Intermediaries for knowledge transfer in integrated energy planning of urban districts

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1. Introduction

Cities play an important role in meeting ambitions of reducing carbon emissions set by many international governments. The Paris Agreement 2015 highlighted the urgency of addressing climate change on an international scale as well as ambitious political goals such as the 202020 targets and SET Plan (EuropeanCommission, 2011b, SETPlan, 2014). Unlike other city concept such as "digital city" or "intelligent city" where the focus is on technical aspects, the smart city extends this focus to social factors such as human capital and education as drivers of urban growth (Lee et al., 2013). The complexity of variables required within a Smart City context is considerable as planning occurs over long time periods and requires knowledge bases of diverse stakeholders (Dixon et al., 2014; Narvestad, 2010; Mirakyan and De Guio, 2013; Mirakyan and De Guio 2015; Salvia et al., 2015). Knowledge transfer is key to ensure plans are being consistently considered by a wide range of ideas but knowledge transfer requires social interaction (Argote et al. 2003; Javernick-Will and Levitt, 2010; Gherardi and Nicolini, 2002; Gherardi et al. 1998). However, knowledge transfer is not always easy as the phased approach of planning to implementation occurring over many years. Social interaction to facilitate knowledge transfer has potential to optimize on intermediary processes and intermediary actors/organization. Intermediaries have been considered useful in the management of knowledge for innovation dissemination (De Silva et al., 2018; Howells, 2006; Hargadon and Sutton, 1997; Kivimaa and Martiskainen, 2018). Integrated energy planning (Mirakyan and De Guio, 2013; Mirakyan and De Guio 2015) requires diverse actors to be included in the planning process in order to access diverse knowledge bases (Mirakyan and De Guio 2015). Technical tools are useful in examining plans but are lacking in socials aspect for knowledge transfer, while communicative planning approaches (Innes and Booher, 2010; 2014) approaches lack repositories to progress knowledge over time. While these approaches are useful for accessing knowledge bases, they lack consideration on how know transfer is required for continuous knowledge development which could be facilitated through intermediary processes and intermediary actors over time. Within this work, we examine the research question of what is the role of intermediaries for knowledge transfer at different points in time. We use three projects examining at early planning stages, progressed planning stage and the implemented stages. The results indicate that intermediators are lacking at the early project stage of planning which means challenges in knowledge transfer to progress plans; use of tools stimulate the intermediary processes to discuss potential problems across diverse stakeholders: intermediator actors come to the fore the implementing stage where their role is primarily reacting to potential problems. The main contribution is that the intervention of intermediaries aid in the progression of knowledge transfer leading to consensus in decision-making.

2. Approaches to integrated energy planning in sustainable cities

The planning of a sustainable city leads to a change in planning practices. The standard process of urban planning does not prioritize energy planning as normally spatial characteristics of an area are planned first and energy planning is carried out after planning has occurred (Resch and Andresen, 2017). The introduction of energy performance goals in the planning of a neighbourhood lead to additional variables to be considered, which include transportation, energy use and supply, indoor climate, reduction of pollution, noise and emissions, common waste treatment, as well as quality of outdoor and green areas (Narvestad, 2010). The general trends in the evolution of city level energy planning approaches are as follows:

- Growing community awareness of the environmental issues.
- Growing interest in the use distributed generation technologies based on renewable resources and small cogeneration systems.
- Increasing number of decision makers with different interests and preferences participating in the planning process.
- Promote across-sectoral analysis among different sectors, such as industry, households and transportation.

(Mirakyan and De Guio, 2013p.290).

Aligned with the aforementioned trends, we use the definition of an integrated energy planning for sustainable development in cities and territories approach based on the work of Mirakyan and De Guio (2013, p.290):

''Regional (sub-national) integrated energy planning is an approach to find environmentally friendly, institutionally sound, social acceptable and cost-effective solutions of the best mix of energy supply and demand options for a defined area to support long-term regional sustainable development. It is a transparent and participatory planning process, an opportunity for

planners to present complex, uncertain issues in structured, holistic and transparent way, for interested parties to review, understand and support the planning decisions''.

The above definition highlights the complexity of energy planning. Integrated energy planning in a city involves both technical and non-technical elements with multiple dynamic interactions (Mirakyan and De Guio, 2015). The planning occurs over a long time period and the future becomes more uncertain as time passes (Mirakyan and De Guio 2015). Dixon et al., (2014:132) states complexity in the "co-evolutionary and non-linear nature of change which incorporates a range of actors and networks operating over long time-scales". As the process of planning is long, stakeholders change and new developments in technology advances which increases the uncertainty of the future (Vogel et al. 2015; Mirakyan and De Guio 2015). In addition, when to access various knowledge bases is ambiguous as infrastructure systems are often separate to energy systems in planning. There is technical knowledge based required from utility companies for the energy infrastructure of a city as well as the detailed knowledge base of city goals within a city required from a planner (Vogel et al., 2015). However, the time when these two knowledge bases should come together.

Integrated energy planning requires mutual information exchange in order to be holistic. Experience, knowledge and expertise from several practices is required to achieve better strategy and transparency as well as a democratic planning process (Salvia et al., 2015). While this type of mutual information exchange is ideal, the execution of integrating knowledge from diverse stakeholders over a long time is not straightforward. There are short-sighted hierarchal agendas which prohibit the incorporation of renewables in urban planning which can be described as inherent temporal (not in my term), spatial (not in my patch) and institutional (not my business) scales (Dixon, Eames et al. 2014). Not all stakeholders view sustainable objectives as equal and their view is highly dependent on the risk perception of the decision makers as well by other planning participants (Mirakyan, and De Guio 2015). There is a lack of communication between district heating producers and energy users which results in a lack of transparency on agreements (Mirakyan and De Guio 2015; Vogel et al., 2015). However, there are recognition and some developments in planning tools aiming to facilitate in closing the knowledge gaps in the integrated energy planning process.

