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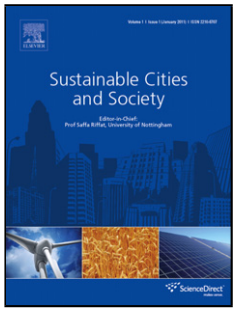
Published in:
Sustainable Cities and Society

Link to article, DOI:
10.1016/j.scs.2017.12.029

Publication date:
2018

Document Version
Peer reviewed version

Accepted Manuscript



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PII: S2210-6707(17)31162-9
DOI: https://doi.org/10.1016/j.scs.2017.12.029
Reference: SCS 901

To appear in:

Received date: 31-8-2017
Revised date: 29-11-2017
Accepted date: 23-12-2017

Please cite this article as: & Petersen, Jens-Phillip., The application of municipal renewable energy policies at community level in Denmark: A taxonomy of implementation challenges.*Sustainable Cities and Society* https://doi.org/10.1016/j.scs.2017.12.029

The application of municipal renewable energy policies at community level in Denmark: A taxonomy of implementation challenges

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Highlights

- The study assesses municipal energy strategies in Denmark on their inclusion of local communities in strategy production.

- A relational definition of energy communities is proposed as an analytical framework including multiple governance levels and sectoral domains.

- Inadequate internal organization, lacking capacity in municipalities, and the complexity of communities led in combination to procedural deficits, which were identified as main reasons that challenged the implementation of energy targets.

- Based on the findings a community-oriented taxonomy of implementation challenges is introduced to ensure an early local anchoring of energy strategies in communities.

Abstract

The implementation of national renewable energy targets requires policies at the local level. Communities are considered as key arenas of transforming policies into actions, where technical configurations intersect with socioeconomic interests. Local governments put great efforts into developing and applying energy strategies. Although many frontrunner projects are well-documented, insufficient attention is paid to the average-performing municipalities that are challenged in linking technical energy scenarios with socioeconomic realities. The following implementation gap between national policy and local practice leads to a non-attainment of national energy targets. This paper analyses the Strategic Energy Plans (SEP) of 17 Danish municipalities based on their development, scope, and inclusion of local communities. As a synopsis, the main technical, physical, organizational and socioeconomic challenges for local energy policy implementation were illustrated. Internal organization, lacking municipal capacities, combined with the complexity of communities leads to procedural deficits in strategy production. The resulting neglect of socioeconomics and other community peculiarities by technology-driven strategies impede strategy implementation. As a consequence, a community-oriented taxonomy of implementation challenges is introduced. This approach might help to improve the scope of SEPs, ensure a local anchoring of energy strategies, and raise awareness for challenges already present during strategy production to facilitate strategy implementation.

Keywords: *Renewable Energy Policy; Municipal Energy Strategies; Community Energy; Local Communities;*

1. Introduction

1.1 Problem statement

In light of the potential consequences of climate change, the transformation of energy systems from fossil fuels to renewable energies constitutes one of the biggest challenges for governments worldwide. After committing to the Paris Agreement, governments pursue the reduction of greenhouse gas emissions through the implementation of national energy policies (UNFCCC Secretariat, 2015). However, implementation of national energy policies requires local action. First, cities are responsible

for roughly two-thirds of global primary energy consumption; thus, they play a key role in transforming the energy systems. Second, local governments have the ability to balance national policies with local interests (Amin, 2004). Third, spatial planning in most European countries is steered by municipalities that have strong governance capacities at their disposal to shape the built environment. Hence, municipalities directly and indirectly influence physical manifestations of energy policies (e.g., Smedby & Quitzau, 2016; Fitzgerald & Lenhart, 2016).

In practice, a gap between energy policy ambitions and implemented solutions in the built environment can be observed (Vergragt et al., 2014). National energy efficiency targets are adapted to municipal documents but are seldom implemented in their entirety in the built environment. Local communities are a major arena for the implementation of energy targets, where abstract strategies are transformed into actions that lead to actual socio-technical configurations.

Municipalities' implementation struggles can be attributed to different factors. In the end, they are a result of the degree of urban complexity coinciding with institutional complexity at the community level. The complexity of energy target implementation has been characterized several times as 'wicked' (Cajot et al., 2015). The reference to Rittel's & Webbers' concept of 'wicked problems' from 1973 illustrates that implementing energy targets at the community level is not just another governance challenge, but requires strategic, systematic, and continuous actions.

Recent studies on municipal energy plans and their relation to communities focus prevailingly on citizen involvement, empowerment of local communities, communication, and mobilization strategies (van der Schoor & Scholtens, 2015). Hence, grass-roots innovations, rare bottom-up community initiatives and first-movers dominate the current literature, whereas the average-performing community is rarely discussed. Despite the eligibility of these studies, inactive communities are the norm. To reach national energy targets, a stronger emphasis on the average-performing municipality and its communities is necessary.

The Danish strategic energy plans (SEP, a form of municipal energy strategies) exemplify this dilemma in a nutshell: while some Danish municipalities are recognized internationally as role models for energy transformation, the majority of the municipalities struggle with the realization of their targets, despite having the same national institutional boundary conditions. The specific local preconditions that enabled these examples are just not reproducible in other settings (van der Schoor & Scholtens, 2015). The passionate, proactive local citizens on the island of Samsø, the long-lasting public-private partnerships in Sonderborg or the strong economy of Copenhagen are unique among municipalities in Denmark (Radzi, 2009).

Nonetheless, these examples provide important lessons. But it makes sense to look at the challenges that 'ordinary' municipalities deal with when implementing energy strategies in the built environment. Therefore, it is necessary to assess how municipal energy strategies integrate the local community level, as SEPs are the most local energy planning documents in Denmark.

1.2 Aim of the study

This study assesses a broad spectrum of municipal energy strategies by means of SEPs from Denmark. The strategic documents are examined as they represent the intrinsic municipal strategies. In analyzing strategy development, scope, and their embeddedness in the institutional context, we can illustrate to what extent SEPs contribute to the energy target implementation. In combination with an understanding of what challenges practitioners face in their effort to implement the strategies, we can draw lessons on the suitability of municipal energy strategies to trigger the actions necessary to implement the energy targets in the built environment.

While previous studies examined the integration of climate change into local governance in forerunner municipalities (Wejs, 2014), or the content of Danish climate action plans from a quantitative perspective (Damsø et al., 2016), we emphasize the procedural aspects of strategies. In analyzing emerging actions and exposing where actual implementation is challenged when the strategy meets reality in communities, we focus on the qualitative aspects of strategies. Hence, the objective of this paper is to identify implementation challenges for municipal energy strategies down to community level, and to systematize these challenges according to their reasoning and origin. This could contribute to an increased understanding of how to improve municipal energy strategies so that the gap between energy policy ambitions and implemented solutions in the built environment can be reduced or even closed. The central research questions are:

- *How are Danish municipal energy strategies developed, what is their scope and how are local communities represented in key considerations of the strategies?*
- *What implications do differing procedural factors have for strategy implementation and what challenges occur throughout the implementation process for municipalities?*
- *How can implementation challenges of energy strategies be framed to improve our understanding of what factors to consider when designing municipal energy strategies?*

Theoretically, this paper provides a local, community-oriented classification of implementation challenges for energy strategies, based on the assumption that public actors take a key role in facilitating energy transition processes. Through the subdivision of implementation challenges based on spatial and in the sectoral origin their interdependency is demonstrated, which might have a practical relevance to enhance Danish SEPs. The study does not pretend to evaluate the Danish SEP program as a whole. Rather, the study systematically points out difficulties in municipalities' work with energy strategies under the given institutional boundary conditions.

Centering the community – hence, taking a socio-spatial perspective with the focus on challenges of energy strategy implementation – instead of looking at barriers for singular technologies, legislation or economics, adds a perspective to the academic discussion that many practitioners face. This perspective is only insufficiently covered in the existing literature. But the challenges practitioners face

in their persistent struggles to implement energy targets are cross-disciplinary and focus on a single community at a time that has its own distinct challenges.

In Section 2, we frame the concept of municipal energy strategies inspired by strategic planning literature, and develop a relational definition of communities for energy planning that build the theoretical framework for the analysis of the municipal energy strategies and their integration of local communities. Section 3 describes the research methodology, whereas Section 4 gives a brief overview about the SEP program. Section 5 presents the results of the SEP analysis and municipality assessment. The results are analyzed and discussed in Section 6, as challenges are grouped according to their genesis using institutional theory to explain procedural issues and in a second step, they are associated to their origins. Section 7 concludes the paper.

