Technological Forecasting & Social Change 142 (2019) 142–153

Contents lists available at ScienceDirect

Technological Forecasting & Social Change

journal homepage: www.elsevier.com/locate/techfore

Identifying and supporting exploratory and exploitative models of innovation in municipal urban planning; key challenges from seven Norwegian energy ambitious neighborhood pilots

Brita Fladvad Nielsen[a,*], Daniela Baer[b], Carmel Lindkvist[a]

[a] Department of Architecture and Planning, Norwegian University of Science and Technology, Norway
[b] SINTEF Byggforsk, Norway

ARTICLE INFO

Keywords:
Smart Cities
Smart energy communities
Explorative innovation
Sustainable urban planning
Integrated energy planning
Zero emission neighborhoods

ABSTRACT

The planning of energy ambitious neighborhood pilots in Norway typically begin with the creation of holistic and socially ambitious visions based on extensive stakeholder collaboration, citizen insight generation and vision setting. However, as projects move from planning to implementation, the exploratory innovation methods are replaced by exploitative approaches. 'The holistic vision and in particular, citizens' described needs, fail to transfer into the implementation phase. This paper identifies four main challenges as to why this happens and link these to theory on ambidextrous organizations that need to exploit existing knowledge while reaching into the future with its rapidly changing goals and technological opportunities. Implementing stakeholders are familiar with exploitative tools, which build on earlier experience and capabilities of the selected implementing stakeholders, and the implementation stage leaves little time and resources for innovation on a lower hierarchical level. While extensive research on smart and integrated planning focus on 'breaking down the silos' meaning sectors and disciplines, our findings argue that the need to manage ambidextrous organizations and support both exploratory and exploitative innovation is equally important. An ambidextrous organization is one that has the ability to be efficient in its management of today's business while being adaptable for coping with the changing demand of tomorrow. We propose a model in which the organizational style and management style of innovative neighborhood pilots focus more on how to transfer knowledge and learn from the bottom-up and horizontally through management that foster both innovation models.

1. Introduction

Increased focus on the integrated energy planning in cities offer an opportunity to reduce climate change impact as a driver for transformative action on sectoral, demographic, spatial and ecological aspects (Hughes, Chu and Mason, 2018). Smart Cities while technologically oriented offers a broader scope into cities in terms of governance and citizen engagement. Indeed, Lee et al. (2013) argues that Smart Cities diverges from other city concepts such as "digital city" or "intelligent city" where the focus is still on technical factors but also extends to social factors. Smart city studies (Hall et al., 2000; Hollands, 2008; Kallaos et al., 2015; Söderström et al., 2014) emphasize how the potential that arrives with novel and 'smart' technologies can be redefined, integrated and developed to meet cities and citizens' needs based on feasible ways of planning cities. Even though among Smart Cities promises is to 'break down silos', smart city efforts are so far limited to certain sectors and in particular the energy sector. Smart city efforts in Europe are so far heavily influenced by the energy sector as illustrated with European Commission promoting "the smart city" calls regarding energy efficiency, renewable energy and green mobility for large urban cities. European smart city initiatives are largely linked to energy integration, focusing on the development of "high performance" zero energy cities (Kylili and Fokaides, 2015). In Norway, this view is supported by the EU funded research funding schemes influencing municipalities in the direction of positive energy districts and zero emission neighborhoods. Energy ambitious pilots are a common term used for neighborhoods or communities' testbeds where data on resource flows, zero emission building technology, socio economic needs and behavior are mapped. Problems that arise in these pilots are addressed by adapting the built environment and the energy system infrastructure accordingly. This will contribute to building the most resource rational and renewable energy based, and near zero emission

* Corresponding author.
E-mail addresses: brita.nielsen@ntnu.no (B.F. Nielsen), daniela.baer@sintef.no (D. Baer), carmel.lindkvist@ntnu.no (C. Lindkvist).

https://doi.org/10.1016/j.techfore.2018.11.007
Received 19 December 2017; Received in revised form 31 October 2018; Accepted 12 November 2018
Available online 19 December 2018

city. Such pilots, which we in this paper will refer to as 'energy ambitious pilots', are terms that can be regarded as subcategories of the larger, full-scale smart city scenario.

1.1. Trajectories of innovation in Smart Cities

Energy ambitious pilots aim to be groundbreaking, in that their expressed ambitions challenge 'silo thinking' and ask for new models of energy use, production, flow, integration and relationship between buildings, neighborhoods, citizens, environment and more. The scope of European efforts is further to change municipal innovation practice by re-shaping organizational structure in the decision making bodies.

It can be useful to divide existing smart city theory into two distinct trajectories. On one side, of exploratory innovation discourse based theory, dealing with multiple factors including not only energy awareness but also spatial qualities, social inclusion, and multiple qualitative and value based visions created in collaboration with stakeholders and citizens involved in the first step of the planning.

On the other side we can find analytical and verification oriented models for smart city planning, focused on technical, indicator and data analysis. These are frequently related to technology and economically oriented disciplines. This theory supports an exploitative innovation model, which is instrumental and following quantitatively supported measurement and evaluation frameworks.

In this way the explorative trajectory relates to an explorative innovation model. Exploration involves search, variation, risk-taking, experimentation, play, flexibility, discovery and innovation. Exploitation can be defined as refinement, choice, production, efficiency, selection, implementation and execution.

"Environment acts frequently have to be understood in terms of relationships among events, actors and structure in the environment, not as responses to what the organization does" (March and Olsen, 1975) The environment of where change occurs matters as does the internal and external contexts which shape exploration and exploitation (Lindkvist, 2015). Learning can be exploitative, building on the experiences of known ideas or explorative which is exploring new ideas (March 1991). Both types of are necessary to ensure current and future viability of an organization but balance is necessary between the two as too much of either limits learning for innovation (Levinthal and March, 1993).

In a Smart City lens, the first trajectory, exploitation frequently includes structured, technical/tool oriented approaches focus on developing indicator based and instrumental tools to measure and monitor developments towards smart and sustainable cities based on the increased amount of data available through smart technology (Kallaos et al., 2015). The most cited definitions of Smart Cities include instrumental and indicator based views on Smart Cities, dealing with "the computation of assigned weights for the considered indicators (…) defining a model that allows us to estimate 'the smart city', in order to access 'European funding' and 'to help in policy making process as starting point of discussion between stakeholders', as well as citizens in final decision of adoption measures and best evaluated options" (Lazaroiu and Roscia, 2012). Measurability is a key attribute of an indicator and hence this aspect is important in these approaches. A significant amount of smart city research emphasize that evidence will support decision-making among urban decision makers (Al Nuaimi et al., 2015). They include but are not limited to key performance indicators, step-by-step process tools or tracking/sensing and monitoring systems. Smart technology simply refers to 'Self-Monitoring Analysis And Reporting Technology' (Zoughbi and Al-Nasrawi, 2015). The SMART technologies basically monitors and analyzes hard drives (hence the name), then checks the health of your hard drive and lets you know if there are any problems. Newer and expanded descriptions refer to technologies that are capable to adapt automatically and modify behavior to fit environment, senses things with technology sensors, this providing data to analyze and infer from, and drawing conclusions from rules. It also is capable of learning that is using experience to improve performance, anticipating, thinking and reasoning about what to do next, with the ability to self-generate and self-sustain. Technologies that allow sensors, databases, and wireless access to collaboratively sense, adapt, and provide for users within the environment. Such 'smart' technologies are currently found in housing designs for elderly and educational environments similar to sensors and information feeds within museums, and in smart energy monitoring (Elwood, 2010). Indicators are often used as a way to provide 'technocratic policy-making' where the policy process is linear and indicator informs on that process through measurability, validity and transparency (Holman, 2009). However, such an approach neglects uncertainty of cities which have a non-linear nature of change and any change is for a long-term period. Urban decision-makers are often constrained with short time-scales and the immediate spatial scale of their jurisdictions with 'nested' governmental hierarchies (Dixon et al., 2014a; Dixon et al., 2014c). In reality, a broad network of actors drives change from both inside and outside government (Holman, 2009). The critical challenge for contemporary urbanism is to understand how to develop the knowledge, capacity and capability for public agencies, the private sector and multiple users in city regions systemically to re-engineer their built environment and urban infrastructure in response to climate change and resource constraints (Eames et al., 2012).