2.1 Comprehensive modelling for integrated energy planning

Recent studies underline the need of a holistic and comprehensive model of a sustainable district as currently energy and planning aspects are commonly addressed separately (Morvaj et al., 2011 and Upadhyay Subho, Sharma MP, 2014). There are too many elements to energy and planning systems for one single model (Chauhan and Saini, 2014). Most of the models exclude interactions between the different energy-related areas (i.e. generation, storage, infrastructure, facilities, and transport (mobility) and the energy-policy planning strategies (i.e. renewable-energy integration for Electric vehicles technology, thermal storage for micro-grid etc.) (Calvillo et al., 2016; Kelman et al., 2012). Therefore, a creation of a comprehensive model to assist urban decision makers in optimizing both energy-related and energy-policy planning strategies is highly desirable. However, this implies for urban decision makers and municipalities to have clearly defined objectives and priorities in the urban planning process. Problems digital tools attempt to resolve are often ill defined as concepts associated with sustainable neighbourhoods such as smart and zero emission are ambiguous (de Jong et al., 2015). Indeed, the abuse of the term of smart cities in many sectors with no agreed upon definitions have created confusion among urban policy makers which regulate the policies that will make their cities "smart" (Albino et al., 2015). Municipalities are making sense of the ideas of sustainable districts while at the same time using technology tools to facilitate implementation.

In order to achieve integrated energy planning, municipalities and associated stakeholders need to improve systems by implementing new solutions through an optimal and integrated approach, by facilitating the synergies among all energy-related areas and the energy-policy planning strategies (Calvillo et al. 2016). There have been developments facilitating a holistic vision. Mirakyan and De Guio (2015) mapping of methods and tools and identification of different stakeholders implemented at the different planning phases. In addition, municipalities are developing innovative approaches to address energy concerns through the use of digital tools based on sensors and big data (Viitanen and Kingston, 2013, CTT, 2016). However, assessment-planning tools tend not to emphasize organizational, social and behavioural dimensions and the diversification of stakeholders involved (Schweber and Leiringer, 2012, du Plessis and Cole, 2011, Schweber, 2013, Kallaos and Bohne, 2013). These tools deliver data and lack the contextual knowledge in which they are developed.

2.2 Participatory processes: Communicative planning

Participatory approaches are useful to gain access to knowledge bases and provide a mechanism for knowledge transfer. Early in the planning stages, there is engagement of different stakeholders visions of future scenarios for proposed plans done through techniques of 'backcasting' (Svenfelt et al., 2011) and community engagement (Eames and Egmose, 2010). Communicative planning theory is at the foundation of participatory processes. It is a process based on participation and discussions between stakeholders (Innes and Booher, 2010). These processes facilitate stakeholders to understand the shared nature of their problems and to address them through practical solutions (Innes and Booher, 2014). For example, of building consensus through shared understanding is examining the different agendas of urban planner who may want to improve quality of life and safety in an urban area “for the common good”, which might aid property developers agenda in achieving high revenues on their investment. Therefore, they can agree on improved quality of life as a common goal and can find solutions harmonized with their overall plans and values (Narvestad, 2010).

The intention is to change the planning process through deliberation, which “shapes understandings, giving meaning to potential actions which in turn motivates players” (Innes and Booher, 2014, p. 198). The process has a typical social focus seeking fairness to address rights and issues of all those affected (Sager, 2017). Therefore, participants should include decision-makers, planners, investors and property developers (that influence the outcomes directly), as well as citizens and other users who have direct and indirect influence in the planning process.

Communicative planning is a tool to achieve the integration of various views on sustainable urban development into a holistic whole (Simeonova and van der Valk, 2009). In order for a process to be called communicative, it is important that the process is truly deliberative and has an influence on the outcomes as opposed to aiming to simply inform participants (Innes and Booher, 2010). In this way, communicative planning provides a platform for intermediation in that it facilitates communication between different organizations and/or policy sectors (horizontally), but also across different levels of decision making (vertically) (Simeonova and van der Valk, 2009). The exchange and co-creation of knowledge in a planning process across all relevant stakeholders enabled through communicative planning enables potential use of the sum of all knowledge amongst stakeholders. The social aspects of this approach promotes long-term collaborative practice (Simeonova and van der Valk, 2009) Indeed, often the most important outcomes are not concrete decisions, but changes to organizational or inter-organizational practices through (personal) relationships (Innes and Booher, 2010).

Communicative practice addresses of harmonizing different agendas and different knowledge bases providing a platform where affected stakeholders can interact in all parts of the deliberation process (Healey, 1996). However, this ideal does not always mesh well with the constraints of established practices or legal frameworks, which include time and cost limitations and pre-conditions set by planning regulations. Communicative planning fails to address the challenge of retaining and sharing knowledge in the course of the planning and implementation process, as knowledge elicitation and integration happens at specific points in time.

While communicative planning is an elicitation process for knowledge transfer, it is seemingly less concerned with documenting and retaining the knowledge. The ideal of all participants “in the same room” is challenging due to spatial issues (in the case of setting up the participatory process), or a temporal one (ensuring continuity). Hence, while participatory approaches are good in coming up with consensually agreed solutions, sometimes decisions are missing the will from stakeholders to implement (Svenfelt et al., 2011). It could be that while the means of knowledge transfer across different stakeholder holders is available through communicative planning, the process of their intermediation after a participatory process has occurred is lacking.

3. Role of intermediators for knowledge transfer in urban planning

The above establishes that integrated energy planning approaches are in a mode of development. There are ongoing challenges we address in this paper on the complexity of accessing relevant knowledge across different stakeholder, the lack of social aspect in technical tool and the need for ongoing inclusion of knowledge bases over time. What seems to be lacking is intermediation to facilitate knowledge transfer amongst diverse practices over time. This section will examine knowledge transfer and the impact of time and the use of intermediators in facilitating knowledge transfer.