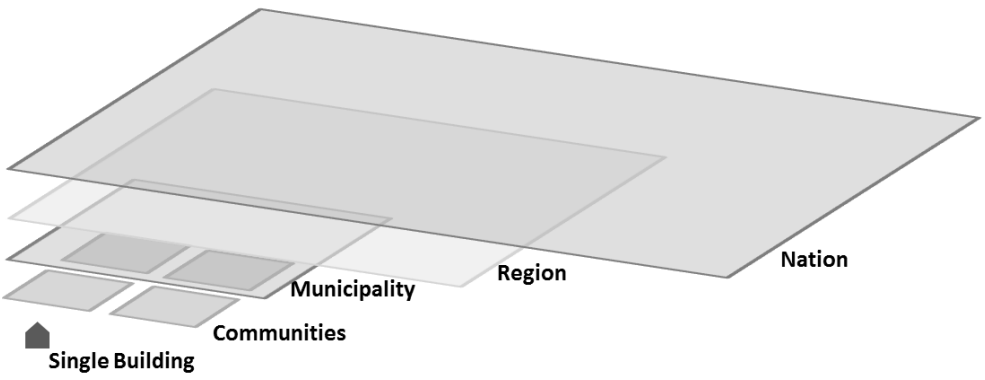
2. Municipal energy strategies in communities: towards a relational understanding of communities and implementation challenges

This section explains theoretical concepts used to build up a theoretical framework to analyze municipal energy strategies. The framework forms the basis for a taxonomy of implementation challenges for energy strategies at the community level.

2.1 From strategies to municipal energy strategies

Several municipalities have in the past years formulated energy strategies to coordinate policies that should promote the implementation of energy targets. Implementation of renewable energy targets is still far from straightforward – energy strategies remain in many cases rather a promise than that they become reality (Bulkeley & Betsil, 2005). While 'strategy' by practitioners is often understood as a document that outlines future actions to reach a desired goal, the term has to be understood in a broader sense: In short, strategies are the systematic organization of collective actions around goals (Bryson, 2011). But strategies encompass an interactive process, where knowledgeable actors ('planners') involve a multitude of other actors, to produce a document to frame considerations of the earlier process. This interaction means that spatial strategies are both a product and a process, understood as a complex human interaction. This process is ongoing from strategy production, over the framing document, up to the retention or implementation of its key considerations through time (Healey & Hilier, 2009). These key considerations are a basis for the collective action to occur, as described by Bryson (2011).

Hence, strategy is not only a plan or a document, it is a pattern. It is often misunderstood as plan, because planners are 'mesmerized by the myth of control' (Mintzberg, 2007), which should get falsified by our day-to-day experiences. Real-world strategies are usually found in between those delib-



erate plans and emergent developments that can be assorted to the plan. In consequence, parts of the deliberate plan stay unrealized and are replaced by emergent strategy elements. Hence, real-world strategies produce both intended and unintended outcomes (Mintzberg et al., 1998). Strategies, if seen as human interactions, are a capacity to link actors with divergent interests, goals, and working procedures to realize certain goals (Daamen, 2010).

Figure 1: *Communities are an intermediate between single buildings and the municipal level*

Acknowledging this capacity is of high importance, if we look at the complexity of communities in conjunction with changing roles of public actors in pluralistic societies where the market actors play a dominant role in implementing strategies (Heurkens & Hobma, 2014). In terms of energy transitions communities are the arena where internal and external actors meet, where conflicts between technological, social, economic and administrative interests are contended and can be potentially aligned by energy strategies (see Figure 1). Despite ambitious municipal documents, the complexity of communities induces a lack of concrete actions. The term community is applied in this paper as a way to conceptualize a specific local neighborhood with its socioeconomic and physical interrelations.

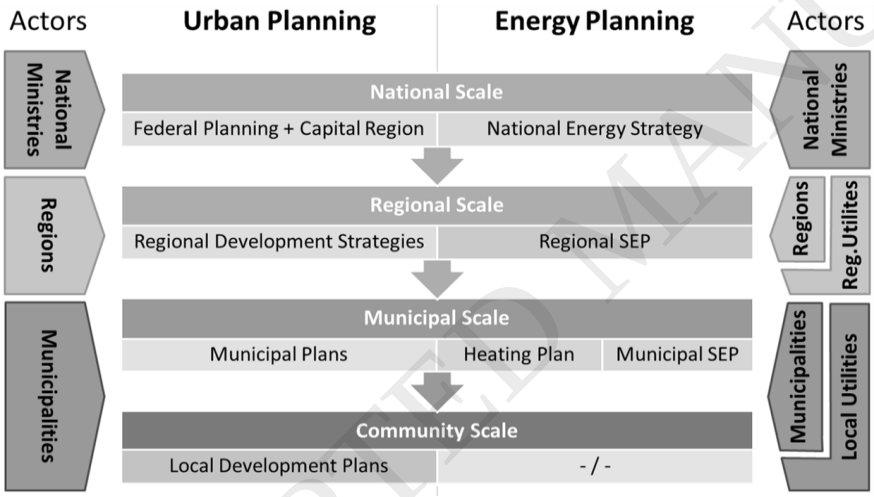


Figure 2: *Comparison of the most used strategic planning instruments and key actors in urban and energy planning on multiple governance levels in Denmark (based on Petersen, 2016)*

The Danish system of spatial planning is distinguished by a strong vertical coherence; aligning urban development between the national, municipal and community level (see Figure 2 and Section 4). In particular, the adoption of key considerations from the Municipal Plans to concrete stipulations in Local Development Plans is a guarantor for this coherence down to community level. For energy planning there is no such coherence. While municipal energy strategies are considered as counterpart to a Municipal Plan, there is no document, and to support our argument, no strategy as counterpart to a Local Development Plan at community level (Petersen, 2016).

Still, there is an interaction between municipal level and community level influencing the implementation of energy targets in the built environment. Despite the absence of formal and often also informal policies to promote the implementation of energy targets, municipal strategies define frameworks and targets that are also viable for communities.

2.2 Horizontal domains of community

The term ‘community' is used ambiguously, depending on the definition used. O'Donnell (1997) clusters the definitions in three groups: Community as specification of a geographic area as origin of social organization (e.g., O'Donnell, 1997; Burgess, 1967); second, as reference to a local social system or set of relationships in a defined geographic area (e.g., McIver & Page, 1949); or third, as description of the quality of relationships, which is often referred to as ‘sense of community’ (Sarason, 1974; McMillan & Chavis, 1986). In recent years, the latter has been used predominantly, whereas the spatial concept of geographic boundaries defining social organization is of decreasing importance. Walker (2011) distinguishes the meaning of community in relation to climate governance into community as an actor, a scale, a place, a network, a process and as an identity. Their commonality is that community is “something good” and generally seen as intermediary between government and households, a place “for achieving carbon policy objectives”.

The distinction between neighborhood and community is subject to numerous urban sociologists’ studies, whereas neighborhood is seen as the smaller limited geographical area and community is seen as larger neighborhoods, subsets of neighborhoods or part of a city (Park & Rodgers, 2015). This paper deviates from this distinction. First, since it is focused on the Danish context, where community features can be found on a much smaller scale (e.g., level of land-use planning, official boundaries of houseowner associations, shared name, etc.). Second, because community energy planning is used as a fixed term for designing local energy systems from only a few up to a couple of thousand households (Walker & Devine-Wright, 2008). This implies the existence of different kinds of communities at various spatial levels (see Section 2.3). Third, we are interested in understanding the role that energy strategies ‘grant’ to the community citizens as recipients of energy and urban planning, since they play an important role in the implementation process (e.g., Bayulken & Huisingh, 2015).