"It is common practice to optimize only one specific parameter without taking into account that municipal decision makers have to face a multitude of criteria" (Harrison et al., 2001). While we agree taking in multicriteria is no easy feat, it is crucial in developing Smart Cities if to succeed at reducing energy use and emission. Smart energy communities and zero emission neighborhoods need to meet social, economic and environmental needs/goals simultaneously, while integrating energy. Smart technology is therefore mere enablers to reach these integrated objectives; yet they do not provide the visions themselves.

Which new opportunities that Smart Technology and the availability and management of big amounts of data concerning people's behavior, energy use and environment provide is for decision makers and advisors to manage and direct. Technology developers depend on clear and meaningful needs assessments from these decision makers.

This second, explorative innovation, trajectory in smart city research takes a rather narrative form (Hall et al., 2000; Söderström et al., 2014) which include adapting to the visions of technology enabled, holistic futures, that the instrumental exploitative approaches cannot. Explorative innovation heavily depends upon narrative forms sensemaking as a whole and cannot be picked apart in the way that the exploitative approaches can. Within this context, a problem is treated as the 'things' of the situation with focused associated boundaries in order to develop coherence of the situation and explore what is wrong in the situation and directions which need to be changed, thus rendering the subjective into something tangible (Weick, 1995). Narrative forms are in other words mainly qualitative and need qualitative approaches to guide them (Hall et al., 2000). A narrative makes sense as an entity, and carries meaning as such. Theory on visions mention broad and ambitious ideas that are value oriented such as '*The vision Iof "Smart Cities" is the urban center of the future, made safe, secure environmentally green, and efficient because all structure*' or "*sustainable and livable cities*" (Hall et al., 2000; Lee et al., 2013). 'Sustainable development' is in itself such a narrative, that stops making sense if we don't look at it as a combination and interrelated balance of social, economic and environmental aspects. Urban planning can in itself be seen as storytelling (Guhathakurta, 2002), where the use of meta-narratives (Campbell, 1996) and the need to understand past and future orientation is highlighted for making sense of complexity.

The link to different innovation models, explorative and exploitative innovation, makes it important to investigate further, because the two trajectories and differences in innovation process may indicate that the two need different support mechanisms to ensure their influence. The

creation of a holistic and 'good' neighborhood in the face of rapidly changing technology options and market models depend on leading organizations that can balance these two.

In order to study the relationship between the exploitative and explorative trajectory in real planning situations, we investigate how these two are applied and balanced in seven Norwegian 'energy ambitious pilots'. By 'energy ambitious pilots' we refer to first time full-scale design and implementation of innovative ways to integrate energy aspects beyond the building level and onto neighborhood thinking.

By exploring these seven cases, we seek to outline the main key challenges as experienced by the involved actors, and that relate to the described division between explorative and exploitative approaches. More specifically, we seek to answer the questions:

1. Which challenges related to explorative and exploitative innovation processes arise when designing and implementing energy ambitious neighborhood pilots?
2. Which impact do these challenges have on the final and implemented design?
3. How can theory from explorative and exploitative innovation research provide support to face the identified challenges?

1.2. Theoretical perspectives of Smart Cities and integrated energy planning

Smart Cities is underpinned through both international agreements i.e. the Paris Agreement 2015 and on national scale when countries set targets on level of carbon emissions. In Europe, with different SCC funding calls. In Norway, as in other European countries, energy integration is high on the agenda of smart city demo projects. Norway's aim is to reduce its emissions by at least 40% by 2030 compared with 1990 levels and be carbon neutral by 2050 through the reduction of domestic greenhouse gas emissions (Alonso et al., 2013; EU Emissions Trading Initiation, 2016). The policy driven approaches incentivize municipalities to think about new applications for driving climate change solutions. Cities are targeted for reduction of emission to aid Norway with its target with as the urban population is increasing and global efforts to reduce carbon emissions are hence focused on cities' ability to reduce them.

The densification and infrastructure of cities also offer the opportunity to utilize Big data as a cross-cutting enabler for developing sustainable efficient solutions that can be monitored and changed based on real-time evidence. Smart Cities through using pervasive technologies enables the access to large amounts in real time data and information on citizen's behaviors. Data is derived from media, consumer sites, search engines, smart phone apps, smart utility meters, credit card transactions, CCTV, etc. (Viitanen and Kingston, 2013). The applications of such interoperable databases enable the possibility for town planners and administration bodies to use information sharing platforms for actions with the objective to improve citizens lives (Dobre and Xhafa, 2014). The UK government strategy for Digital Built Britain aggregates and combines data-sets connecting them with Smart City and Smart Grid initiatives (Whyte et al., 2016). There is a clear discourse here that there are mechanisms to support a smart city, but possibilities is the underlining narrative within the technological discourse as in practice these possibilities implies an understanding that city planners know what type of data can be produced without being overwhelming and how they can apply it in planning a city.

Norwegian researchers have added influential knowledge to the zero emission building (Marszal et al., 2011) literature, and contributed to high standard requirements in terms of passive house thinking. In terms of energy ambitious neighborhoods, integrated energy planning (Mirakyan and De Guio, 2013; Swisher et al., 1997) has been the most prominent term used within research. The planning of neighborhoods and communities that take into account the crosscutting issues of energy; from energy awareness to sustainable behavior and energy utilities role (Eising and Jabko, 2001; Nielsen et al., 2017) and market regulations, requires that zero emission building knowledge expands to include insight into how the practice of city planners can facilitate energy ambitious neighborhoods. While engineering based research sectors such as ZEB may advance significantly based on instrumental and exploitative approaches, urban planning is complex and may depend on an adaptation of these to a more explorative form. This complexity is reflected in the "co-evolutionary and non-linear nature of change which incorporates a range of actors and networks operating over long time-scales" (Dixon et al., 2014b). Urban planning is includes a diverse picture of 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). Within our work, we focus on the energy use and supply aspect to understand, involving stakeholder within this sector early has on the planning process. According to Resch and Andresen, (2018), normally urban planning considers spatial characteristics of an area first while energy planning is carried after planning has occurred. However, the single disciplinary by disciplinary approaches is insufficient to realize sustainable ambitions of cities as an integrated disciplinary approach is envisioned to lead to goals being realized (Resch and Andresen, 2018).

While this aspiration in promises sustainable measures to have increased capability to be realized, the process is not straight forward. Studies on integration of idea/knowledge of multi-disciplinary teams highlights the challenges of that integration can be enacted where teams seems to be performing integration acts, but in reality they return to their own known practices (Moe and Lindkvist). Diverse stakeholders in urban planning have the potential to implement changes and work together resulting in agreed solutions, it is not always clear who takes responsibility to implement solutions into planning (Svenfelt et al., 2011). Indeed, the integration of knowledge between each stage of the planning process to implementation lacks clear intermediary processes and actors for knowledge transfer (Lindkvist et al., 2018). There are also shortsighted hierarchal agendas (Moe, 2016), 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 et al., 2014b). However, integration is not impossible if teams can work together through coordinated process (Whyte et al., 2016).

2. Method and scope

The empirical part of our qualitative study consists of 44 interviews with directly involved stakeholders from the planning of seven 'energy ambitious' community and neighborhood projects (see Fig. 1). By 'energy ambitious' we mean that the project and the involved stakeholders in the projects' conceptual phase have declared an intention to move significantly beyond the technical standards that are legally required in terms of energy reduction, energy production and energy use as a holistic design principle. Included in the PI-SEC project and the Zero Emission Neigbourhood project. The PI-SEC (planning instruments for smart energy communities) project is a cross-disciplinary research project at NTNU with the municipalities of Bergen and Oslo, while the pilot cases within the Centre for Zero Emission Neighborhoods in Smart Cities (ZEN) include also Trondheim, Elverum, Bodø, Evenstad and Steinkjer. In the ZEN Centre, a neighborhood is defined as 'a group of interconnected buildings (new, retrofitted, or a combination of both) and infrastructure (water, sewage, roads, communication and data lines) located within a confined geographical area and with a defined physical boundary to the electric and thermal grids'. The combination of buildings and infrastructure is below termed as 'built environment'. In the PI-SEC project, a Smart Energy Community (Nielsen et al.) is defined as 'an area of buildings; infrastructure and citizens sharing planned societal services,[1] where environmental targets are reached