3.1 Knowledge transfer and time

The long time span of integrated energy planning to implementation in sustainable districts means there are various iterations to plans. The life cycle of a development is long and within this development people in the project leave while new people join. The very nature of a project as a “temporal and transient and distributed organization imposes certain limitations and opportunities in terms of organizational learning” (Styhre et al., 2004, p.964). The combination of diverse knowledge effectively within the long time span means that it may also be forgotten quickly - ‘organizational amnesia’ (Graber, 2004). In addition, ideas understood in one phase may take on another meaning in a new phase of the project. Knowledge continuity cannot be assumed across projects due to the reoccurrence of change. Lervik et al. (2010, p.299) identified “temporal discontinuity” as a challenge in their research on maintenance engineers’ ability to “mobilise and draw upon the resources and relations needed to develop new understandings in their work”. The lack of presence in a new time and context hinders the implementation of knowledge. Knowledge transfer requires a certain amount of intermediation in order for it to occur as it is a social process (Javernick-Will and Levitt, 2010). In this way, a communicative planning approach is an ideal platform for knowledge transfer. Technical tools on the other hand are a repository. They are in some ways memory objects which is available for knowledge management and learning between projects (Gherardi et al. 1998; Cacciatori, 2008). Both technical tools and communicative planning play in key intermediary roles in the process of knowledge transfer.

Earlier research indicates how time and space plays a significant role in understanding the transmission of knowledge when it is one-way. "Original intent and context can only be inferred because the receiver can no longer engage the sender in dialog to validate the meaning of a memory" (Stein, 1995 p.22). One study considered the future use of knowledge use as a process of active coordination of information through social interaction of current and future knowledge bases probing the potential use of information within new context (Whyte et al, 2016). An integrated knowledge approach of various stakeholders across the life cycle will help in ensuring energy performance targets set up in the planning phase can be realized at the point of implementation. Nevertheless, the research on knowledge transfer indicates that coordination of knowledge does requires intermediation in order to have knowledge continuity.

3.2 Intermediary and knowledge transfer

The context in which integrated urban planning occurs is in several programs and subprojects (Mirakyan and De Guio 2015). Sharing knowledge across projects is impossible when practices do not connect and it is easier to find patterns of connections of knowledge if knowledge is transferred in one company rather than across several independent companies (Argote et al. 2003 and Newell et al. 2006). While Gherardi and Nicolini (2002) view learning from one community of practice to another as being fostered through discursive practice in a constellation of interconnected practices. The planning of sustainable districts draw on multiple stakeholders ranging from contractors, designers, installers of materials and technology and municipal governments who have not structurally coordinated their activities and who have diverse interests goals and motivations (Kivimaa and Martiskainen, 2018; De Silva et al., 2018). This makes collaboration difficult (De Silva et al., 2018).

Recent work shows how the role of municipalities is expanded to address concerns on energy and environment from national policy makers resulting in an influencing role in municipalities (or local authorities) to challenge or transform existing patterns of energy decision-making and practices (Fudge et al. 2016). In this context, there is a shift in focus of roles for municipalities from one of being decision maker to one of being negotiator (Nielsen et al., 2017). An innovation intermediary plays a key role in bringing together partners with different knowledge bases and facilitate consensus (De Silva et al., 2018 and Hargadon and Sutton, 1997). Howells, (2006, 721) defines innovation intermediaries broadly as "organizations that provide a supportive role for collaboration between two or more parties during various stages of the innovation process" but at the same time acknowledges that intermediaries are also individual actors. Whilst top-down approaches ensures the whole organization coherently achieves its vision, focusing on intermediary as primarily an organizational level risks neglects individual level determinants and empowerment (De Silva et al., 2018). Indeed, Hargadon and Sutton's (1997) study on technology brokers, viewed the role of the intermediator (whom they referred to as broker) as having a repository for knowledge transfer. With this role an intermediator, whether actor or organization take on differing roles ranging from project level intermediation; to intermediating niche technologies and services, championing roles, process or project facilitators (Kivimaa and Martiskainen, 2018). Municipalities play an important role in the facilitation of the construction projects, creating a market for new technological solutions and implementing new technological designs through the social housing stock (Kivimaa and Martiskainen, 2018). With this work, we take a closer examination of the role of individual actor and/or organizational intermediaries influencing knowledge transfer in the energy planning process to implementation and what type of intermediaries are prominent in these phases.

3.3 Theoretical framework of intermediaries for knowledge transfer over time

There is a lack of research in how the different phases of the planning processes link to implementation, but the indication is from the theory that intermediaries play a key role but it the function of intermediaries over time is unclear. In this work, we examine individual actor and organisational intermediaries through examining participatory processes (communicative planning) and knowledge repositories (tools for knowledge management). Both technology tools and communicative planning play key intermediary roles in the process of knowledge transfer. Figure 1 illustrate the complexity of developing knowledge transfer across diverse organizations with their own goals and agendas over time. Time plays a key role in knowledge continuation where intermediary processes and actors could potentially facilitate knowledge transfer. Within this work we examine specific points in time to understand how and if intermeidaries transfer knowledge to aid the decision-making process and project progression in integrated energy planning and it's implementatin in a neighbourhood.