Hence, the term community is used in this study analogous to neighborhood to highlight the concurrency of non-physical and technical aspects. There is a tendency to associate mostly techno-economic methods to community energy planning. Community is typically defined by administrative borders or physical parameters for which a technical concept should be developed (Østergaard & Sperling, 2014), which is a contradiction in itself. Technical configurations do not work, when these are developed from a technologists’ rationale in disregard of other factors. In continuing perceiving communities in energy planning as either administrative or physical units, we neglect the internal socioeconomic actor networks and technical potentials reaching beyond administrative borders. As Shove (1998) argues, barriers arising from these domains shouldn’t be seen as extrinsic and need to be considered simultaneously, since they are co-evolving. Communities ‘are constituted through the topologies of actor networks which are becoming increasingly dynamic and varied in spatial constitution’ (Amin, 2002).

As a consequence, a more holistic and systematic understanding of community in relation to energy planning is necessary. This study delineates four socio-spatial domains that in conjunction shape communities: technology, physical conditions, socioeconomics, and public organization (see Figure 3).

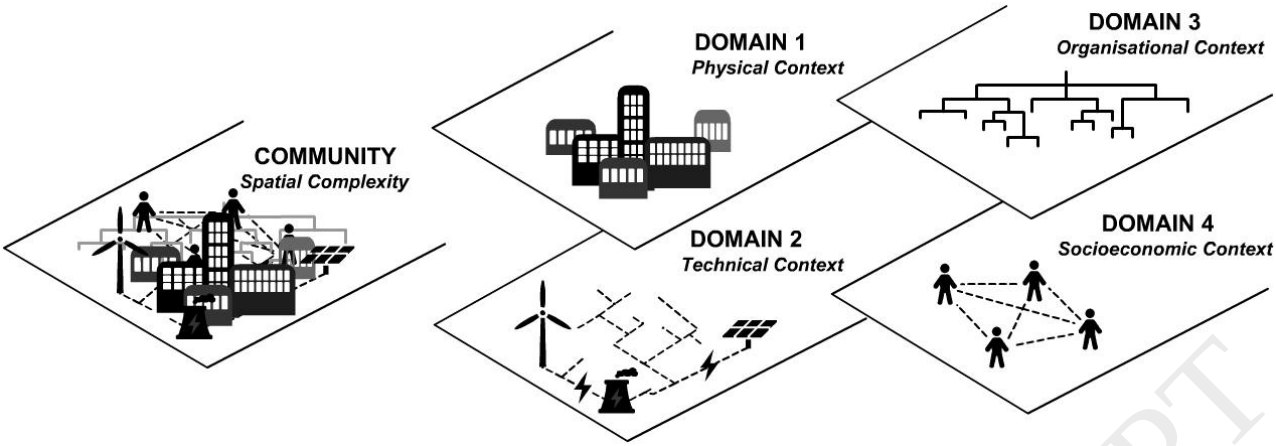


Figure 3: *The study delineates between four interlinked horizontal domains that shape communities in relation to energy planning. The communities represent different disciplines and problem areas.*

This implies in relation to municipal energy strategies that we have to be aware of other challenges besides physical and technological issues to incorporate these into the strategy production (Fuchs & Hinderer, 2014). The involvement of the socioeconomic domain through the involvement of local stakeholders has been proven as one of the key factors for a successful implementation of energy targets (Bayulken & Huisingh, 2015), since technology alone will not be able to solve the issues occurring during the energy transition (Vergragt et al., 2014). Balancing and aligning stakeholder interests is crucial, as they can contribute to the implementation of energy strategies with different competencies. The understanding and incorporation of different 'actor worlds' (Callon, 1986) requires a deliberate proceeding to incorporate these competencies – or at least not to work against local resistance.

The introduced community definition with four sectoral domains delineates itself from existing barrier literature in focusing on the local community as arena of energy strategy implementation. Recent studies classify barriers based on their sectoral origin, such as markets, behavior and organization, but exclude politics as contextual and non-inter-organizational factors (Sorrell et al., 2000). In contrast, Weber (1997) distinguishes barriers according to institutions, market, organization and behavioral origin. Hence, there are various ways of framing barriers originating from sectoral domains for local energy projects. While three domains are emerging in most studies – technical, socio-economic or socio-cultural, and the governmental domain (e.g., Sherriff, 2014) – a separation of the technical factors into techno-economic and physical factors seems appropriate. First, separated municipal departments work on technical or physical (urban) issues (Larssen et al., 2012). Second, this leads to different working practices (Callon, 1986), which is of relevance as we are analyzing energy strategies from a practitioner's perspective. Third, practice and agency shouldn't be underestimated when considering domestic energy demand (Higginson et al., 2014), which is more strongly connected to physical than to technical factors.

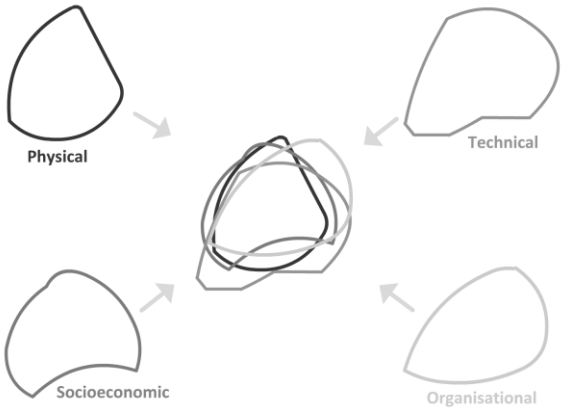


Figure 4*: Illustration of the fragmentation and fuzziness of communities: The four domains require a relational community definition, as they are spatially not congruent*

Further, we have to acknowledge that the sectoral domains are spatially not congruent (e.g., social relations don't stop at administrative boundaries) – place and community are not the same (Jones, 2003), which makes an exact socio-spatial definition of a community and its challenges for the implementation of energy strategies difficult (see Figure 4). And even if the municipal planners incorporate all sectoral domains, the challenges are still vertically interlinked.

2.3 Vertical integration of communities

Multi-level governance, legal and organizational entanglements across spatial levels and global markets are expected to have a strong influence on implementation of energy targets at community level. If municipalities are assigned to implement national or global energy targets, but the necessary competencies are diminished for instance by national legislation, municipalities face challenges that can't be resolved (Amin, 2004). The emphasis on the existence of 'internal' and 'external' barriers (Cagno et al., 2013), in combination with the actor-approach that associates barriers to three spatial levels – micro, meso and macro level (Reddy, 2013) – is crucial to understand the challenges faced by planners when implementing energy strategies at community level: Planners face issues occurring from both local context and higher spatial levels, such as global markets or national governments. But both are a challenge manifesting at the community level that have to be considered when producing and implementing energy strategies.

The need to include external framework conditions and internal local context into consideration when designing energy strategies is beyond debate (Wirth, 2014). Whereas the distinction between only two levels, either internal or external, is too undifferentiated: If local communities are recognized as arena of implementation for municipal energy strategies, we have to acknowledge that plans are developed above the community, at municipal level. But from a municipalities' perspective this level is still internal, since it is their level of operation which can partly be influenced by their activities. The same applies for the local community level. A differentiation between changeable and fixed factors seems more appropriate. As a consequence, a differentiation in accordance to Reddy (2013) between the macro level (national or regional, external, not changeable), meso level (municipal, external and internal, partly changeable), and micro level (local community, internal, mostly changeable) is used to define the local community.

Due to the fuzziness of community definitions, one could also argue for other forms of communities existing than the 'local community' (as defined in Section 2.1) – vertically through personal relationships, or on higher levels through political units or defined by 'bonding' as main criteria (Jacobs,