[1] By societal services is here meant 'samfunnstjenester' as in the Norwegian

	City population (1.1.2017)	Project owner	Area size in m^2	Planned/Existing function	Construction	Phase
Elverum - Ydalir	14 877	Public (Municipality)	430 000	Residential area with a school and kindergarten	New construction: 1 000 dwellings (ca. 100 000 m^2), a school (under construction) and a kindergarten	Planning
Oslo - Furuset	666 759	Public (Municipality)	870 000	Multifunctional sub centre with 1 400 dwellings and 3 800 inhabitants, 213 100 m^2 (existing)	Retro-fitting/upgrading and new construction: 1 700 – 2 300 dwellings and 2 000 – 3 400 work places (up to 160000 m^2)	Implementation
Bergen - ZVB	278 556	Private (Developer)	378 000	Residential area with a kindergarten and additional services (planned)	New construction, 720 dwellings (92 000 m^2), a kindergarten and additional service functions	Planning
Trondheim -Sluppen	190 464	Public (Municipality)	275 000	Multifunctional sub centre with a mobility hub (planned)	Retro-fitting and new construction	Planning
Steinkjer – Former NRK site	12 744	Public (Municipality)	11 113	Kindergarten and dwellings (planned)	Re-use and new construction of 10-12 dwellings	Planning
Evenstad - Campus	2 530 (Municipality)	Public (University)	61 000	University campus (existing)	Building stock in use: 10 000 m^2, no further construction planned	Operation
Bodø – New City – New Airport	51 002	Public (Municipality)	3 400 000	Multifunctional city centre extension with residential and business areas (planned)	Re-use and new construction: 2 800 dwellings in the first construction stage	Planning

Fig. 1. The seven pilot projects.

through the integration of energy aspects into planning and implementation. The Smart Energy Community aims to become highly energy efficient and increasingly powered by renewable and local energy sources and lowered dependency on fossil fuels (Nielsen et al.). Its spatial planning and localization consider reduction of carbon emissions through its relationship with the larger region, both through the design of energy systems and by including sustainable mobility aspects of the larger region; it further encourages sustainable behavior through its overall design from building and citizen scale to community scale. The application of open information flow, large degree of communication between different stakeholders and smart technology are central means to meet these objectives'.

Each of the pilots are focused on a scale from building to neighborhood, meaning that it involves studying spatial planning, regarding it to include social, economic and environmental aspects of combined infrastructure, buildings, and 'full scale' living environments yet of different complexity. However, the common ground for these projects is that the political and spatial planning is conducted by a Norwegian municipality; leading to the focus of this paper being to provide insights relevant to municipal planning. In this paper we look broadly at planning on one side and implementation on the other, acknowledging that these can be broken into more nuanced categories. As can be seen from the table, one of the seven pilot projects, the ZVB pilot, is driven by a private developer while the municipality manages the respective cases. To include a private planned project in our analysis gives us the opportunity to compare different ways to approach planning. Part from this, the stakeholder presence can be said to be similar in each of the cases; including a municipal city planning office, a climate department/environmental officer, one or more private developers with a property agreement either with the municipality or private, and finally, one or more utility companies. Depending on the involvement in the two phases planning and implementation, of the neighborhood development, the stakeholders could be divided into planning and implementation stakeholders. With the planning stakeholders involved in the planning and design phase and/or the implementation stakeholders involved in the implementation phase.

The pilot projects are at different stages in the development, with Bodø and Steinkjer at a very early stage as the area for later ZEN development is still in use with another purpose. Trondheim and Elverum are actually working on the masterplan development while parallel to that the first buildings are erected in the coming 2 years. The masterplan development is completed in Bergen and Oslo. While Bergen is waiting for the approval, construction of the first buildings has started in Oslo. On Campus Evenstad the construction of a new administration building was completed in 2016 and the neighborhood is now in the operation phase.

2.1. Interviews

44 interviews provided insights into both the private sector and public planning sector view of the process. The totality of the interview data included a broad range of stakeholders, from municipal city planners, one regional governor, environmental departments within the municipalities, researchers, utilities, private landowners and consultancies. Within these seven pilot projects, we chose a researcher with an overview of the PI-SEC cases and the ZEN cases or the project owner as a starting point for interviews, and selected other key informants in each case through a selective snowball sampling approach. Our goal with the selection of participants was to gain as many perspectives on the project design and planning phase as possible.

The interviews were conducted as individual interviews and some as group interviews (Table 1).

The interviews followed a semi-structured interview guide, where we asked the particiants to go through the entire planning process from the beginning until present, in a narrative manner. The interviews were between 45 and 60 min each, conducted in person, with a strong focus on the planning process and stakeholder involvement. The participants were asked to explain the process from idea to implementation, in the tradition of narrative interview approach (McCormack, 2004). Due to the novelty of the object of investigation, a qualitative research approach with a narrative focus was useful. A narrative interview focus (Sandelowski, 1991; Webster and Mertova, 2007) entails asking the participants to tell their version of what happened, in a chronological manner. We asked each participant to give accounts for how they perceived the process of the planning and implementation of the pilot

(*footnote continued*)
Planning and Building Act 12.7: such as energy delivery, transportation and road net, health and social services, kindergartens, play areas and schools.

Table 1
Interviews per sector.

Type of stakeholder	Interview	Group interview	Total number of interviewees
Private developer	5	2	6
Municipal (urban planners and climate section)	21	1	21
Utility company	7		7
Private architect/consultants	2		2
Researchers	3		3
Regional authority	1		1
National road administration			1
Other	4		4
Total			44

projects. Storytelling is also appropriate in situations where people from different professional backgrounds need to be understood and analyzed in a comparative way (Jonassen and Hernandez-Serrano, 2002). We enriched the insights generated through a narrative focus by asking 'how' something happened rather than only 'what' happened and asking them to elaborate when the story mentions a conflict or a change of meaning. The narrative approach taken in the interviews further made the analysis, looking for narratives that could provide insights into the research questions, feasible: 'Which socio-economically related challenges arise when designing for integration of energy into urban planning through available tools?' and 'Which impact do these challenges seem to have on the final implemented design?'

3. Findings

From the interviews, we could extract insights into which tools were seen as more useful, as well as which tools the interview respondents think would be useful for such projects. Secondly, we gained insight into how the available tools influence the final and implemented design of the energy ambitious neighborhood pilot.

3.1. Available tools and the implementation of energy ambitious projects

We have defined a tool as a 'device or an implementation used for carrying out a particular function'. In order to decide which tools we need for the purpose of designing and implementing smart energy communities (SECs) and ZENs in Norway, we therefore need to understand which *functions* we are looking for. A function is an operation with a purpose. In order to understand which functions city planners need to fulfill to facilitate the implementation of SECs, we need to know more about the *purposes* of the stakeholders involved in the planning and implementation of SECs. Interviewees illustrate the range of meaning of 'tool'; a tool does not necessarily have to be a technical or physical object but can also be a social construction. For example, the participants illustrated this clearly by adding 'experience' as a relevant tool. This means that a tool can also be a relationship between two people sharing experiences; in other words, a meeting place can serve as a tool' (Nielsen et al.).

3.2. Tools applied in the planning of energy ambitious pilots

The figure below (Fig. 2) explains in blue which tools the involved stakeholders apply during the design of SECs, while the grey boxes include tools that they wish they had. The grey boxes are hence tools that they perceive would improve the design process and design.

We can divide these tools into explorative and exploitative innovation process tools.

By technical tools participants referred to the planning and building act, documentation, property regulation, climate and energy strategy, tools for calculating impact, technical requirements for buildings, sound shadow modelling, Norwegian standard, application procedures, localization.

By explorative tools they mentioned scenario building tools, simulation tools, stakeholder workshops, better integration of energy into urban planning, visualization, experience, incremental learning, buildings that facilitate sustainable behavior.

We further see that the participants describe a timeline where the explorative tools are applied at the beginning of the conceptualization of the neighborhoods and where the technical tools play a main role as the project approximates implementation stage.

The explorative approach is a part of urban planning practice. Other more exploitative and technical tool oriented approaches are also brought in early in ZEN and SEC projects than what has been the tradition of normal planning projects. This is because emission reduction depends on integrating energy and construction to the complex city planning earlier in the planning process. The explorative innovation approaches help create a vision, but the tools commonly used by the implementing stakeholders are unable to function in combination to fulfill the vision. During the timeline of each project, the explorative and exploitative approaches play their parts at different stages. Our evidence shows that explorative approaches are of importance at the beginning of the planning phase in each project. However it becomes difficult to translate explorative innovations into actions once the pilot has reached implementation stage, see Fig. 3. The data analysis and categorization singled out six key challenges within the pilot projects related to the balance between explorative and exploitative oriented approaches. City planners find that they are the ones with the agency to fulfill citizen needs. However, they explain how the development of Sustainable Energy Action Plans (SEAPs) (Bertoldi et al., 2010) has brought good practices for energy mapping and innovation, but that they have not seen that social elements, access and mobility has gained enough focus. This shows how tools, such as SEAPs, influence the process and may lead to social aspects or mobility aspects that were a part of more holistic and explorative approaches, becoming less of a focus.