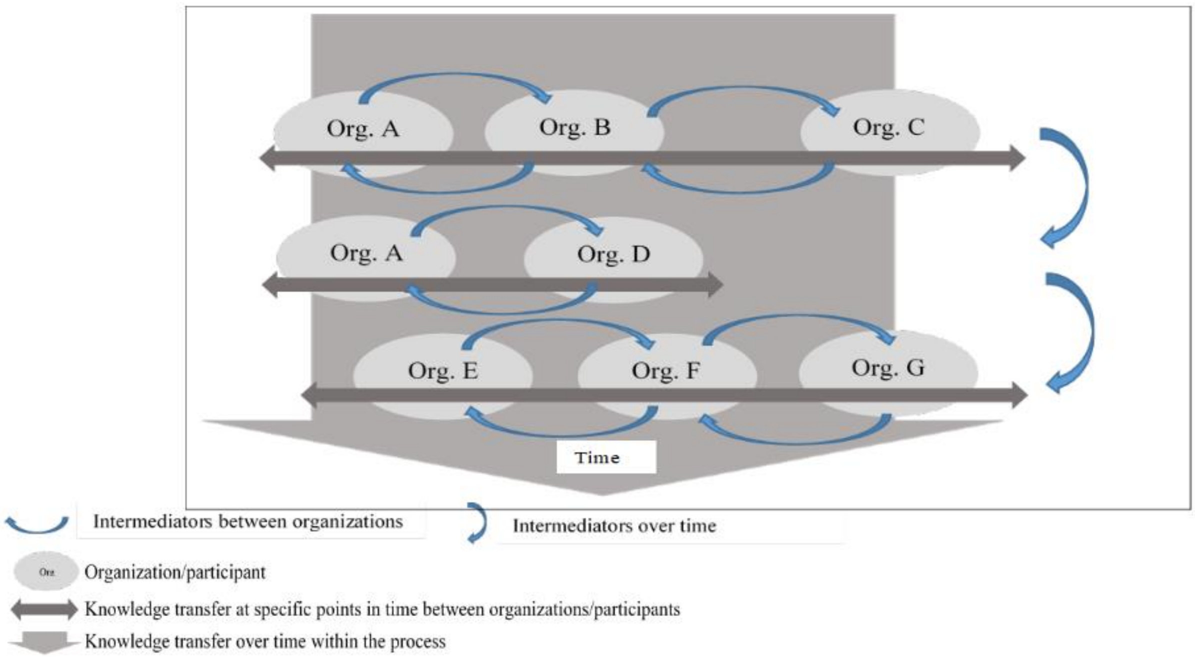

Figure 1intermediaries of knowledge transfer over time in integrated energy planning

4. Research questions and methods

With this work, we take a closer examination of the role of individual and/or organizational intermediaries influencing knowledge transfer in the integrated energy planning process to implementation at specific points in the planning and implementation process. Ongoing research results in projects based in Norway, Spain, France, Sweden and Austria address the research question in two ways. Firstly, we examine what is the role of intermediaries in the early and later planning phases and secondly, we examine the impact of time, which changes the role of intermediaries between planning and implementation stages. The projects focus on different underlying concepts – smart energy communities, nearly zero energy neighbourhoods and carbon neutrality – but have in common an objective to reduce energy consumption and create a sustainable living environment in an urban environment. The results presented here are part of an ongoing investigation and the table below illustrate details of each project:

Table 1 Aim and methods of projects

	Project aim	**Method**	**Focus of data**
PI-SEC (2016-2019)	Investigation of municipal planning instruments and key performance indicators in the planning and implementation of smart energy communities	Documentation review and 20 semi-structured interviews with public and private sector.	Develop an understanding of the status quo of urban planning activities and the current link to reducing energy use and utilization of local energy generation in the area.

	based in Bergen and Oslo, Norway		
Smart Itz GoeS	Analyses of different options for low to zero carbon refurbishment for planning Goethesiedlung neighbourhood in Salzburg-Itzling, Austria	Development of three scenarios until 2020, 2020 to 2040 and after 2040. Scenarios are defined by life cycles of the buildings.	Outputs for a long-term vision to serve as a basis for one or more implementation projects.
ZenN (2013-2017)	Tracking building renovation in 4 European demonstration projects to significant reduce energy consumption on a neighbourhood scale.	Cross case analysis of 37 semi-interviews with building owners, design/construction consultants and end-users in each participating demonstration country.	Emerging challenges, solutions and opportunities in ZenN renovation.

4.1 PI-SEC

PI-SEC is a three-year project started in 2016, funded by the Norwegian Research Council, investigating municipal planning instruments and key performance indicators in the planning and implementation of smart energy communities. In order to ensure the relevance of the work for municipal planning departments, the project follows two neighbourhood development cases in Bergen and Oslo in Norway. The work presented here is based on twenty-one interviews conducted in order to understand the use of different tools and approaches used in the two case studies. The interviews were approximately an hour long and followed a semi-structured design with a focus on the planning process and the relevance of energy use and generation within this process. The analysis of the interviews used the highlighting technique and combination of pre-defined and emergent codes.

4.2 Smart Itz GoeS

Smart Itz GoeS (Smarte Sanierung Itzling-Goethesiedlung) is an exploratory research project funded by the Austrian Climate and Energy Fund within its “Smart City Demo” project. It started in September 2015 and finished the end of 2016. The project analysis different options for low to zero carbon refurbishment in Goethesiedlung neighbourhood, Salzburg-Itzling. This decade was a period of intense residential construction activity in Austria. Today, an update to modern standards is necessary for these housing complexes built 40-50 years ago. The Goethesiedlung neighbourhood is a social housing complex built in the 1970s and currently has about 2,500 inhabitants. It is under strong pressure to deliver higher quality accommodation as well as meet the increasing requirements for energy efficiency and carbon emissions reduction from the city. Based on these conditions, we use scenarios to examine the feasibility of an energetically ambitious and socially sustainable retrofit. In terms of energy supply, the redevelopment concept of the Goethe residential area focuses on a low-CO2 heat supply and the integration of solar technologies into the existing energy infrastructure. Three different development scenarios are considered for now until 2020, from 2020 to 2040 and after 2040. The life cycles of the constructed building are embedded in the development of scenarios. Subsequently, scenarios mirror requirements of diverse stakeholders – namely the housing associations, the energy network operator and other relevant stakeholders and are developed in an iterative process to an agreed long-term vision for the neighbourhood This long—term vision will then serve as the basis for one or more implementation projects.

4.3 Nearly Zero Energy Neighbourhoods (ZenN)

ZenN is a project funded by the European Commission's FP7 programme between 2013 and 2017. It concerns residential building renovation with an aim of significant reduction of energy consumption on a neighbourhood scale. There are four demonstration projects based in Norway, Sweden, Spain and France. The results presented here are based on the findings of a report on stakeholder awareness and behaviour aiming to understand the implementation of energy efficiency measures in the renovation processes. There were interviews with stakeholders (building owners, design/construction consultants and end-users) individually or through focus groups. Thirty-seven interviews were conducted by researchers from the four participating countries and were between one to two hours long.

4.4 Analysis

In the development of this paper, authors responsible for conducting research in the different projects were asked to examine the following questions in the analysis of their data.

- What are challenges developed within all projects?
- How challenges are addressed?
- Is there instances of knowledge transfer in their data?
- What type of intermediator processes and/or organization facilitates knowledge transfer?

In this way, researchers examined the same questions but in projects based within different phases. Authors examined these questions in the context of the projects, which they were focusing upon. The findings derived from this initial analysis led to an iterative process where authors discussed their findings and further explained their findings as the paper developed. Once findings from the individual cases studies responded to these analytical questions. The use of theories from intermediary and knowledge transfer literatures aided in the understanding of our findings. We further discuss our findings drawing on the contextual literature we used to understand integrated energy planning and approaches of its development based on communicative planning and technical tool/model development.