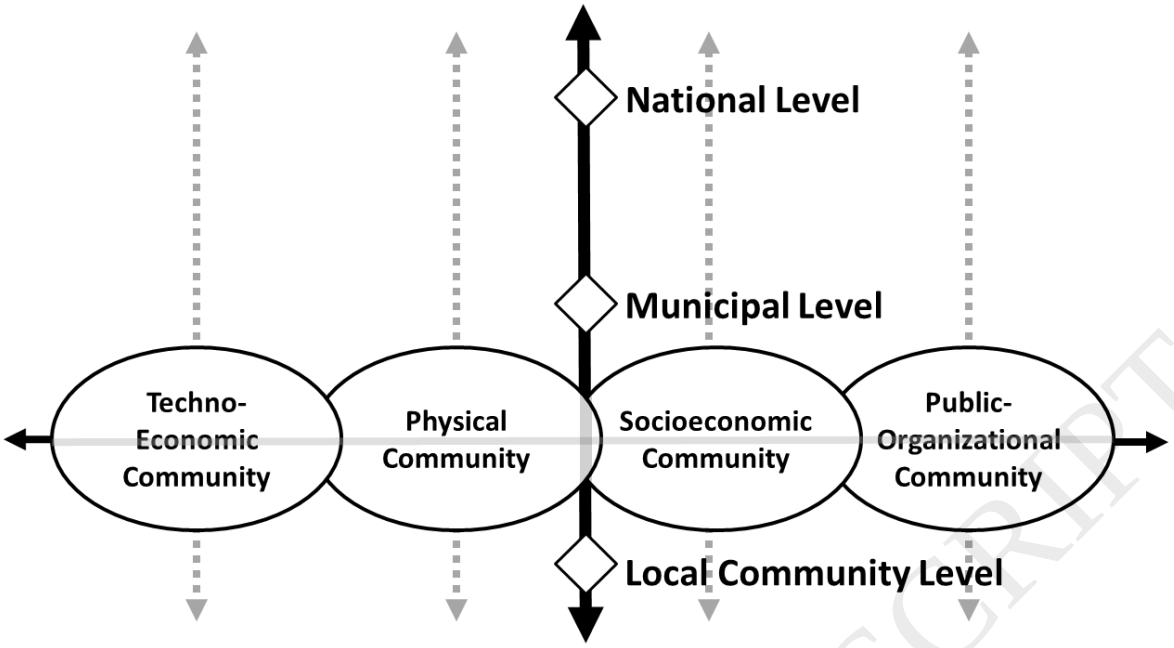


Figure 5: *The figure illustrates the relational community model used as analytical framework for the study. The community consists of four horizontal domains that are vertically integrated.*

1961). In this tradition, a municipality could be a community. We acknowledge but disregard this connotation of community, since the classification at hand is focused on factors relevant to the implementation of energy strategies into the built environment, which happens locally, below municipal level. A vertical categorization of factors influencing the implementation of energy targets according to levels is of importance for sense-making, while navigating in this complex construct of interdependencies across sectors and levels (Krippendorff, 1989). Hence, the suggested categories that define a local community are not absolute and are only constructed to help frame challenges in community energy planning.

2.4 Towards a relational community definition as basis for energy strategies

Challenges in urban energy planning are interwoven horizontally and vertically, because actor-networks, legislations and technical networks are often local, municipal, national, or even global at the same time, while influencing local communities (Hoppe & van Bueren, 2015). Haughton et al. (2013) state that most geographies of contemporary problems are fuzzy, and adequate policies are thus required to be made in-between spaces of formal governance scales.

Hence, a more relational sense of place and space is necessary when developing energy strategies: Vertical and horizontal relations and not only proximity are important when mapping communities. A desired technical constellation or energy should not be in the center of attention for energy strategy design, but the community and the inherent challenges should be. This perception requires a shift in strategy development. National and municipal preconditions should be integrated as top-down boundary conditions (Turcu et al., 2014), while local knowledge on the four sectoral domains of communities adds a bottom-up element to align general targets with local needs.

While it is common practice to optimize parameters of only one domain when designing strategies (Harrison et al., 2001), we propose a relational community energy model (see Figure 5) that incorporates the notion that a successful implementation of energy targets requires flexible policy approaches integrating a multitude of decision criteria, meeting motivations and targets of each domain and level simultaneously (e.g., Rydin, 2010; Sherriff, 2014). We apply this model as analytical framework for the municipal SEPs, to assess how local communities are represented in the energy strategies and which consequences this has for implementation of energy targets.

3. Research methodology

In a first step, a comparative analysis of strategic energy plans of Danish municipalities was conducted. The 98 Danish municipalities were divided into six similar-sized groups by the number of inhabitants (see Table 1) and evaluated on the availability of strategic energy plans or similar municipal energy strategies. Three of the remaining municipalities from each group were selected on the basis of their structure and geographic location for an analysis of the development process and scope of their SEPs (see Figure 6). It was ascertained that all regions, rural, urban, coastal and inland municipalities were represented in the total of the 17 analyzed SEPs to have maximum case variation (Flyberg, 1993). The regional SEPs were considered in addition, if relevant.

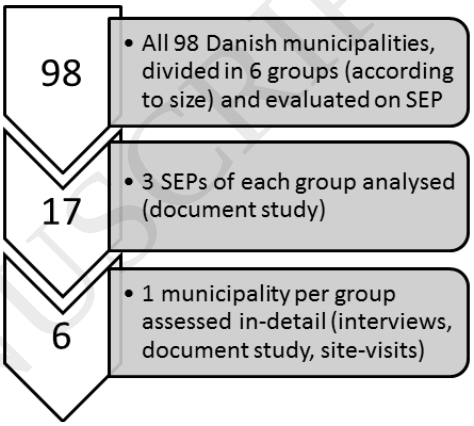


Figure 6: *Illustration of the assessment procedure of the SEPs in three stages*

To understand how municipalities institutionalize SEPs and how effectively they are implemented, one municipality per group was randomly chosen for an in-depth assessment. Each of the six municipalities appeared broadly representative of the group of municipalities. The municipal energy strategies were assessed by using a combination of qualitative research methods, including document study, interviews, site-visits and observations.

Eight interviews were conducted in Danish between mid-2015 and early 2017. The semi-structured interviews, each taking between 60 and 90 minutes, were conducted with key actors of the municipal administration that were responsible for the implementation of the SEP, or development and implementation. All interviews were transcribed and, together with the gathered documents, summarized in English under thematic headings for each case. These documents built the basis for the comparative analysis and lesson-drawing from the cases.

Each case was evaluated individually, and in comparison, to identify differences as well as patterns in the behavior of actors, with challenges and drivers occurring for energy strategies. Throughout the discussion, the municipalities and all interviewees remain anonymous, as this was requested by two of the participants. A basic overview of the 17 analyzed, respective six assessed municipalities is provided in Table 2. The data were supplemented from a media review as secondary source by using the

archives of national journals and newspapers (Altheide & Schneider, 2012). The challenges identified in the cross-comparison of the assessed municipalities were grouped and conjugated to the four sectoral domains of community energy and spread over the three levels of governance to form a taxonomy of community energy implementation challenges.

4. Setting the scene: a brief overview on strategic energy planning

4.1 Historic background on strategic energy planning

Denmark set the national target for a building sector solely supplied by renewable energies in 2035 (The Danish Government, 2013). Nevertheless, in the 1970s policies to decrease the dependence on energy exports were introduced, which led to long-term energy plans at the national level (Lund, 2010). A first generation of municipal heating strategies was established in the 1980s, followed by a second generation of municipal heating strategies in the 1990s to initiate the transition to more eco-friendly energy sources. Since then, heating planning has been stagnant. Electric energy – except for siting of wind power facilities and general project approvals – has until now not been a planning issue for municipalities (Sperling et al., 2011).

In the 2000s, municipal energy planning was mostly project-based and done by energy utilities (see Figure 2): The utilities came up with a project proposal (e.g., the extension or alteration of district heating systems), whereas the municipality had the responsibility to peruse and approve the proposal. This passive reacting instead of acting is inadequate in regard to the much-needed transition towards decentral, flexible and integrated solutions. The lack of strategic and long-term orientation of municipal heating planning led to incoherent and suboptimal solutions.

To counteract this development, the Danish Energy Agency initiated a subsidy program to develop ten municipal and six regional energy strategies, the SEPs, to align energy planning activities spatially and between sectors (The Danish Government, 2012). Accompanying guidelines were published on how to develop SEPs (Danish Energy Agency, 2012). A SEP is commonly understood as a planning framework to define how transitions towards renewable energies at the local level can be designed. While the main purpose is to design the supply infrastructure, the demand side is interrelated and should be addressed as well. Alongside the 16 government-funded projects, several other municipalities have, since 2010, independently enacted SEPs or similar municipal energy strategies (see Table 1).

4.2 Municipal strategic energy plans in Denmark: a snapshot in February 2017

Currently 49 municipalities enacted SEPs since 2010, with the majority being developed from 2013 to 2015. Additionally, twelve municipal SEPs were under development – according to municipalities' own statements, without being able to evaluate the status of the developments. In a broad interpretation, another 13 municipalities had energy strategy documents similar to SEPs, as SEP is neither a fixed term nor a mandatory plan document. The definition of strategic energy plans is fuzzy, as there is

no compulsory procedure on how SEPs should be developed or what they should contain. This is reflected in the available SEPs, where various approaches in development and content were observed: document types reached from memorandum of understandings with only a few pages up to detailed energy scenarios with attached action plans covering several hundred pages.