Participants explain that data material acquired through the narrative approaches such as forecasting, mapping, student workshops etc., and the visions created in these participatory processes become important factors in the pilots' identity, which is used for external communication.

3.3. Key challenges that prevent the explorative innovations from being implemented

The following sections will explain why the implementation of explorative approaches which result in visions of the planning stakeholders are lost at point of project implementation. We identified two reasons why the explorative approaches are not implemented:

Firstly, knowledge acquired through explorative approaches fails to be realized once projects move closer to and into the implementation phase. This is also the moment where stakeholders involved in the actual construction phase are better defined than stakeholders in the planning phase. The implementing stakeholders do not have the mandate nor know how to transfer the knowledge from the explorative approaches into practice. The implementing stakeholders in the construction phase are from the energy and building sector. The planning stakeholders include climate section staff and city planners, who are responsible for developing a vision within the explorative approaches, have trouble transforming these visions into the final design.

Responsibilities are handed over from city planners to implementing stakeholders as projects move towards the implementation phase, and the stakeholder involvement is set between developers, land owners and finally the utility company(ies). During this transitional phase from planning to project implementation, we see that a common vision is replaced by each implementation stakeholder's responsibility and way of working. These responsibilities and ways of working are guided by tools and challenges that are available to the implementing

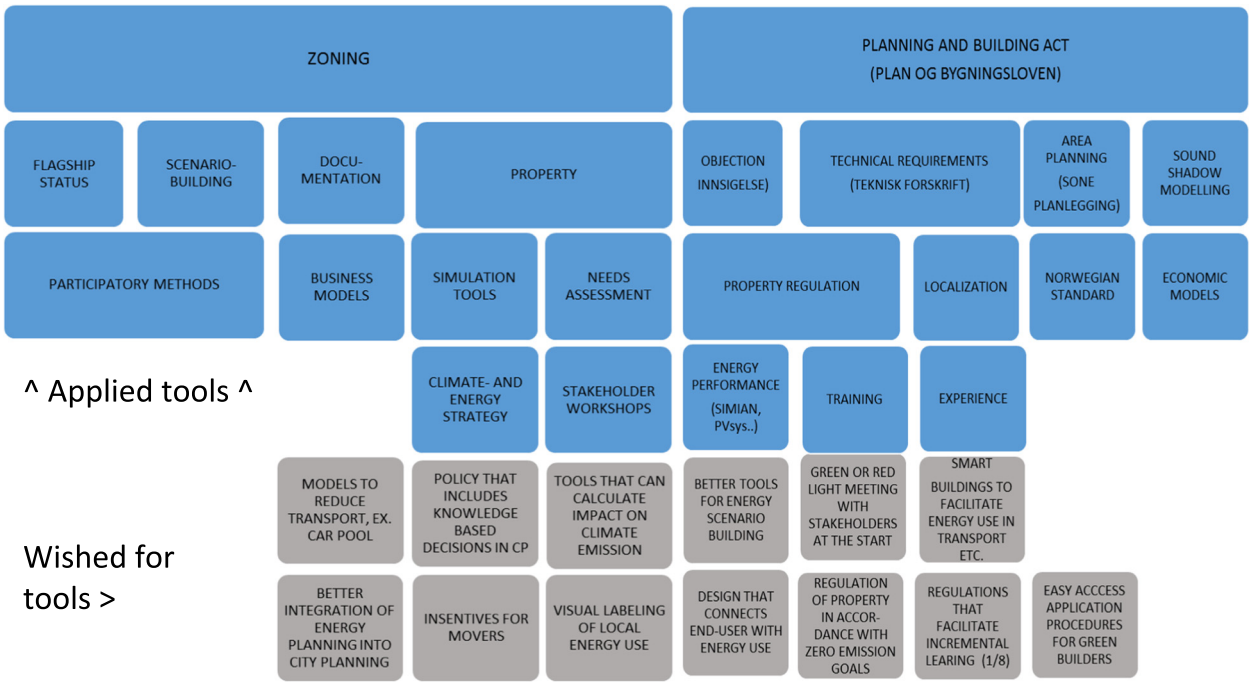

Fig. 2. Described tools of importance for the planning of energy ambitious neighborhood pilots. (For interpretation of the references to color in this figure, the reader is referred to the web version of this article.)

stakeholders, as required in other building projects. In the following sections, we will show that the challenges are limiting the tools being used by the implementing stakeholders resulting in a disconnection from the explorative visions set up in the planning phase. The current practices between planning and implementation stakeholders are lacking tools to follow up explorative visions as the challenges limit the implementation of these visions.

Secondly, there is a lack of adequate tools or tools available are not used due to different reasons. This results in a limited number of what the implementation stakeholders apply when constructing final design. This narrowing down of applied tools from explorative and holistic towards technical and stakeholder dependent, are due to 4 main challenges identified in the interviews. These challenges seem to increase until just before and within the project implementation phase. These challenges are cost for filling both energy and emission ambitions and socio-economic aspects, Time and moving targets in citizen involvement, Regulatory limits and conflicting agendas within and between system borders. The following sections discuss the four main challenges identified, that narrow the possibilities of implementation created by explorative approaches on influencing the final neighborhood design.

I) Cost for filling both energy and emission ambitions and socio-economic aspects

"*Should we yield on some of our decided requirements, just so we ensure that all the stakeholders involved in the process will be onboard still*?"
Project owner, Ydalir pilot project

In the Ydalir pilot, the project owner has ensured a broad stakeholder participatory process including possible implementing stakeholders. The project owner has decided on placing the extra cost for

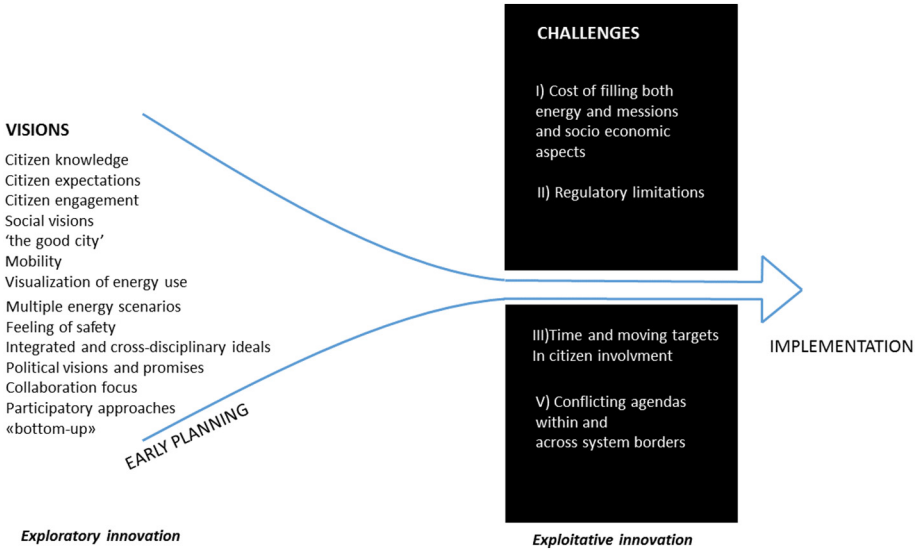

Fig. 3. Exploratory innovation and exploitative innovation.

public infrastructure into the property price. However, with the increased energy ambitions and the extra cost this implies for the private developers and utility companies, they see that at implementation stage, investors decide not to buy property after all. This is an example of how the extra cost of high-energy ambitions and quality for the citizens are difficult to fulfill in practice. It shows that a combined vision of livable neighborhoods and environmentally sustainable neighborhood is difficult to translate into practice by the implementing stakeholders.

