's use. They also made a unique contribution to the role of Advancement of sustainability aims (IR4). Through the creative and speculative nature of their processes, they were able to carry out additional activities that evaluated the concept's systemic, sustainable impact, further evolving the sustainable direction of the initiative.

The knowledge produced by both contributors was converted into reports and deliverables, fulfilling the role of Communication and dissemination of knowledge (IR14). Through the roles of Provision of advice and support (IR16) and Education and training (IR15), both also used their information channels to provide relevant insights to other participants in the initiative, most notably in piloting activities, aiding the role of Prototyping and piloting and the corresponding role of Articulation of needs, expectations, and requirements (IR1).

While WP leads in piloting focused mainly on questions about technical set-ups with occasional additions of economic insights, the design team advocated for user needs and familiarized participants with how to better consider them in concept development by introducing various design methods. Further, while WP leads kept concept definitions vague and through the decoupled manner left the conversation separate for each pilot site, the design team pursued co-creation of a general concept that would best address user needs, sidelining pilot constraints. This allowed them to elevate concept definitions, mapping user flows and supporting technical and organizational systems and informing pilot sites on the concept's implementation, covering functionality prioritization, MVP building, and testing. The level of the concept's definition thus effectively contributed to the role of Accreditation and standard setting (IR21), aiding the WP7 task.

As the development of the energy flexibility marketplace service concept required broad coverage of expertise, both contributors struggled with managing the abundance of knowledge the research produced, as it needed to be adapted to various participants' backgrounds and be made to consume time efficiently. The design team also faced issues in the utilization of their insights. As they at first stemmed from a single local source and later from a general concept definition, many participants were not inclined to use them, likely due to them not being relevant enough for the particular own pilot case. This was true for user as well as concept implementation insights. This outcome likely also caused overall disinterest in participant involvement in the design effort, which slowed down progress on planned activities that aimed to amend it. Alternatively, the design team's work could have also been hindered by the overall participants' unfamiliarity with design methods and the recent poorer reputation of the industry.

Alignment

As WP leads and the design team supported research and piloting, they also engaged in numerous coordination activities that pursued alignment between participants and their processes. Both fulfilled the role of Configuring and aligning interests (IR7) yet differed in their approaches in doing so.

WP leads' organization of work package meetings and participation in management committee and general assembly meetings, supported coordination between high-level decisions and pilot site specific requirements. The decoupled ethos in the leads' approach empowered pilots to choose processes that fit their cases best. However, as pilots considerably differed in their environments and organizational structures, the decoupling produced a wide variety of processes, which all required case by case support from the initiative, increasing management complexity. The WP leads addressed this by encouraging pilots to share their issues in a timely manner, allowing the leads and the rest of the initiative to coordinate on providing support. Yet, as the argumentation remained based on expertise and organizational agendas, additional arbitrage efforts were necessary, in dire cases requiring aid from the founding team as the main representing party to fulfill the role of Arbitration based on neutrality and trust (IR18).

The baseline for all the design team's activities was fulfillment of user needs and expectations. This allowed them to sideline pilot constraints and organizational agendas and push towards the co-creation general concept. These conditions allowed participants to first focus on creating a valid concept, clarifying all its technical and organizational requirements and then express their inclinations on which aspects they could contribute, supporting the role of Arbitration based on neutrality and trust (IR18). The intensive workshops allowed these decisions to be made promptly as the participants had the opportunity to address problems head on. However, as already mentioned in the previous chapter, the over-general nature of the concept hampered carrying out these decisions. The participants had trouble translating the concept to their specific cases and lacked organizational commitment due to unaddressed agendas. The additional activities that the design team planned aimed to aid in this, however they struggled to engage participants further.

Foundations

The initial organization of the initiative was mainly facilitated by the founding team. They outlined its plan that focused on actualizing theoretical energy flexibility concepts and fulfilled the roles of Strategy development (IR2) and Creating conditions for learning by doing and using (IR17). Following this, they assembled a consortium that could support the plan. They thus fulfilled the role of Creation and facilitation of new networks (IR5) while also addressing the roles of Identification and management of human resource needs (skills) (IR9) and Gatekeeping and brokering (IR6). The design team did, however, contribute by introducing users to the network, as they weren't part of the initial consortium.

Additionally, the founding team secured resources for the initiative through the EU call, fulfilling the role of Managing financial resources – finding potential funding and funding activities (IR8) and correspondingly addressing the agendas of participants by aiding the role of Creating new jobs (IR22) and Investments in new businesses (IR13). The role of Policy implementation (IR20) did, however, remain unmet. The impact of the gap in this outcome was seen in the piloting constraints, where tests could not be carried out due to the concept's conflicts with local policies.

Chapter 6: Conclusion

The study of the GLocalFlex initiative contributes to the transition field, particularly to its strategic niche management counterpart, by highlighting the persistent micro-level dynamics present in the socio-technical transition initiative in the context of its local-global niche development. The initiative's efforts in defining a strategy that could support a valid innovation concept, building a sufficient and representative initiative network, emerging relevant insights informing the concept, and managing its experimentation in pilots required considerable contributions from work package leads and the design team with the aid of the initiative's founding team and pilot representatives. Tested by the diversity in participants' and pilots' priorities, needs, and corresponding numerous supporting processes, the work package leads and design team had to commit to additional activities to align the concept's development.

The intermediary strategy of the work package management focused on technical implementation and economic analysis, pursuing continuous negotiations, knowledge circulation, and data extrapolation while keeping pilot processes locally managed and decoupled. While maintaining a sufficient flow of technical and economic insights, the leads raised concerns about the concept's acceptance among users and struggled with keeping the various locally contextual requirements and processes aligned. The auxiliary design effort was able to amend these shortcomings through its intermediary strategy that provided valuable insights into user needs, informing the concept's requirements. It did so through a neutral environment and co-created a general service concept, successfully aligning the initiative's participants on development priorities. However, due to its general approach, the concept's implementation proved to be unclear. Such an outcome lessened the participants' inclination to engage further, an issue already at the effort's start, likely stemming from the same doubts about the concept's relevance.

Despite the strategies' prominent contributions, the root of the initiative's issues seems to point to the balance of the concept's heterogeneity and generalization brought upon by its local-global niche setting. This highlights a requirement for management strategies to be, in such cases, tactful in not leaning too far on each side by ensuring an aligned concept formulation when decoupling, all while maintaining sufficient version variety and adaptability. Managers pursuing a similar strategic combination should thus clearly communicate to participants the function of alignment that the concept's generalization brings in order to reassure and secure commitment in later phases of the concept's local adaptations.

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