5. Findings

The following sections present the findings of the above projects. We first present the PI-SEC project as it illustrates the early challenges of transferring knowledge and the use of intermediaries; Smart Itz GoeS represents developed ideas in linking energy ambitions in the planning processes based on scenarios and ZenN represents intermediary actors in the implementation stage.

5.1 Development of energy ambitions in the planning process - PI-SEC (Early phase)

PI-SEC follows two cases, which are neighbourhood developments in Norway. The first case is Furuset. This case includes the smart renovation, densification and upgrading of the social attributes of an existing neighbourhood of Oslo. This project's driver is the municipality of Oslo and the FutureBuilt association. The second case, Zero Village Bergen, is a flagship project of 800 innovative buildings with a high solar energy generation potential. Both projects started in 2009 and are still primarily in the early planning stage. The purpose of investigating these projects is to develop instruments for linking land-use and energy planning in municipal planning departments. The findings presented illustrate that knowledge is created early in the project process with the objective of being implemented but activating this knowledge into decision-making is not always clear. In this way, there is a lack of intermediary processes established within this planning process to aid knowledge transfer.

5.1.1 Ill-defined multi-criteria

Municipal planners expect neighbourhood-level projects to include a scope of multi-criteria such as citizen behaviour, transportation of people, goods and services. However, in practice, the process behind this scope is not well defined. Therefore, stakeholders find it challenging to tackle neighbourhood-level ambitions. Land-use planning and energy system planning needs alignment with each other in order to implement energy efficiency and energy generation in neighbourhood projects. In PI-SEC, financed activities facilitated alignment with land use planning and energy use systems, for example, digging up the park to fit an energy storage to develop the infrastructure. These necessarily additional costs for energy ambitious buildings and renovation of older buildings require increased investment into the surrounding infrastructure (i.e. transport) for optimal socio-economic conditions or/and sustainable behaviour aspects. However, private investors are reluctant to further contribute to the finance of infrastructure as it starts to cut into their profit margins based on their initial investment into buildings. Private investors want profit from investment, which does not always align well with the expensive of implementing a sustainable neighbourhood driven by municipality's plans and target to reduce carbon emissions. In this problem of aligning profit and sustainable agendas intermediaries could be used through the communicative planning approach to build consensus. However, this was approach was not engaged for this challenge.

Within PI-SEC, there is a time dependency for knowledge but not necessary a widely held knowledge of when to engage professional expertise. Late design of energy infrastructure links to the design of buildings and if they do not complement or align well with each other, there may be a reconsideration of agreed plans. For example, in one of the PI-SEC cases, the construction of a public square was put on hold in order to decide whether to put an energy storage under it. Knowledge transfer between the stakeholders of early concept development and the stakeholders responsible for the implementation of a sustainable energy system was not present in this context. There was no clear intermediary process to align the different knowledge bases and time played a role. There was no continuous vision holder or intermediary making sure the first ideas (including spatial qualities) and continuous knowledge transfer to link stakeholders responsible for the plans at the early stage to the final stage, but also because political interests in the city and district changed over time.

The multi-criteria in linking the various systems (e.g. infrastructure and energy) are ill-defined, but broader aspects when energy use needs consideration in a neighbourhood scale. Traditionally, participatory processes focus on social aspects of urban developments, such as liveability, aesthetics and safety. Energy-efficient neighbourhood development should also address the needs and habits of citizens in terms of energy use. Design workshops are a participatory tool to facilitate intermediary processes to transfer knowledge but can be performative. In PI-SEC, design workshops were used as an intermediary process to engage citizens into the planning process, but the pitch of the workshop was too technical for citizens. In this way, while information was transferred, the workshop as an intermediary process had minimum impact for knowledge transfer. However, the knowledge bases from citizens as energy users is difficult to access and therefore the intermediary process of participation is exposed to what participants is available. Participation in workshops sometimes depended on citizens who were available during the day. In the case of one workshop, citizens were elderly and children. This had limited benefit to the development of the area as the agendas of citizens were for the short term and not the long term, which is required for planning. However, the short-term nature of citizen's agendas in this context may not be relevant for the long-term insight required for planning.

"*The children have now grown up and are not that interested. The old people mostly participated to object when the road was planned. They were scared it would increase traffic through the area". (Municipal interviewee).*

Municipalities in interviews highlight a gap between the type of information needed and gathered through citizen participation. Participatory processes can be intermediaries if they are designed in a way that allows local residents to provide input that is directly relevant for energy efficiency and generation as a focus of neighbourhood planning.

Actors responsible in the planning process as well as different professionals (architecture and urban planning) mediated through knowledge generated early in the process; very different professions (energy systems engineers and business developers) form the later knowledge base. These two groups come from different knowledge bases and speak different languages. There is a lack of continuation of knowledge mediation as different knowledge bases come to the fore at different times of the planning process, resulting in key participant knowledge no longer appearing relevant as new project participants gain prominence as plans progress in time.

5.1.2 New territories in linking planning to energy

The early involvement of utility companies do not align well with current regulatory frameworks. Energy utilities do not know if they will be the distributors for a said area both due to unpredictability of construction and competition regulations. In this way, the long time and the uncertainty of the situation makes it unclear who to engage in an intermediary process and how to maintain knowledge transfer continuously from early planning to implementation stages.

The lack of intermediary process for knowledge transfer is clear when urban planners consider the time to engage utilities companies in the planning process. The planning of energy systems is the domain of energy providers and their involvement is necessary to understand the energy aspects of the area. However, there is a reluctance to engage with each other. Urban planners perceive early involvement would complicate the planning process, whereas the utility companies cannot see a reason as to why they would need to be involved early in the planning process.

"Most stakeholders do not want utility companies to participate in early meetings, as it would complicate the process" Urban planner

"We don't have incentives to participate in early meetings between private developer and municipality. They have a reason to be there, we don't" Utility company

There is no clear leadership on how to direct the planning with the inclusion of energy aspects. Private stakeholders see the high demands regarding energy efficiency and generation from municipality related to higher financial risk than conventional building plans, and therefore there is a need for incentives to influence first movers. While the municipality see the situation as everyone waiting to see who will be the first movers, the utility companies identify the municipality as needing to take up a leadership role.