At the same time, implementing stakeholders are benefitting from the explorative approaches, as it seems to be important for their internal innovation practices as "*that we can start using massive wood and will learn on project Ydalir in relation to this with the ZEN*" (private developer). Another reason is the publicity and positive image of the project as

> "… *it gets a lot of attention around it* (Raisch et al., 2009)" and "*will be used as examples both here and there*"
>
> (Elverum municipality)

> "*Thus, we do not want western edge/eastern edge class divisions in our housing stock. We want a mix of people then, young, elderly, people with different - different economic power* […] *and we are very unsure about that how far we manage to go to bake into that dimension in the project here.*"
>
> (Steinkjer Municipality)

Private developers and city planners in all the pilots also fear that these costs, often viewed as an extra, will result in higher than normal real estate prices. They think that the high costs will limit the real estate market. This line of thinking reduces municipalities confidence in realizing social sustainability goals and they fear a lack of acceptance of energy reducing residential projects among citizens. A high acceptance among the residents is seen as an important success factor as it is one factor to guarantee the replication of the transformation on another neighborhood, but also to demonstrate the realization of investments.

II) Timeline and moving targets in citizen involvement

In general, planning is a time consuming process. Planning in a new and more integrated manner as Smart Cities require, is perceived to take more time than planning in a conventional way within the existing frameworks. Particularly for pilot projects, testing new ways to plan and build is a learning process.

During a project planning timeline, the citizen or participation is not a static entity. Who participates, both from implementing stakeholders and citizens, can change over time. There is more support for a project at the beginning and that this changes as the project becomes closer to realization.

Time also influences what type of insights is available through participatory approaches with citizens. Municipalities in Fureset conduct visionary workshops at the beginning with a broad set of stakeholders.

> '*In the beginning, children and elderly proposed ideas and particularly wanted to improve the feeling of safety in the neighborhood. We designed a park and planned for more green infrastructure*'.
>
> (City planner, Oslo)

The explorative approaches, where citizens create visions together with city planners in Fureset, are presented as positive processes that create ownership. However, once parts of the projects infrastructure is being implemented, the contact between municipality and citizens are replaced by public meetings ('folkemøte') and these meetings receive a different type of opinion.

> '*particularly the elderly population showed up at these meetings, asking when things would be implemented and showing their objection to the planned road through the area*'
>
> (City planner, Oslo)

Similarly in the other pilots, information meetings are meant to be participatory, but city planners assess them as "… not good participation" (City planner Trondheim). Citizen asses them as not participatory and they trigger reactive responses. This does not mean that they are not important, but the evidence shows that they play a different role than the participatory workshops. In public meetings, people expect the municipalities to present results that meet the expectations expressed in the participatory processes at the beginning. This may indicate that public meetings are not a way to ensure participation in a project, and that information sharing and co design processes should be seen as separate measures. It further illustrates how methods that differ during the timeline also influence which goals are being discussed.

The utility companies on their side depend upon the input they receive from the municipality from these meetings, and do not have participatory approaches as a part of their own practice. It is up to them to translate this information or not, using the tools they have available and through a dialog with the municipality. As there is no knowledge transfer between citizen and utility companies, the utility companies depend on the technical tools for designing the energy system. Within this situation, there is a loss of knowledge from the citizen perspective. There is no incentive for the utility company to connect to the citizen perspective and this is overshadowed by the implied necessity to change as citizen become possible prosumers of energy. This illustrates how during the timeline project targets move as different stakeholders agendas take precedence.

It is also clear through the interviews that implementing stakeholders think political visions directed top down carry a responsibility for ensuring that visions are realized. Political changes at government level influence the projects, as pilots may be seen as illustrative of governmental impact. In Bergen and Oslo, time constraints caused by conflicting agendas and political priorities have created an extra barrier to implementing citizen based visions. As more housing has been a political goal, the innovative pilots requirement for more time and resources are in conflict with the need for more housing. Finally, the projects experience that promises made by earlier governments are not followed up by new government or new city administrations. This makes the visions crumble into less ambitions development projects along the timeline.

III) Regulatory limits

> "*For us, that's the way it is - that is, the municipality in isolation also has very high environmental objectives, but we can not really impose a private, external developer to do that.*"
>
> (Trondheim Municipality; Rådmannens Fagstab)

Regulatory limits narrow the scope for what is legally feasible and regulations are in a state of flux during the project time line. Participants argue that the regulatory framework is perhaps not suited for 'true' cross-disciplinary collaboration and innovation. A lack of incentives and requirements for private sector to plan how the communities and neighborhood will meet social needs/citizen needs from the beginning of a project. By incentives, private developers and utilities for example mention that they would like to be prioritized in some way as a reward for fulfilling higher goals than what is legally required. Faster processing times and stronger influence on the final design of an area is something they value more than reduced processing fees or other financial incentives that they consider insignificant.

> "*We'd like the municipalities to treat the other developers stricter, by for example not letting them build in the ambitious energy area and declaring it 'no-go' zones*"
>
> (Developer, Bergen)

Private development consultancy, Bergen Utilities and private developers explain that they would expect incentives, especially faster

processing times or more financing assistance, in pilots to ensure that they also contribute to socioeconomic goals. City planners describe a limited influence on how utility companies and private developers integrate opportunities they see for energy efficient neighborhoods. The municipalities wish for regulations that put the cities in position to require that buildings and neigbourhoods are designed to enable sustainable behavior, also through the use of smart technology. To achieve this, regulations should encourage utility companies and private developers to think of end user behavior as a collective goal. Examples of these ideas are from utility companies who would like to integrate smart technology for citizens to easily understand and influence their energy consumption, for example, energy prices to be visible during the day, and in this way increase consumer awareness through smart technology. Another example is how they would like to enable citizens to manage access to car pools through smart technology from each apartment in a building.

On the building level, city planners would like to see, for example, that private developers plan ground floors of buildings to facilitate bike storage and maintenance. However, city planner does have influence on energy consumption through spatial planning strategies such as limiting urban sprawl and localization. Keeping new dwellings within the densification zone are seen as a rule of thumb for enabling smarter energy communities, reduce car transport, rationalize resources used for infrastructure and maintenance, and limit the need for transport.

'*Then we ask, do our citizens want to live dense? I think that if we plan it well, they see how they don't need transport and have access to everything they need, then they will want to*'

City planner, Bergen

City planners can also make sure that housing is accessible by sustainable mobility, or through the regulations that require houses to be positioned so that they receive a certain amount of sunlight per day.

"*We have quite a lot of influence on the energy use in buildings simply by how we place them, with little shadow or wind and a lot of sunlight*"

City planner, Bergen

Some municipalities try to set higher requirements for private developers, for example asking them to reach at zero emission rather than passive house standard, within the public tender and public procurement process as planned in Steinkjer or by the developing of a masterplan for the neighborhood as in Ydalir. In the Zero Village Bergen pilot, a cooperative masterplan development with the developer and regional transport authority as partners try to secure the establishment of a sustainable mobility structure in the neighborhood. They were doing this by a car sharing pool, limited parking space on the sites and shuttle buses to the car sharing spot within the neighborhood. But the possibilities to set higher standards as national law and regulation are seen as limited by the municipalities. For example, a property can be resold to a new owner and the legally binding contracts to build near zero will not follow. This makes it easy, according to municipalities, to ignore ambitions that can lead neighborhoods towards a zero emission goal.

IV) Conflicting agendas within and between system borders

There are system borders between the public bodies that are part and on the periphery of the planning process. By system borders, we here mean governance and regional levels. In Norway, for example, transport is on a higher system level (regional) than private development (municipal). By sequencing, we mean the order in which planning and construction happen, and by conflicting agendas, we mean the interest by which the stakeholders act.

'*I don't know why you want to interview me about energy. I am trying to make good living environments for citizens in Bergen*'

City planner, Bergen

There is a significant gap between the role city planners perceive that they have and the objectives they defend, and the current demand for planning energy infrastructure as a more integrated part of the municipal master plan. They further explain how conventional participatory methods include participatory meetings/workshops with citizens, qualitative and human resource heavy methods that require competency from city planners.

The inability of current tools to deal with –and measure- both social/citizen perspectives and energy/climate at the same time makes it difficult for city planners to achieve their visions for 'good living environments' by balancing social and environmental goals.

Further, the implementing stakeholders' agendas influence how and if they take social and citizens' perspectives into account. For example, he issue of citizen needs and 'good living environments' is complex and makes the planning of integrated and innovative smart energy communities a matter of stakeholder negotiation where agreement is central. This issue is demonstrated by the views of the regional governor of Bergen. He prioritizes environmental needs and health and safety needs of citizens and as two sides of the same coin. Based on national environmental protection regulations, he opposed the political approval of the project, because he believes that the planning of SECs on common green areas should be avoided. In the newer political framework of Bergen, new dwellings should be planned within the planned densification zone of Bergen, and this has posed additional challenges for processing the zoning plan. Finally, in terms of health and safety, the regional governor further thinks that the plan for the ZVB community is too close to the planned extension of an airport landing strip, which will increase the noise level to above national health recommendations. This illustrates how conflicting agendas may interfere with a project.