Summarizing, only every second Danish municipality enacted a SEP. Three-quarters of all Danish municipalities are to some extent engaged with energy as a matter of municipal activities (disregarding the mandatory heating plans that are often administered by utilities). Noticeable is that there were fewer small municipalities, according to inhabitants, that had municipal energy strategies, while energy strategies were more common in bigger municipalities (see Table 1). Considering the regional distribution, it is remarkable that a high share of municipalities in the capital region and Funen (region south) didn't have a sovereign municipal energy strategy - disregarding them being covered by regional SEPs. In contrast to Funen, most municipalities in the equally rural Jutland (region south, central and north) have sovereign energy strategies.

Table 1: *Overview of municipal energy strategies in Denmark (grouped in order of size)*

	Municipalities in total	**in %**	**< 25.000 inh.**	**25.001 - 40.000 inh.**	**40.001 - 50.000 inh.**	**50.001 - 70.000 inh.**	**70.001 - 100.000 inh.**	**> 100.000 inhabitants**
Enacted SEPs	49	50%	7	8	12	10	6	6
SEPs under development	12	12%	1	3	1	5	1	1
Similar municipal energy strategies (often sectoral strategies)	13	13%	1	5	4	1	2	0
No municipal strategy to coordinate energy planning	24	24%	9	6	4	3	2	0
Total	98	100%	18	22	21	19	11	7

5. Results: strategic energy plans and their implementation challenges

The results of the assessment of implementation challenges of SEPs are displayed in two steps: First the results of the 17 analyzed documents are presented. Second, the results of the in-depth analysis of how the energy strategies are implemented and what challenges occurred in relation to communities in six municipalities. The results are synoptically merged in Section 6.

5. 1 Analysis of the strategic energy plan documents

The collected 17 strategic documents were compared on authorship, methodology, scope, content, the inclusion of communities, and anomalies. A premise of the analysis was that the quality of the document indicates how well the strategy is incorporated in the local actor landscape, which facilitates implementation (Vergragt et al., 2014). The criteria for analysis are based on the proposition of strategy

as pattern and the rationale that 'planning is an intervention in, or an influencing of, the creation and use of the physical environment by others' (Needham, 2000).

5.1.1 Authorship and methodological approaches

Like the authorship of the strategic documents varied, so did the approach taken. In smaller, rural municipalities the municipal administration was often in charge to develop the SEP, whereas the documents of the small to mid-sized municipalities in urbanized regions were often developed by consultancy firms with the energy utilities as contracting authority. The methodological approaches ranged from bottom-up strategies, aligning existing projects into a strategic direction, over a mixed approach, to a classical top-down approach that set the target in advance with a rigid and specific technical configuration on how to reach a target. In three cases – where energy utilities used the same consultancy firm to develop the SEP – the top-down methodology and the following suggested technical solutions were almost identical, despite a different spatial setting.

5.1.2 Content and scope of strategic documents

All strategic documents addressed the heating sector, emphasizing the shift from natural gas to district heating and the replacement of oil-fired heating systems. Some documents contained detailed feasibility analyses, while other documents just named the heating area as main sphere of activity. The latter continued for the power sector, which in the majority of documents was only addressed in an abstract manner, if addressed at all. Primarily rural municipalities addressed the extension or repowering of wind energy facilities. Serious approaches in integrating transportation policies were only endeavored in combination with local biomass or biogas projects, which limited the scope of urbanized municipalities' energy strategies for transportation to a minimum. Through many documents' single-focused approach on the heating sector, a serious attempt to integrate energy systems was not fulfilled. The main business areas of the utilities involved seemed to have defined the suggested activities in the document. The relation to individual communities or the community level is weaker in the documents that were developed in a top-down approach, since they didn't incorporate and react to ongoing developments. The community level was mainly represented through new urban developments that have to be connected to energy infrastructure. Existing communities were mostly mentioned in an abstract form.

5.1.3 Targets and flexibility

Notable is the use of exact figures and the targets for GHG emission reduction. Some documents set very ambitious targets to reach climate neutrality by 2029, while others were guided by abstract national targets or didn't set any specific targets at all. This continued in the specific energy sector policies, where some documents didn't contain any figures at all. Documents developed under the lead of energy utilities were very specific in expected energy demands and emission reductions. Due to shifting priorities of actors, varying energy prices or technical progress, these narrow target ranges would require periodic updates, which is either only performed every few years, or in most cases didn't

happen (with the average age of documents ranging between three and five years). Hence, most municipalities have independent annual action plans for energy activities that should be in relation to the individual SEPs, which have, by contrast, not been updated for years.

5.1.4 Summary of document analysis

Around one-third of the analyzed documents can be considered as simple memoranda of understanding. Another third are energy scenarios, in some cases linked to general action areas and substrategies. The last third are integrated strategies that have the capacity to coordinate efforts in the energy domain. Thus, the majority of energy strategy documents were both too simplistic and inapt to promote the implementation of energy targets, or rather rigid technocratic energy scenarios without processual character. It is questionable if these documents can frame a strategy, or if they can be considered strategic at all, due to lacking a procedural component.

Despite difficulties in generally relating these findings to the authorship of the strategic documents and the development approach taken, there are indications that these documents were mostly developed in a top-down approach and by single actors (e.g., the municipality or energy utilities) without the incorporation of other actor groups. In particular, the common lack of involvement of citizens and other municipal departments is seen as problematic in regard to strategy implementation, since both directly and indirectly spatially allocate energy demand patterns and energy supply infrastructure at local community level.

5.2. In-depth assessment of six municipal energy strategies

Following, we compare the implementation efforts of six municipalities representing a broad spectrum of Danish municipalities. Rather than presenting each case individually, we emphasize generalizable observations that can be related to findings from the document analysis to assess municipalities' implementation challenges based on the theoretical framework introduced in Section 2.

5.2.1 Drivers for the strategy production

The motivations to prepare energy strategies were differing, depending on the situation of each municipality (e.g., location and economic situation – see Table 2 for an overview). While main drivers for the municipality B & C were the general improvement of the sustainability profile of the municipality, the economically stressed municipalities D-F are incentivized by local business potentials. Further motivations were the need for decision support on where to prioritize actions. Due to previous problems with wind power planning municipality F developed a SEP to improve the coordination of wind power projects, nature protection and settlement development.

Table 2: *Overview of in-detail assessed municipal energy strategies with key characteristics*

Municipality	**Group** (according to size, see table 1)	**Document type**	**Year enacted**	**Developed by**	**Time frame**	**Scope**	**Key driver**	**Location of responsible coordinator**
A	Very Large	SEP	2011	External Consultant	2029	Heating, power, gas	Coordination & Growth	T&M*
B	Large	SEP	2015	Municipality/ External Consultants	2020/ 2035	DH***, solar, energy utilities	Energy Transition	T&M*
C	Medium-Large	SEP	2016	Municipality	2025/ 2035	DH***, solar, biogas	Coordination of Activities	T&M*
D	Medium	SEP	2010/ 2016	Municipality/ Utilities	2020/ 2029	Biogas, wind power, transport	Business Development	Own Secretary under T&M*
E	Small	SEP	2014	Municipality/ University	2035/ 2050	DH***, power, biogas	Business Development	BD**
F	Very Small	Climate Action Plan	2013	Municipality/ Utilities	2020/ 2050	DH***, wind power, biogas	Coordination & Growth	T&M*

*Administration for technology and environment
**Administration for business development
***District heating

In most cases, the impulse for a strategy development came from within the administration. It took municipalities B & C several years to initiate the SEP development, despite it being on their agenda. In municipality C it took more than two years from the idea of developing a SEP until the strategy production actually begun, while the task was passed around in-between departments due to lacking competencies on energy, resources and low prioritization. The document production was mostly carried out by one or only a few civil servants who functioned as expert and coordinator for energy- and climate-related issues. Usually the responsible person is located in the administration for technology and environment and has no engineering education (except municipality B), which required the involvement of external partners for the technical energy scenarios. The external partners were in most cases external consultants or utilities. Only municipality E used a close cooperation with a university that is functioning as external advisor on technical questions. The responsible planners stated that due to insufficient financial resources, this was also their only possibility to include the required competencies, which was also the reason for the municipality to develop their SEP in-house and in a bottom-up approach. Similar patterns can be observed in municipalities C, D & F, where international research projects or the regional SEP program delivered the necessary technical input, data basis, and financial resources to set up an energy strategy.