"Now we have a situation where everyone is waiting for everyone to make the first move" Municipality

"The municipality should lead the way" Utility company

There is many knowledge bases in the early planning phase but little willing to engage in an intermediary process that would result in knowledge transfer and consensus building due to a lack of uncertainty on how visions will be realized in the future. Municipalities do not have the power to ensure energy ambitions set in the planning phase will be realised in the implementation phase. Planners are sceptical about projects promoting energy efficient development, as they cannot create legal binds for the energy targets, which may lead to promises by partners unfulfilled. Private developers, on the other hand, expect quicker and more transparent case handling processes if they are to commit to fulfilling the demands.

6.1.3 Need to utilize links of consequences and decisions

There are processes in place to facilitate knowledge transfer in neighbourhoods being planned for in PI-SEC, but such processes are not always utilized within the planning process. Norwegian planning has a history of many projects having restrictions but still failing to complete directives and decisions. The municipalities are becoming heavy handed in their goal to meet climate emissions reduction targets. On social aspects and spatial quality aspects however, no one is accountable for the results that come from participatory processes with citizens. Responsibility in the planning and implementation of the pilot cases suggest that there is a need for tools to act as intermediaries to city planners in integrating the investigation of alternative energy scenarios into their daily work.

'It is in the regulation plans that we have the possibility to integrate extra ambitions and to ask for these to be evaluated regarding to consequence – but someone has to ask for this to be done' (City planner, Bergen).

Recent changes to the Norwegian Planning and Building Act in 2015 require large building areas of more than 15 hectares to be evaluated for consequences (konsekvensutredning). This leaves room for integrating energy ambitions more clearly into the planning practice system. It would allow decision makers to be aware of the interrelations between physical planning and the energy systems, as the consequences reports allow to put conditions for bikes, walkability charges etc. which influences energy systems; and thereby providing a starting point for measuring consequences of decisions made about either.

"We depend on predictability, regarding the development of a neighbourhood, before we make energy plans for customers" (Utility company).

The consideration of consequences of decisions may be a step towards enabling the predictability that utility companies are seeking for their plans for customers. The consequence report and preferences from public level can give narrower frames for what is allowed. Regulations that are more detailed give utility companies a better predictability of the shaping of neighbourhoods and a possibility for them to better simulate future energy solutions. In this regard, the consequence reporting could be regarded as one such intermediary process to bring knowledge about what may be, into a concrete function to make projects more holistic.

5.2 Use of scenarios for integrated energy planning - Smart Itz GoeS (Progressed planning stage)

Smart Itz GoeS project is a low to zero carbon refurbishment for the Goethesiedlung neighbourhood in Salzburg-Itzling with a current population of 2,500. Today, 40-50 years after construction, these social housing complexes need updating to modern standards. The Province of Salzburg in which these social houses are located intends to become energy autonomous and carbon neutral by 2050 and the City has adopted a Smart City Master Plan. However, breaking down these overarching goals to site-specific planning objectives and concrete actions is challenging. In the case of Salzburg, a citywide analysis identified the Goethesiedlung as a potentially suitable showcase for achieving carbon neutrality by refurbishment measures. The neighbourhood in Goethesiedlung is part of Smart Itz GoeS project and findings from this project indicate carbon neutrality will be hard to achieve in this neighbourhood in the short and medium term as the legal framework for social housing hampers the implementation of an energy ambitious neighbourhood. There is strong pressure for change with demands for higher quality accommodation and increasing requirements for energy efficiency and carbon emissions. In this section, we examine the feasibility of an energetically ambitious and socially sustainable retrofit based on the aforementioned conditions.

5.2.1 Developing scenarios to meet cities energy and climate targets

Three different scenarios for the periods until 2020, from 2020 to 2040 and after 2040 are developed for buildings in the neighbourhood in Goethesiedlung where solutions considered technical, economic and social aspects equal. In terms of energy supply the redevelopment concept of the Goethe residential area focuses on a low-CO2 heat supply and integration of solar technologies into the existing energy infrastructure. There are a number of approaches used to develop scenarios:

- Calculation of the current energy demand and energy consumption based on metering data and building standards;
- Tool-based simulation of the impact of the energy demand and the carbon emissions of the development scenarios;
- Assignments of costs (investment, operating costs) and effects (energy saved), calculation present values of all the costs, and of equivalent energy prices (price of 1kwh saved).

Scenarios are based on the following:

- ECO (low cost, currently available in existing structure) 2020 scenario. This consists of measures which can be implemented in the short run (until 2020) with little financial effort (e.g. improvements in the building operation, installation of photovoltaic or solar thermal installations)
- High Performance (major investment, based on current systems) 2020-2040 scenario. This scenario entails measures of the ECO scenario plus improvements of the building envelope, replacement of radiators and use of heat pumps for warm water supply, which

would significantly reduce the thermal energy demand for heating and warm water supply.

- Future Performance (foreseeable future technology, rethink current systems, capital intensive) 2040 and after scenario. This scenario entails capital-intensive measures, which can be implemented in the long run. The installation of a new energy system using low thermal temperature energy from heat pumps and replaces the current district heating system. Large-scale deployment of new renewable energy systems and the energy efficiency is drastically increased.

The following section discusses how the results of the economic feasibility of implementing energy ambitions over the short and long term were discussed and led to consensus building across different stakeholders.

5.2.2 Scenarios for cost-benefit analysis

The scenarios were useful as a tool for the intermediary process to facilitate possible futures in terms of economic value. None of the scenarios structured a yield with a high revenue return for building developers of Goethesiedlung. This was true even under the most favourable conditions, i.e. overcoming all barriers to implementation and refinancing. There was no scenario, which yielded sufficient revenue return to finance investments entirely even if the energy savings would be beneficial for the developers. It is therefore necessary, in all the cases examined, to provide financial funding support to stimulate the retrofit in Goethesiedlung.