The energy utility companies on their side take two different approaches to energy in the pilot projects that suggest how stakeholder agendas matter. One is the market-oriented side, trying to find out how to address the change in consumer needs regarding energy. For example, they propose smart solutions for how to make the citizens more aware of energy consumption. Yet, on the energy system design, for example when creating a district heating energy system for the neighborhood, utilities mainly work together with the municipalities on the technical design, and in this process citizens are not involved whatsoever. This indicates that the municipality's role as a customer makes a difference in energy utilities' approaches.

City planners believe that the large infrastructure planning decided by the national road administration (Vegvesenet) is independent of the work that they do with the municipal master plan. For example, the plans of the national road administration may interfere with the plans of the neighborhood design, something that delays the processing and makes it difficult to make predictions regarding the feasibility of the design.

A result of conflicting interest on different levels of national management, seem to lead to projects and tools leaving mobility out of the equation. City planners argue that this is a significant problem, as mobility is one of the largest contributors to emissions that they are seeking to reduce.

'*We have to find a way to include mobility, that is very important to us*'

(Climate department, Bergen)

In Norway, different public bodies are not obliged to invest into facilities which will accommodate the activities of other public bodies. This becomes problematic in planning on a neighborhood level as the infrastructure needs to be in place to support the livability of the new housing development. In the Furuset case, an important raison d'être behind giving Furuset priority for SEC planning, is to increase the attractiveness of the area. An important touch to ensure this, was to include a 'highway lid' ('lokk over E6') which has been presented publicly as adding an important element for the citizens. This tunnel was thought to add more room for dwellings as well as green space, and

more importantly to reduce noise in the Furuset area. However, the National Road Administration is not under any obligation to follow municipality level plans, and have decided that they will only plan highway bridges if there are significant safety concerns to be solved. The National Road Administration is not willing to pay for the highway lid and the municipality explains that there are many such requests from different zoning plans.

'*the national road administration will only build the highway lid if there are safety concerns, while we want it to make the area more attractive*'
(City planner, Oslo)

The priorities of the planning authorities in Furuset are not aligned with the National Road Adminstration which limits the vision implemented through explorative approaches as the impact of cost to other bodies come to the fore. In Bergen, the national road administration plans are relevant for the ZVB on many levels, because transport is part of the vision developed through explorative approaches. The most significant relevance is that ZVB is located too far from the public transport hub and too far from the highway both of which leads to the center of Bergen, in relation to national construction standards. The National road administration's policy is to ensure citizens will favor public transport; hence they are reluctant to improve the car transit from ZVB to the main highway. However, this policy interferes with ZVB thorough work to include private electric cars to its overall design. This private car suggestion is in conflict with the National Road Administration's policy to hinder private cars. This conflict has added to the political tension surrounding the processing of the ZVB plan.

Trondheim has similar challenges to align national road planning with municipal planning interests in the pilot projects. The national road administration is part of the Forum Sluppen, a meeting format for implementing stakeholders within the Sluppen pilot project development and a forum to discuss conflicting interests in the neighborhood development. The planning of the transportation system is an important factor for the general development as a private landowner and developer state:

"*Nothing will be developed before the transport solutions are clear*".
(Developer, Trondheim)

Early discussion and involvement with national authorities, like the national road administration, in the masterplan development would mitigate potential contradictions between national authorities plans. The development in closing system borders has started in Bodø in terms of an early dialog with Vegvesenet on the development of the ZEN neighborhood.

These three examples show that national priorities and municipal planning are dependent on each other yet national infrastructure planning is difficult to integrate into plans for communities. As the issue of the national road administration in Bergen illustrates, planning of a SEC is not only a matter of city planner's ideas and municipalities' political approval.

4. Discussion

As the neighborhood, designs are passed from a broader public influence, to private and decided stakeholders, the agency for the broader visions that include citizen needs, spatial qualities, socio economic aspects and amenities in general that are developed through the explorative approaches, loose impact. Our findings indicate that as an energy ambitious pilot reaches implementation stage, the visions acquired through explorative approaches at the beginning fail to transfer to implementations stage. We have identified four challenges that seem to trigger a shift from explorative to exploitative innovation approaches. First, the resource conflict between meeting both environmental and socio-economic issues for upgrading of an area. Second, the problem of moving targets and expectations that aren't met. Third, regulatory limits that make it difficult to follow the exploratory trajectory. Last, the issue of where the system borders for energy ambitious neighborhoods and how stakeholders from regional and national level impact the project owners ability to complete the vision. The lack of connectivity, which emerges from learning in the explorative trajectory to the exploitive trajectory means limitation, emerge for innovation in the planning of an energy ambitious neighborhood. Levinthal and March (1993) state the necessary relationship between exploitation and exploration innovation trajectories which we do not see emerging in our study. The findings resembles the discourse of aligning organizational ambidexterity's conceptualizations and outcomes (Martini et al., 2013).

The first challenge of resources are mentioned as an issue in discourse on ambidextrous organizations (Martini et al., 2013), and is said to lead to a polarized situation where a decision has to be made between choosing the explorative or the exploitative model. The issue of other stakeholders introducing new, regional decisions resonates with the argument that top-down management limiting exploratory innovation. This is because top-down implementation styles do not leave enough time or resources to build the necessary capacities on the bottom and horizontally in the hierarchy of the involved stakeholders.

An increasing number of researchers are progressively focusing on a dynamic process through which it is possible to combine exploratory and exploitative activities (Magnusson and Martini, 2008). Further, innovation studies focusing on exploratory and exploitative innovation, shows that in order to achieve explorative innovation goals in larger organizations and complex planning processes, capacity building further down in the hierarchy is essential. This supports the findings from the interviews about useful tools (illustrated in Fig. 2) where participants talked about the difficulty of transferring knowledge and experience from the decision makers in climate departments and urban planning, down to technical implementers, including carpenters and energy system developers. Fig. 4 shows the suggestions found in literature on ambidextrous organization for open innovation, for how the project owner or drivers can balance exploratory and exploitative innovation. This will theoretically increase the ability for citizen's needs and holistic issues to affect the final design largely. More importantly, a municipality that can balance these two modes of innovation will spread important knowledge that will prepare the organization for the quick changes that may occur from the new technological opportunities and market that emerges around smart city technology and infrastructure.

Citizen involvement composes a significant part of the work done at the beginning of the project, and our evidence shows that it plays a part in making projects attractive. Project owners apply explorative approaches to achieve attractive vision of the holistic design, that focus on connecting different elements. These include energy innovation, energy use and business models with goals of mixed population, affordable housing, spatial qualities, aesthetics and community building. As the projects move into implementation responsibilities are divided between the implementing stakeholders and approaches that exploit already existing solutions are taken. There is no responsibility or capacity to find new tools that may increase the interconnectedness of different aspects from planning into project implementation phase. The focus on innovating the building sector has led to a lack of available tools to link mobility aspects and localization which are important to decision-making when planning and implementing 'smart energy communities' or 'zero emission neigbourhoods'. City planners instead rely on private developers and utility companies to apply the tools they find right for the task. In this regard, city planners loose some control over the final outcome of plans to private sector in regards to citizens and mobility.