5.2.2 Scope of the energy strategies

The strategic documents vary from five pages up to 80 pages. Here, the length of the strategic document did not correlate to the energy strategies' comprehensiveness: The non-use of exact figures and the resizing of the SEP document to 20 pages in municipality B were deliberate, as the SEP should be used to communicate the strategy to politics, within the municipal administration and to the public.

The underlying estimations and technical scenarios were explicitly not published to avoid too high expectations and to retain flexibility, since techno-economic boundary conditions were seen as subject to variation. While strategy A was very technical and F rudimentary, the strategies B – D were more process-oriented and contain a mix of suggested measures to increase energy efficiency and an increased use of renewable energies. Despite different approaches, varying data quality and sources, all documents stayed rather vague when mentioning the expected effects of policies to foster the implementation of energy targets. All documents pointed out geographic focus areas or cross-cutting issues, such as e-mobility. Only municipalities B & D also actively worked with the internal organization of the municipality as administrative body.

5.2.3 Implications and embeddedness of the strategies into municipal activities

If it comes to implementation of the strategy in day-to-day practice, the strategic document fulfilled more of a communicative than a normative purpose. Due to the informal status of the SEP, the incorporation of the issues and targets raised in the strategy have to be transferred to other areas of municipal policies, such as the municipal plan or local development plans. Municipalities C & F explicitly named the enhancement of the municipal plan, through the SEP as a sub-strategy, as purpose of the document. Municipalities B & D saw it as communication tool to set the political agenda, and the planners in municipality E used the document as an internal working plan to include other departments of the municipal administration. All SEPs were backed up by sub-strategies, for instance energy renovation programs or wind power extension plans that defined actual policy instruments. Still, most of these policies stayed vague and seemed to depend on the involvement and workload of the responsible planners, since they were not publicly available in a written document. This dependence from individuals was notably strong in municipalities C & F, while the others had more than one responsible civil servant.

5.2.4 Challenges for the implementation of the energy strategies

Technical issues played a minor role, since municipal strategies were mostly concerned with heating and to some extent power infrastructure based on known technologies. Contradicting national legislation, natural preconditions (e.g., proximity to the sea, biomass availability), or physical restrictions (e.g., dispersed settlement structures, old building stock) represented bigger challenges for the implementation of energy strategies.

Lacking technical knowledge, in contrast, was named by municipalities C – F as a critical factor. In combination with tight municipal budgets, municipalities depend on external funding to finance detailed energy scenarios, monitoring and other activities at project level. Tight municipal budgets were in the cases D – F accompanied by difficult private economic situations of the citizens and low real-estate values, which posed challenges in incentivizing private investments in energy renovation or the replacement of old heating infrastructure. Here, energy strategies were challenged that were not aligned

to local communities and simply didn't get implemented, since the municipalities, in case of renitence, reprioritized their activities to other areas.

The alignment of municipal targets with the citizens' interests and local actor-networks was emphasized by all municipalities. However, tailoring policies, communication and planning approaches were challenging for municipalities, since the knowledge on communities was fragmented and required high efforts to obtain. Data privacy, separated databases on energy consumption and supply, or the inaccuracy of the Danish Building and Housing Register, required manual data acquisition of technical and physical community parameters. Energy scenarios based on deficient data, in conjunction with socio-cultural opposition, lacking support in communities, and economic factors, were named as main reasons for rejection of energy projects.

All municipalities, except F, named onshore wind-power as an example where national policies interfered with local interests. The change of national government in 2015, accompanied by decreased political and financial support for the energy transition, was perceived by all as a serious threat. Hence, higher administrative-level decisions or neighboring municipalities' activities challenged local interests. Further challenges occurred from insufficient internal cooperation within the administration (e.g., municipality E), the non-alignment of municipal and energy utility working agendas (e.g., B & C), or changes in local politics that were either a driver for the energy transformation, as seen in municipality B, or a massive restraint, as seen in municipality C.

5.3 Synopsis of main tendencies challenging municipal energy target implementation

With recourse to the 17 SEPs and the assessment of six energy strategies, there were five main tendencies in municipal energy strategies recognized, that are described in the following:

5.3.1 No consistency in procedural or document structures

There is no consistent procedure on how to develop or structure SEPs (Danish Energy Agency, 2012). This is not automatically an issue, since it allows the necessary adaption of energy policies to local contextual factors (Walker, 2011). However, if municipalities lack capacity they were either not able to develop SEPs in-house, or they had to buy in expertise, which requires financial resources. That was an issue for smaller municipalities where tight budgets allowed neither the employment of sufficient specialized staff, nor the engagement of external consultants. This became evident when analyzing the scope and quality of many SEPs.

5.3.2 The level of political support and sense-of-emergency define quality of energy strategy

Small municipalities employing specialized staff for energy planning showed that the level of political support defined how municipalities prioritized development and implementation of energy strategies, which was a factor defining the quality of strategic documents. Leading smaller municipalities (e.g., municipalities D and E) actively sought the inclusion of economic growth policies and other municipal activities into energy strategies to incorporate different actors to facilitate implementation – de-

spite tight budgets. Emphasizing the added value of addressing energy issues at municipal level created, in these cases, the political support for the allocation of the necessary resources. The stronger commitment in the rural municipalities could partly be explained by an economic sense of emergency (municipalities D, E & F), since renewable energies provide possibilities for local employment and cost savings in economically stressed regions, as a potential driver for economic growth (Walker, 2008). This is in line with earlier studies on climate action plans of forerunner municipalities, where a lower performance due to significant difference in capacity between small and large municipalities was not observed (Wejs, 2014). Rural municipalities were even found to be more ambitious (Damsø et al., 2016).

5.3.3 Frequent lack of technical expertise in municipal administrations

Even municipalities where energy planning was politically prioritized often lacked technical competencies. Hence, they depended on external advisors for some part of the strategy development and implementation process. If sufficient financial resources were available, consultancy firms were used from data editing (e.g., municipality B) up to full policy conception. In municipalities with spare financial resources, strategic partnerships with universities (e.g., municipality E) or the participation in research projects (e.g., municipality F) were the only source to obtain the required technical competencies, whereas the project steering remained in the municipal administration.

5.3.4 Strategic or project steering expertise defines approach in energy strategy development

The aforementioned municipalities were examples of strategies developed in a bottom-up approach: The use of existing projects and sectoral strategies established the basis for an integrated energy strategy, enhanced by new project proposals and policies that contributed to the achievement of energy targets. These projects emphasized local anchorage of the energy strategies. This was contrasted by municipalities that first set the desired energy target and suggested generic solutions to reach the target, as a top-down approach. In municipalities lacking technical and project steering competencies, with low political prioritization but sufficient financial resources, the strategy development was totally outsourced: Among the 17 analyzed SEPs are examples where municipal utilities hired consultants to design energy scenarios – mainly for the extension of district heating networks – that were enacted by the municipality as SEP. Despite intentions to reduce CO_2-emissions, it is questionable if such a document should be called SEP, since it is single-sectoral, lacks overall strategic consideration, and excludes local actors.

5.3.5 Lacking integration of various actor types and non-alignment to local communities

The sole focus on technical possibilities and the production of technical scenario documents without involving local actors (which at last are responsible for the implementation of the energy strategy) aggravated the already existing implementation challenges originating from the complexity of communities. The comparison of the six assessed municipal energy strategies showed that in communities, as endemic setting for urban development projects, the successful implementation of energy strate-

gies may be blocked by conflicting objectives, values or divergent tactics by local actors. The deviant temporal and spatial levels for operation of public administrations, private actor-networks and energy markets – from global to municipal level – were added as further challenges manifesting at the community level. The neglecting of this complexity in energy strategies, or in reaction the required flexibility, made the implementation of energy targets even more challenging.