The ECO scenarios were closest to economic feasibility, while for the high performance variants illustrated energy savings potentially used to cover around 30% of the investment cost. It was not possible to calculate the economic feasibility of the future performance scenario, but as the related investment cost for the energy infrastructure would be much higher than in the high performance scenario, its economic feasibility is highly unlikely.

These scenarios became part of an intermediary process and facilitated the project team in decision-making drawing three conclusions from the results of this analysis:

1) *Need for integrated financing:* As energy savings are not sufficient to finance the refurbishment, additional sources for the refurbishment of the area are needed. One of them is moderate densification by adding additional floor space on roofs or underused parking spaces. This strategy requires an integrated planning approach, as it has consequences for the built and open spaces, the transport network and the social infrastructure of the area.
2) *Need for integrated planning approaches:* Rents in social housing in Austria are basically fixed, so the incentive of low energy prices, energy savings and carbon reduction alone will

not convince housing companies or political decision makers to take financial and political risks of refurbishing in existing district. It became apparent in the project that additional arguments related to improving the quality of life of the local population are needed to convince decision-makers to proceed with refurbishment. Therefore, the project consortium decided to develop an integrated vision for the future of the neighbourhood, addressing carbon neutrality and energy savings, but also quality of the apartments, the quality of the open spaces, sustainable mobility, and citizen engagement. This integrated vision was discussed with political decision makers and experts from the public administration, and it was well received.

3) *Need of an energy system perspective:* Due to difficult framework conditions for financing the refurbishment of social housing complexes, the suggested refurbishment activities will reduce the carbon footprint of the neighbourhood, but will not lead to carbon neutrality in the short and medium. In order to realise this, it would be necessary to decarbonize the district heating system, e.g. by using deep geothermal energy as main heat source. This would be technically possible, but it would require significant changes in the business model of the local utility company. Such changes cannot be achieved in the short term, but need a rather long-term transition process.

Scenarios presented here examined economic value on energy aspects were a useful to stimulate an intermediary process amongst stakeholders. The scenarios opened up a platform for discussion of potential economic results would mean on social aspects. Local politicians, planners and other stakeholders considered social aspects as equal to economic ones. These social aspects included the improvement to quality, affordability of housing, providing new transport options and designing of open spaces as equally important as reaching ambitious energy and climate targets. The scenarios indicated that there was no way to finance an “energy only” scenario. Refurbishing the district to anything close to carbon neutrality is only possible if new apartments can be built in the district or other used can be brought to the district. A prerequisite for this is a holistic analysis and an integrated urban design concept for the district.

Neighbourhoods cannot be analysed and planned in isolation. Urban design, citywide energy system as well as the stakeholder environment and the legal and regulatory framework have to be taken into account. Holistic approaches to refurbishment that go beyond mere energy aspects open up windows of opportunity for improving the quality of life in districts, but also in terms of business models and funding. The use of scenarios as part of an intermediary process opens up the scope where potential contradictions in the different priorities of planning a city addressed early and stimulate knowledge transfer from different stakeholders.

5.3 Intermediary actors in the renovation process of Zero Energy Neighbourhoods (ZenN) - (Implementation stage)

The ZenN project tracked the refurbishment of four high-energy performance neighbourhood projects in Norway, France, Sweden and Spain over 4 years. All projects are between 1 to 3 building blocks and were completed in 2016. The following explores diverse perspectives of the challenges that arise during the implementation of the renovation project and initial operation. The findings are from interviews with residents, renovation project participants and building owners.

5.3.1 Intermediary actors facilitating acceptance of new energy targets in ongoing projects

While all projects had energy ambitions, these targets increased after they received funding won by their municipalities from the EU. At the time, zero emission buildings and neighbourhoods were new concepts in the building industry and not necessarily widely understood by all stakeholders. Projects teams were sometimes sceptical that energy efficiency targets could be reached and their initial reactions to the funding from ZenN was often viewed as being disruptive to project processes rather than facilitating them.

"*What is this &£%?*" (Project Manager I) or "*again another funding procedure that will lead nowhere*" (Project Coordinator I).

There were concerns that project goals would need to change in order to accommodate these increased ambitions. In one project, there was a lot of disagreement among stakeholders on how to implement the changes in a project that had already started but a 'collective spirit' came together facilitate by the intermediary skills of a contracted Energy Assistant. The energy assistant had knowledge on technical elements that showed project and energy objectives were achievable, but he delivered this message with a positive discourse ensuring it would be "fun" to develop. In this context, the technical solutions were available, but the individual intermediary skills of the Energy Assistant introduced a calm and a positive outlook to developing energy solutions for the neighbourhood. The below indicates the outlook which the Energy Assistant wished to support in the project team.

> "*It is not easy to (implement new idea) well into the project conception and then, have another step, another set of objectives to meet with yet another actor in the middle*

controlling their actions. Yet, (the project team) took this as an opportunity rather than a nuisance. And that made the whole difference" *(Energy Assistant).*

5.3.2 Intermediary actors between project decisions and impact on residential behaviour

Two-way communication between project team and end users is important to ensure understanding of expectations of energy behaviour in the use of a building. One example of this came up in the decision on the type of insulation installed in the walls, which reduced the floor surface of the balcony. While this met the goal of reducing energy demands in the neighbourhood, the reduced space was problematic for residents who used the balcony for their washing machines. There was intermediary actors involved in the project process, which facilitated the solutions for this problem. These actors were the residential committee who represented residents of the apartment and the Architect studio responsible for informative meetings with residents and clarifying their technical doubts about the renovation. The Architect studio was also responsible for overseeing the construction company's performance in order to guarantee the quality of the renovation, and to inform the residential committee about different problems and alternatives for decision making during the renovation. In order to address the problem residents had with the type of insulation for the balcony, the architect engaged the project team to think further of how to reach a consensus in order to continue to meet energy efficiency goals of the project and maintain residential current usability practices of the living space. The agreed solution was to change the material of the balconies from brick to thinner phenolic panels, which gained the necessary space for the insulation. This type of intermediation between actors aided in the discovery of new, mutually accepted solutions amongst the project team and residents'.