Participants in our study further see this conflict between energy and environmental frameworks and social goals as a conflict of agendas that increases along the project timeline. These qualitative assessments of citizen concerns is undertaken in the early planning of a project; yet once the project is ready to be implemented, these assessments are old and difficult to follow up due to other and more pressing concerns such

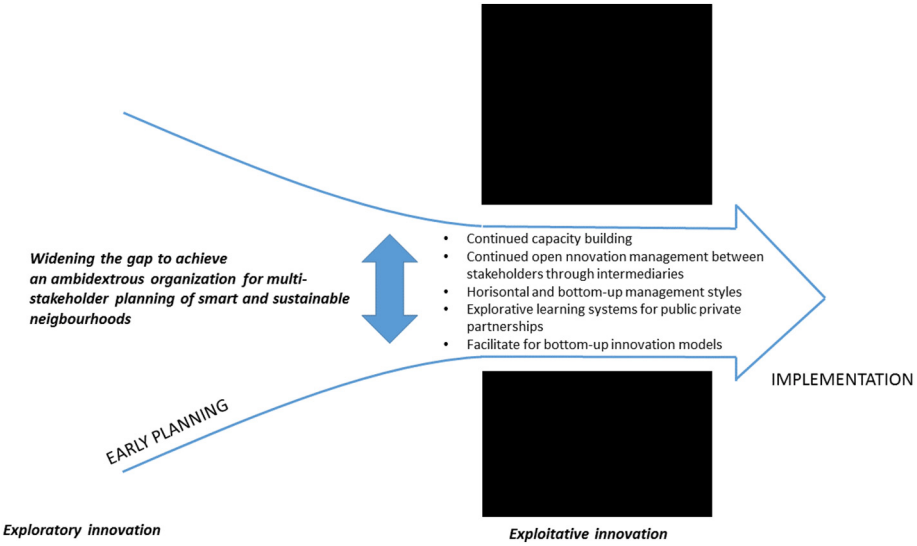

Fig. 4. Achieving an ambidextrous organization for the design and implementation of smart and sustainable neighborhoods.

as cost, investment and need for housing and densification. City planners express that energy concerns for them need to be in synergy with their overall objective to ensure the 'good city'. By this, they mean that the city should fulfill the citizens' needs in terms of social aspects such as access to services and work. City planners think that their main influence on energy objectives is met through their ability to locate housing in short distance to these jobs and services; as well as ensuring good spatial planning. They use the regulation of location and positioning of buildings in relation to sun, the planning of an attractive public space and a mobility infrastructure which prioritize walking and biking as one way they can affect both user experience/good living and energy use at the same time.

The project planning restricted timeline further challenges the integration of crosscutting issues with combined elements from different sectors (energy, citizen needs, stakeholder involvement etc.). Different stakeholder perspectives (private developer, city planner, climate section staff, and regional governor, utility) in trying to move forward with planning from one public sector but dependent on decisions of another public sector who do not share the same priorities illustrate a misalignment across system boundaries. This results in a lack of control over the outcome from the city planning side and major setbacks in the planning of smart energy communities within our pilot projects.

The inability to achieve impact through explorative innovation in municipal managed and stakeholder-led planning, illustrates how there is a need for scenario building tools in the early planning that can balance ideas with cost and feasibility is also something that is emphasized by utility companies and private developer. The early implementation of these requirements into the master plan, which come to the fore during project implementation, would make it easier for the project owner to ensure commitment from stakeholders, instead of reaching a trade-off situation once the project is close to implementation.

Since research on zero emission so far has focused strongly on emission reduction frameworks for buildings and monitoring of energy use, the work on making citizen inclusion and social visions effective and applicable on a similar level seem to either have lagged behind or is not well known among the involved stakeholders. This also seem to be connected to the fact that municipal city planners are important at the beginning of the planning but private stakeholders gain grounds as the projects move towards implementation.

5. Conclusion

Integrated, smart city models proposed for the design of innovative neigbourhoods frequently address the need to 'break down silos'. Based on our findings, we propose the idea that distinction between explorative and exploitative innovation models are of equal importance to the achievement of sustainable smart neighborhoods. While we found little evidence to support that, the disciplinary silos were a challenge; it rather seemed as if it were exploratory and exploitative innovation processes that pulled the projects in different direction. While the stakeholders at the beginning applied explorative innovation models, management was unable to transfer these models into implementation stage; and when confronted with resource restrictions, returned to exploitative tools and approaches. This difficulty of achieving ambidextrous organization structure is supported by theory on continuous and open innovation.

An ambidextrous organization is one that has the ability to be efficient in its management of today's business and also adaptable for coping with the changing demand of tomorrow. The technological advances that the smart city paradigm brings to the table, means that the municipality and the stakeholder-driven design needs to become more ambidextrous. According to theory on ambidextrous organization management, capacity building and exploratory learning may be of as much importance than removing the silos. As cross-disciplinarity is becoming the new norm, the organizational model consisting of municipality departments, private developers and later utility companies and citizens, may not be capable of creating the appropriate innovation model. This innovation model, recently called Continuous Innovation or Open Innovation, needs the driver, in this case the municipality, to be capable of managing both exploratory and exploitative innovation in the same project.

As complex products are to be achieved by multiple stakeholders, it is argued that forces tends to open up the gap between exploration and exploitation axes to the point where they becomes diametrically opposed – leaving no choice but to move in one direction or the other. The municipality hence needs to look for how they can achieve oorganizational ambidexterity: which means being able to be efficient in its management of today's business and also adaptable for coping with tomorrow's changing demand. A concrete advice from organizational theory is to ensure capacity building in the lower parts of the organization. Regarding the municipality or 'driver' of a project as a manager, bottom-up and horizontal knowledge inflows of managers positively relate to these managers' exploration activities, while they do not relate

to managers' exploitation activities.

Smart city and zero emission neighborhood theory could therefore gain from focusing more closely on finding out how municipal planning involving multiple stakeholders can combine explorative and exploitative innovation techniques to ensure the degree of innovation that highly ambitious neighborhood planning require. The explorative approaches can play a greater part in guiding the exploitative innovation path once responsibilities are divided between implementing stakeholders. Can research within social studies and qualitative research traditions contribute, or does the technology and quantitative focused economics and engineering sphere direct an exploitative innovation path for energy ambitious neighborhoods to develop?

It will be central to find models that can increase the implementing stakeholders' abilities to follow through explorative innovation. While the building sector is increasingly regulated, neighborhood infrastructure and the connection between neighborhood and building is less regulated. Improved and more appropriate methods for citizen involvement and needs assessment also including energy aspects are needed, as well as for evaluating qualitative city aspects during and after a project is finished, will be needed. However, in order for the social narratives to gain influence on the final designs, it is clear that municipalities also need better negotiation tools to ensure commitment from the involved stakeholders for reaching the overarching visions so that their Smart Cities also become 'socially smart'. Stakeholders express the difficulty to manage these objectives in parallel. Making a city 'socially smart' is not only an issue to please citizens. If a neighborhood does not achieve its social goals alongside the energy and emission requirements, city planners show us that the cities will become socially divided and that in the end become environmentally unsustainable. Both because people will not want to participate, and share; promoting individualist consumerism and individual choices; but also because these energy ambitious projects can contribute to gentrification and a polarization between social classes living environmentally sustainably within the densification zone and lower classes living in polluting and polluted areas in less attractive areas.

The responsibility and authority of municipalities, counties and state, city planners and politicians on the timeline interfere with a visionary integrated city planning model, different interests among the involved stakeholders from municipalities, counties and state contribute to this. Yet, if these challenges are addressed early on in the conceptual design phase with a broad stakeholder commitment approach, city planners believe that many challenges can be avoided by introducing these intentions into the master planning directives.

The opportunities and the challenges of introducing Smart Cities thinking requires that governance institutions have approaches in place that help them manage these opportunities in order to balance social, economic and environmental perspectives of their cities. It further challenges the set of legal and regulatory frames, professional and power structures, by requiring a truly integrated vision.

More research should be done to suggest options for how an different innovation models and ambidextrous can guide and influence the public and/or private management, planning and implementation of integrated urban planning and innovative models for how the future smart and sustainable neigbourhoods.

Acknowledgements

The authors gratefully acknowledge the support from the Research Council of Norway and several partners through the Research Centre on Zero Emission Neighbourhoods in Smart Cities (FME ZEN).