6. Framing challenges for energy strategy implementation

The challenges for municipalities in implementing energy strategies can be framed in two ways: First, after their origin according to discipline and spatial level, which allows a systematic overview of challenges. Second, associating challenges after their reasons to explain cause-effect chains leading to difficulties in implementing energy strategies. Both have their importance in understanding implementation challenges. Since the main aim of this paper is to systematize challenges in a community-centred taxonomy, we are first looking at the latter – challenges occurring in relation to their reason. In a second step, we can integrate these dynamic factors into the more static, but also more comprehensive, taxonomy of implementation challenges.

6.1 Insufficient strategic documents: challenges framed according to reasoning

In summary, three challenge groups were identified: Internal organizational issues, the complexity of communities, and procedural deficits in strategy production. While they can be analyzed individually based on intrinsic theoretical approaches, it has to be remarked that they are mutually dependent and led in conjunction with insufficient SEP documents, which are accompanied by suboptimal municipal energy strategies.

6.1.1 Internal organizational issues in municipalities

Internal issues in municipality administrations influenced the development of energy strategies and how strategic documents were constituted. For instance, they define the level of political support of the resources that were used within the administration for energy issues. If the staff was either sparse, lacked capacity or technical competencies, or had an inferior position without discretionary competencies, the energy planning challenges occurring from the complexity of communities were difficult to address.

The organizational structure of Danish municipalities is traditionally based on silos of professional sectors that form administrative departments and sub-departments with limited cross-sectoral coordination (Larsen et al., 2012). As explained in Section 2, energy planning requires more than technical expertise, since the implementation requires cross-sectoral efforts. Hence, the isolation of energy planning in one sub-department within one silo, typically the technology and environment department, was aggravated by the organizational fragmentation and the resulting different professional languages, priorities and working procedures (Mintzberg, 1983).

The influence of the municipal organization on the energy strategy production can be demonstrated by the application of Richard Scott's three pillars of institutionalism (Scott, 2001). The regulative processes, here the demand for a municipal heating planning by law (Sperling et al., 2011), did require formalized energy planning in the past. With the ease of this rule and the transfer of this task to the utility companies, the municipal competencies were indirectly outsourced in many cases. With an increase of renewable energy in the energy system and the needed integration of different energy sectors (Lund, 2010) – a far more complex task – municipalities often lacked these competencies. The regulative system, here the national government, only set abstract demands and made SEPs mandatory in neither content nor form (Danish Energy Agency, 2012). As a consequence, normative and cultural-cognitive processes within each individual municipality took over and defined how the task energy planning is performed (Scott, 2001). Department responsibility and chosen planning approaches (rational versus collaborative) became a normative question. General working procedures and available resources within each municipality defined the framework for energy planning. Cultural-cognitive processes defined the resource allocation for energy planning, or if it is done at all. That implies that the predominant values in municipalities defined the level of engagement in energy planning – for instance, if climate change was politically acknowledged, or if renewable energies were seen as a means for local economic growth. This is supported by Wejs (2014), stating that adequate internal organization requires both formal administration and informal factors, such as legitimacy.

The absence of a regulative institutional framework for SEPs in Denmark left energy planning up to normative and cultural-cognitive frameworks within individual municipalities. Hence, different local preconditions and the resulting internal municipal organization defined the starting point for energy planning procedures, and constituent procedural challenges for the implementation of energy strategies in communities.

6.1.2 Complexity of energy planning on community level

The complexity of the community as described in this paper with its four domains is, in combination with the internal municipal organization, the second reason for implementation challenges. The interviewed municipalities struggled with aligning desired technical configurations to the actual features shaping the local communities. National legislation, natural preconditions, physical restrictions, citizens' interests or their economic situation were named besides others as main challenges. These aspects are spread over all four domains of community and exemplify that the inclusion of various actors, levels, time-horizons and disciplines is necessary when producing and implementing energy strategies (Cajot et al., 2015).

Hence, long-term planning processes based on extensive local context knowledge are required to align opposing interests, which is a challenge in itself in regard to the prevailing planning culture and internal organization of municipalities. Or as formulated in Biesbroek et al. (2015): 'Measures taken in one policy domain to reduce climate impacts are often not linked to the impacts of these measures taken

in another policy domain'. Since proactive and integrated energy planning is a new topic for municipalities, the lack of knowledge and data adds further challenges to the planning process. If the internal organization of the municipal administration is not adjusted according to the complexity of the task of community energy planning, procedural deficits will follow. The task becomes too complex to be handled by linear standard planning procedures, since it requires a constant negotiation of interests (Langlois-Bertrand et al., 2015).

6.1.3 Procedural deficits

The combination of inadequate internal municipal organization and the complexity of communities led to procedural deficits in strategy production. According to Healey & Hillier (2008), energy strategies can be understood as both product and process. This implies that the quality of the SEP as framing document depended on the quality of the planning process: the quality and chances for implementation of the strategy are related to process quality. The initiation of a planning process without sufficient expert competencies, resources and awareness of local conditions leads to exclusion of central actor interests, which should actually carry or support the strategy implementation (Needham, 2000).

This was observed in many of the 17 analyzed SEPs that were developed in a top-down approach by either one or a small group of actors, neglecting socioeconomic and cultural factors of the local community. This negligence, caused by the lack of municipal resources and technical knowledge, led to strategic documents being developed by third-party technologists that 'tend to neglect the economic, political, social and cultural dynamics' (Verbong & Geels, 2010). While municipal administrations typically deal with such issues in urban planning processes (Juhasz-Nagy et al., 2017), these dynamics are in other 'communities of practice' (Lave & Wenger, 1991), where the technologists and leading actors come from, uncommon. The inherent 'different sets of rules' (March & Olsen, 1989) were the reason for techno-economic energy scenarios, which rather define technology 'end states' than 'dynamic pathways' on how to reach the energy targets (Verbong & Geels, 2010). The task of including and convincing local actors to carry out the necessary actions was postponed to a later stage and delegated to the municipality.

This aggravated the collective action to occur that is necessary for strategy implementation, as described by Bryson (2011). Hence, a large share of the analyzed SEP documents were essentially energy scenarios without the capacity to link actors with divergent interests and goals, and working procedures to realize certain goals (Daamen, 2010) – as strategies could be able to – since many of the actors (public and private) were not involved in strategy formulation.

In summary, the emergence of inadequate energy strategies was caused by three reasons: procedural deficits, shaped by internal challenges (the municipal organization) in conjunction with relational or spatial challenges (the complexity of community). The latter are not directly influenceable for municipalities, but they are crucial for a successful strategy implementation.

Figure 7 shows the combinations of reasons identified in this study that led to insufficient SEP documents, which by implication led to difficulties in implementing the inherent energy targets. While this overview can help explaining general deficits in strategy production, it does not provide an overview of which contextual factors to consider when developing energy strategies. The overlapping challenges require a more holistic view, since they – no matter if internal or external – all have to be considered in energy strategies (Langlois-Bertrand et al., 2015).

For sense-making (Krippendorff, 1989), from a municipal energy planners' perspective the identified challenges were categorized in the community energy model from Section 2. In the following, the implementation challenges are arranged according to their origin to the four community domains on the horizontal axis, and to the three spatial levels on the vertical axis.

6.2 Classification of implementation challenges into a community-centred taxonomy

The implementation challenges identified in the study for municipal energy strategies are, in the following, associated to the community energy model from Section 2. The aim is to merge these procedural, organizational and spatial challenges into one scheme centering on the community as a level of