5.3.3 Intermediary actors in neighbourhood use

There is a necessary adjustment period after an energy efficiency renovation is complete to allow users to familiarise themselves with how the technology impacts (or not) to their day-to-day living and to highlight any functionality problems that occur with the technology as it goes into full operation. In one demonstration, the project responsible was involved in both the project process and in the initial months of operations. She was an intermediary actor between building users and project participants, which was useful when problems became apparent in the initial months of operation. In some ways, she was a knowledge repository having developed experience from the project and then being present and available to building users in initial operation. Users of the building described the project responsible as being hands on and quick to address any of their problems and mis-understandings of the energy efficiency measures. She had the knowledge of who to contact in order to address problems quickly. One building user described the impact of her intermediation below:

"People have been available, I have had rounds of the building with the project responsible Friday evenings at 7pm, you know, we have had long days. They have made themselves available, I have nothing to complain about in that regard". (Building user)

6 Discussion and Conclusion

The development of integrated energy planning is an important part of Smart Cites as it increases the likelihood of meeting national carbon reduction targets on a city scale. However, there are clear complexities in energy planning as it involves a wide range of diverse stakeholders and it is not always known when to engage them within the long planning process (Dixon et al., 2014; Mirakyan and De Guio, 2013; Mirakyan and De Guio 2015 Vogel et al. 2015). It is clear from the planning literature that knowledge bases are important to coordinate and transfer knowledge. However, it is unclear how and when to access different knowledge bases during the integrated planning process (Salvia et al., 2015) and hierarchal agendas can which prohibit this coordination (Dixon, Eames et al. 2014). Within this work, we found that the use of intermediaries as important for knowledge transfer across different practices, however sometimes the intermediary processes is not engaged so the decision making process is stagnated. This situation is unlike the implementation process where the time line for realisation of goals is within a near future, so when problems arise, intermediary actors are ready to engage. We found that tools like building scenario are a way of stimulating intermediary processes and knowledge transfer across diverse stakeholders.

Engagement to access knowledge is problematic in the early planning process. The early phase is at the start of a long planning period and futures becomes more uncertain as time passes (Mirakyan and De Guio 2015). Integrated energy planning is new to the municipalities and utility companies so it is not clear how decision they make will play out as time passes. In the early planning phases, our findings illustrate a clear sense of not knowing when to access knowledge of different fields as certain systems such as land-use and energy-use are reliant on each other but there is a concern of engaging them too early or too late. This is something shared in Vogel et al., (2015) study, when it was not certain of when it was too early or too late to engage diverse knowledge bases. However, we saw, at this early phase, a reluctance to engage with different stakeholders. Groups normally associate with the early planning phase (e.g. architects and urban planners) not wishing to engage to avoid confusion and stakeholder of the later stages (e.g. utility companies) not seeing the point of engagement. The disconnection between these two phases with no intermediary process for knowledge transfer may mean that early knowledge is lost on new decisions that these solution bring. Information received in a new context by different stakeholder can only infer meaning of original intent if the knowledge based actor cannot engage with the new context (Stein, 1995). This indicates there is a need for more explicit intermediary processes amongst key decision makers early in the planning process.

In the implementation stage, discussed through the ZenN project, intermediary actors played a key role in facilitating solutions to problems. These intermediaries interacted with different stakeholders to understand what was wanted and come up with ways to reach consensual based solutions. These social interactions aided for knowledge transfer (Javernick-Will, and Levitt, 2010) from different stakeholders to understand their different perspectives. The implementation phase differs from the early phase in that stakeholders are committed to the project goals and external funding facilitated their committed to energy goals. The early planning process has ongoing negotiation of goals and while the external funding was seen as needed to incentivise private industry, it was not there in this context. While in general the municipality are intermediary actors (Nielsen et al., 2017; Vogel et al. 2015), they do not have the power to implement decisions. Integrated energy planning requires changes in practice (Vogel et al. 2015; Narvestad, 2010) and municipalities are in a learning process while at the same time making sense of the situation.

Communicative planning approaches aspire for shared understandings amongst diverse stakeholders to address the rights and issues of all those affected (Sager, 2017; Innes and Booher, 2014), access to the right stakeholders is not so easy. While there was minimum use of intermediary processes in the early phase of the PI-SEC cases, there were some design workshops engaging citizen perspectives. This is clearly supportive of an intermediary process for knowledge transfer to gain interaction of citizen wishes and municipality plans. Citizens who attended these workshops were primarily elderly or children who views were the short term. The question arises how intermediary processes be used to engage citizens with long-term views of the planning process.

There have been a call for tools to become more comprehensive and holistic to respond to the needs of sustainable districts but there are too many elements to consider in one model (Chauhan and Saini, 2014) so models exclude energy related area which impact energy planning (Calvillo et al., 2016 and Kelman et al., 2012). In addition, tools are criticized for not considering social and organizational aspects (Schweber and Leiringer, 2012, du Plessis and Cole, 2011, Schweber, 2013). However, the use of scenarios in our findings indicate that focusing on certain elements, such as economic implication of energy solutions do lead to broader discussions, such as how economic value affects social values as in the case of Smart Itz Goes. In this way, while the data from tools may neglect social and organizational aspects, but facilitate an intermediary process for knowledge transfer in creating discussion of data amongst different stakeholders. The results of the scenarios guided the stakeholders where they needed to focus their attention, as these results while not providing certainty in the future, allowed them indicative data of where they needed to put energy into solutions and development leading to progress in the decision making of this planned area.

Overall, this work has implications for integrated planning practices to become more aware of the role of intermediaries in resolving issues early in the process. Actively seeking out intermediaries and make use of current intermediary tools in place could potentially speed up decision making in planning processes. The data and results from planning tools should not be seen as an end in itself, but part of the intermediary process to stimulate discussion across different knowledge practices. Intermediary is ongoing in the implementation stage but is more actor oriented and reactive to problems than in the planning stages.

The limitation of this study is that we have examined intermediary processes for knowledge transfer at particular points in time in different projects, in order to see how intermediary processes are used for knowledge transfer over time, a longitude study is required. Such a study would be beneficial in developing capabilities of when intermediary processes are needed for knowledge transfer rather than continuously questioning the time dependency point to access knowledge from actors responsible for different systems relevant to integrated energy planning.

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