References

Al Nuaimi, E., Al Neyadi, H., Mohamed, N., Al-Jaroodi, J., 2015. Applications of big data to smart cities. J. Internet Serv. Applic. 6, 25.
Alonso, M.J., Stene, J., Bantle, M., Georges, L., 2013. Simulations of Heat Pumps for Nearly Zero Energy Buildings. Country Report of IEA HPP Annex.
Bertoldi, P., Cayuela, D.B., Monni, S., De Raveschoot, R.P., 2010. Existing Methodologies and Tools for the Development and Implementation of Sustainable Energy Action Plans (SEAP). Covenant of Mayors (EUR, 24309).
Campbell, S., 1996. Green cities, growing cities, just cities? Urban planning and the contradictions of sustainable development. J. Am. Plan. Assoc. 62, 296–312.
Dixon, T., Eames, M., Britnell, J., Watson, G.B., Hunt, M., 2014a. Urban retrofitting: identifying disruptive and sustain technologies using performative and foresight techniques. Technol. Forecast. Soc. Chang. 89, 131–144.
Dixon, T., Eames, M., Britnell, J., Watson, G.B., Hunt, M., 2014b. Urban retrofitting: identifying disruptive and sustaining technologies using performative and foresight techniques. Technol. Forecast. Soc. Chang. 89, 131–144.
Dixon, T., Eames, M., Britnell, J., Watson, G.B., Hunt, M.J.T.F., Change, S., 2014c. Urban Retrofitting: Identifying Disruptive and Sustaining Technologies Using Performative and Foresight Techniques. 89. pp. 131–144.
Dobre, C., Xhafa, F., 2014. Intelligent services for Big Data science. Futur. Gener. Comput. Syst. 37, 267–281.
Eames, M., Marvin, S., Hodson, M., Dixon, T.J., Guthrie, P., Lannon, S., 2012. Briefing: re-engineering the city 2020–2050–urban foresight and transition management. In: P. O. T. I. O. C. E.-U. D. & Planning. 167. pp. 1–4.
Eising, R., Jabko, N., 2001. Moving targets: national interests and electricity liberalization in the European Union. Comp. Pol. Stud. 34, 742–767.
Elwood, S.A., 2010. Embedding ubiquitous technologies. In: Ubiquitous and Pervasive Computing: Concepts, Methodologies, Tools, and Applications. IGI Global.
EU Emissions Trading Initiation, 2016. In: Birger Skjærseth, Jon, Wettestad, Jørgen (Eds.), Initiation, Decision-making and Implementation, 1st Ed. Imprint Routledge, London, pp. 230 First Published 28 February 2008.
Guhathakurta, S., 2002. Urban modeling as storytelling: using simulation models as a narrative. Environ. Plann. B. Plann. Des. 29, 895–911.
Hall, R.E., Bowerman, B., Braverman, J., Taylor, J., Todosow, H., Von Wimmersperg, U., 2000. The Vision of a Smart City. Brookhaven National Lab., Upton, NY (US).
Harrison, K.W., Dumas, R.D., Solano, E., Barlaz, M.A., Brill, D.D.J., Ranjithan, R., 2001. Decision support tool for life-cycle-based solid waste management. J. Comput. Civ. Eng. 15 (1), 44–58.
Hollands, R.G., 2008. Will the real smart city please stand up? Intelligent, progressive or entrepreneurial? City 12, 303–320.
Holman, N.J.L.E., 2009. Incorporating Local Sustainability Indicators Into Structures of Local Governance: A Review of the Literature. 14. pp. 365–375.
Hughes, Chu, Mason, 2018. Multilevel governance and climate change innovations in cities. In: Climate Change in Cities, pp. 361–378.
Jonassen, D.H., Hernandez-Serrano, J., 2002. Case-based reasoning and instructional design: using stories to support problem solving. Educ. Technol. Res. Dev. 50, 65–77.
Kallaos, J., Valentis, G., Houssin, L., Bharathi, K., Shrestha, P., Acre, F., Lobaccaro, G., Landa, N., Wyckmans, A., 2015. D2. 3-Climate resilience in architecture, infrastructure and urban environments. In: Analysis of RAMSES Case Study Cities.
Kylili, A., Fokaides, P.A., 2015. European smart cities: the role of zero energy buildings. Sustain. Cities Soc. 15, 86–95.
Lazaroiu, G.C., Roscia, M.J.E., 2012. Definition Methodology for the Smart Cities Model. 47. pp. 326–332.
Lee, J.H., Phaal, R., Lee, S.-H., 2013. An integrated service-device-technology roadmap for smart city development. Technol. Forecast. Soc. Chang. 80, 286–306.
Levinthal, D.A., March, J.G., 1993. The myopia of learning. Strateg. Manag. J. 14, 95–112.
Lindkvist, C., 2015. Contextualizing learning approaches which shape BIM for maintenance. Built Environ. Proj. Asset Manag. 5, 318–330.
Lindkvist, C., Juhasz-Nagy, E., Nielsen, B.F., 2018. Intermediaries for knowledge transfer in integrated energy planning of urban districts. Technol. Forecast. Soc. Chang.
Magnusson, M., Martini, A., 2008. Dual Organisational Capabilities: From Theory to Practice – The Next Challenge for Continuous Innovation.
March, J.G., Olsen, J.P., 1975. The uncertainty of the past: organizational learning under ambiguity. Eur. J. Polit. Res. 3, 147–171.
Marszal, A.J., Heiselberg, P., Bourrelle, J.S., Musall, E., Voss, K., Sartori, I., Napolitano, A., 2011. Zero energy building–a review of definitions and calculation methodologies. Energ. Buildings 43, 971–979.
Martini, A., Laugen, B.T., Gastaldi, L., Corso, M., 2013. Continuous innovation: towards a paradoxical, ambidextrous combination of exploration and exploitation. Int. J. Technol. Manag. 61, 1–22.
McCormack, C., 2004. Storying stories: a narrative approach to in-depth interview conversations. Int. J. Soc. Res. Methodol. 7, 219–236.
Mirakyan, A., De Guio, R., 2013. Integrated energy planning in cities and territories: a review of methods and tools. Renew. Sust. Energ. Rev. 22, 289–297.
Moe, E., 2016. The Political Economy of Sustainable Energy Transitions. MIT Press.
Narvestad, R.A., 2010. Casestudier av norske byutviklingsprosjekter med miljø-og kvalitetskrav (Casestudies of Norwegian neighbourhood developments with environmental and quality demands). Sintef, Report.
Nielsen, Brita Fladvad, Resch, Eirik, Andresen, Inger, 2017. The role of utility companies in municipal planning of smart energy communities. Int. J. Sustain. Dev. Plan. 13, 695–706.
Raisch, S., Birkinshaw, J., Probst, G., Tushman, M.L., 2009. Organizational ambidexterity: balancing exploitation and exploration for sustained performance. Organ. Sci. 20, 685–695.
Resch, E., Andresen, I., 2018. A database tool for systematic analysis of embodied emissions in buildings and neighborhoods. Buildings.
Sandelowski, M., 1991. Telling stories: narrative approaches in qualitative research. J. Nurs. Scholarsh. 23, 161–166.
Söderström, O., Paasche, T., Klauser, F., 2014. Smart cities as corporate storytelling. City

18, 307–320.
Svenfelt, Å., Engstrom, R., Svane, O., 2011. Decreasing energy use in building by 50% by 2050—a backcasting study using stakeholder groups. Technol. Forecast. Soc. Chang. 78, 785–796.
Swisher, J.N., Martino, J., Redlinger, R.Y., 1997. Tools and methods for integrated resource planning. Improving energy efficiency and protecting the environment. In: United Nations Environmental Programme.
Viitanen, J., Kingston, R., 2013. Smart cities and green growth: outsourcing democratic and environmental resilience to the global technology sector. Environ. Plan. A 45.
Webster, L., Mertova, P., 2007. Using Narrative Inquiry as a Research Method: An Introduction to Using Critical Event Narrative Analysis in Research on Learning and Teaching. Routledge.
Weick, K.E., 1995. (J. T. O. S. P. I). Sensemaking in Organizations (Foundations for Organizational Science).
Whyte, J., Stasis, A., Lindkvist, C., 2016. Managing change in the delivery of complex projects: configuration management, asset information and 'big data'. Int. J. Proj. Manag. 34, 339–351.
Zoughbi, S., Al-Nasrawi, S., 2015. Regional development getting smarter with ICT. In: Encyclopedia of Information Science and Technology, Third edition. IGI Global.

Brita Fladvad Nielsen Post-doctoral researcher at Planning Instruments for Smart Energy and Communities (PI-SEC), applies design thinking as a research process to make sense of complex stakeholder systems. Her Ph.D. was on framing the humanitarian relief market in relation to the case of off-grid energy. In her post-doctoral position, she develops tools for the multi-stakeholder planning of Smart Energy Communities. Besides academia, she worked for the United Nations Industrial Development Organization, and Design without Borders.

Carmel Lindkvist Associate Professor in Facilities Management and is a member of Smart Cities@NTNU since 2013. One of her key areas of interest is on knowledge transfer that occurs (or not) in temporal disconnected practices across the life-cycle from planning to implementation. Her research builds on organization management theories to understand the interplay of practices, clients and end users in the renovation of low energy emission neighborhoods.

Daniela Baer Research scientist at SINTEF Building and infrastructure, is an economic geographer who works in the context of urban development. Her PhD was about cities in transition and how unused sites could be re-used with services. Besides academia she worked as a consultant for cities and municipalities in Germany. As a neighborhood manager in Norderstedt (Germany) she was responsible for the further development of a local commercial center and her work was located at the interface between citizens, businesses and the municipality.