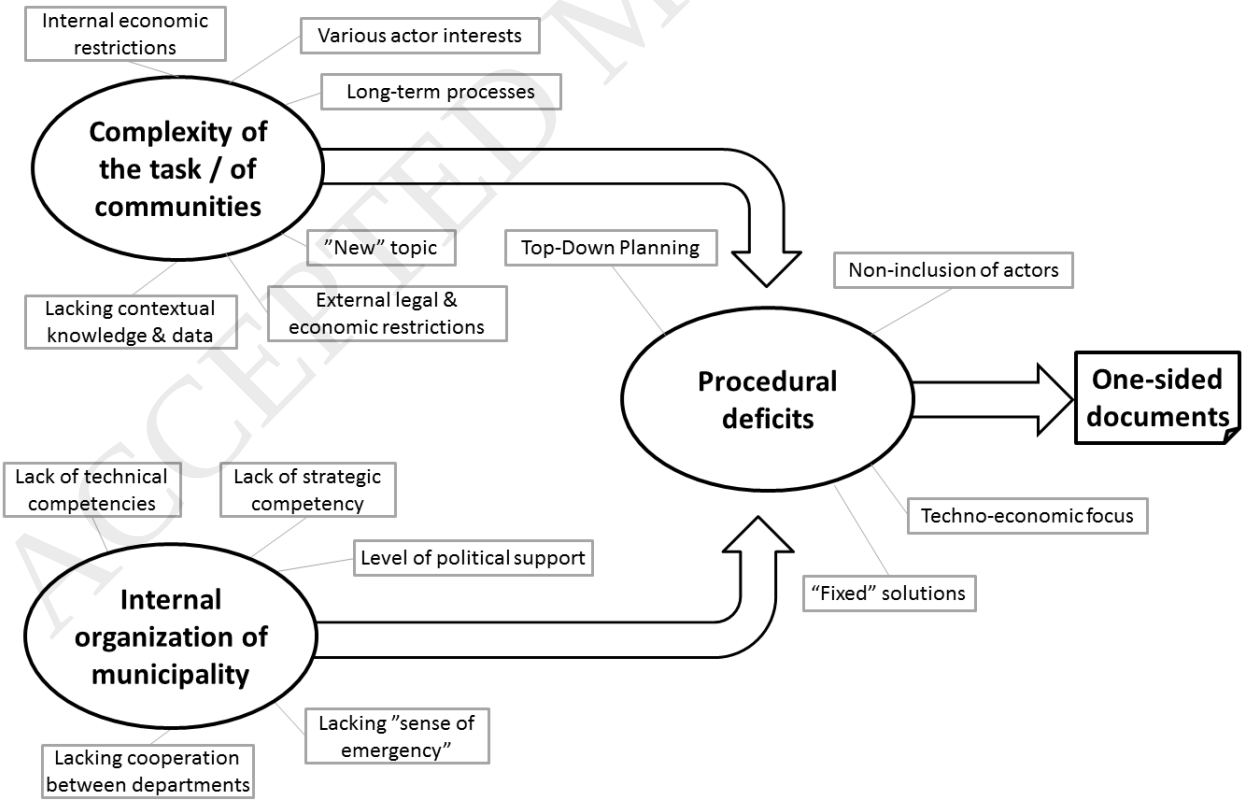


Figure 7: *The flowchart illustrates how the implementation challenges were grouped in accordance with their reason and how the combination of the three explains the formation of inadequate energy strategies*

implementation of energy strategies, to be able to describe the challenges and their interrelation that the municipalities should be aware of. As of now there exist – to our knowledge – no framework or tool addressing non-technical challenges in relation to energy scenarios for communities. Also, the practitioners' guidelines for the SEP development in Denmark contain no reference to such considerations. As a result, we have seen that many municipal energy strategies are based on techno-economic parameters only, which has contributed to the described implementation gap.

Similar patterns have been identified in other contexts. Already, 35 years ago, Mintzberg described how departments within (municipal) organizations handled tasks within their profession efficiently, but struggled with tasks falling in-between professions and standard procedures. As a reaction, one profession carried out the task on its own, instead of sharing responsibilities, leading to insufficient task management as described here (Mintzberg, 1983). But energy planning, as part of climate change planning, is a classical interdisciplinary task and requires interdisciplinary collaborations (Wejs, 2014). For this purpose, a taxonomy of implementation challenges encompassing all four domains (or disciplines) is introduced in the following.

The aim of this taxonomy in taking a socio-spatial perspective, with the focus on energy strategy implementation, is to illustrate challenges according to their sectoral and spatial origin. This could help in raising municipalities' awareness of what to consider in energy strategy production and implementation for specific communities.

As shown in Table 3, the challenges deducted from the analyzed SEP documents and the inherently assessed municipal energy strategies were grouped. The challenges spread equally over the four sectoral domains and three spatial levels, as introduced in Section 2. All challenges have specific characteristics for each spatial level. For instance, are global or national energy markets and the related energy prices of high significance for the implementation of energy strategies at community level, while energy markets at community level are either non-existent or insignificant for the implementation of energy strategies. In contrast, have socio-cultural values at the macro level a lower impact than on the micro level. Hence, wording and scope are adapted for each spatial level.

Table 3: *Challenges for implementation of energy strategies at community level*

	Techno-economics	**Physical conditions**	**Socioeconomics**	**Public organisation**
Macro level (nation & region)	- Existing infrastructure on a national level - Potential infrastructure on a national level	- National environmental conditions - Predominant building & construction characteristics	- Economy & markets at global or national level - Actor-networks & activities	- National legislation, plans & programs - Administrative structures (EU, nation, region)
Meso level (municipality)	- Existing municipal infrastructure - Potential infrastructure on a municipal level	- Municipality specific environmental conditions - Settlement characteristics	- Situation of local economy - Local actor-networks & activities in energy related fields	- Municipal legislation, plans & programs - Administrative structure - Process stage, activi-

	- Energy demand patterns at municipal level		- Local values, structures & traditions	ty level & sensitivity for energy
Micro level (community)	- Existing supply infrastructure in community - Potential energy supply infrastructure in community - Factors influencing the energy demand at community level	- Single building types and characteristics - Urban form characteristics	- Financial capacity of community members - Community actor-networks, activities level & knowledge in the energy field - Social structures, local values & traditions	- Locally binding legislation - Local activity level & stage of development

Depending on the spatial level, there are several implications for energy strategy implementation: Challenges on the macro level are fixed constants that cannot be governed by municipalities, since they are outside of their purview (Hoppe & van Bueren, 2015). If relevant challenges from the macro level negatively influence the implementation of energy targets for municipalities, potentials at the meso or micro level to outweigh these have to be found.

In contrast, challenges at the micro level are often influenced by municipal activities (even though some challenges remain fixed, such as the existing building stock as part of the physical conditions). Here procedures, project design factors, and the municipal organization are highly changeable and dependent on the specific setting. Potentials to handle challenges are mostly found on the meso level, which is a mix of changeable factors (e.g., municipal plans or the internal organization of municipalities) and fixed constraints (e.g., environmental conditions of the municipality). Implications for the adaption of energy strategies should be considered by municipalities for each implementation challenge. As mentioned earlier, technical competencies within municipal administrations and strategic knowledge are important factors to produce and implement fitting energy strategies. However, all strategies should be in line with the local context as the base of strategy production to capture potential challenges or possibilities. The introduced taxonomy provides a systematic and cross-sectional overview of which factors to consider at an early stage to adapt technical energy scenarios to the local context. The relevance of this approach is justified by the inadequate alignment of SEPs to local challenges, as presented in Section 5.

7. Concluding discussion

This study has examined municipal energy strategies in Denmark by means of strategic energy plans as framing documents. The insights of the document analysis on targets, authorship, scope, planning approach and the inclusion of local communities were combined with a systematic classification of implementation challenges that impede the realization of the strategies' intrinsic energy targets. This enabled a better understanding of deficits and optimization potentials for municipal energy strategies, while the taxonomy of implementation challenges gradually contributed to a more systematic mapping of contextual factors from multiple spatial levels and disciplines relevant for energy strategy implemen-

tation. This might help municipalities to understand the scope of implementation challenges for energy strategies in communities, as it illustrates how implementation trajectories are dependent on external constraints and internal challenges.

We conclude by highlighting the three key conclusions disclosed throughout the study. First, the majority of the 17 analysed strategies were developed in a top-down approach by only a small group of actors in sync with the origin of the energy targets – with the result that local communities were rarely included in strategy production and framing documents. These static, technology-focused and less process-oriented energy strategies rarely genuinely integrated different energy systems. Hence, the varying quality is reflected in the impact of the strategies on implementation in the practice of public planners, as the six in-depth analysed municipalities illustrate.

Second, the neglect of local context led in many municipalities to a non-attainment of energy targets, since mostly socioeconomic, cultural or organizational challenges have not been considered during strategy production. Summarizing, three main reasons caused municipalities difficulties in developing adequate energy strategies to implement energy targets: Internally, municipal administrations were not well positioned (e.g., lacking technical capacity, financial resources, political support or internal non-alignment). Vogel (2015) and Wejs (2014) found similar patterns in Danish municipalities, where sustainability ambitions and practices deviated due to the plurality of municipal targets: the established departments and the inherent growth-agenda overruled the environmental targets. Externally, communities as an arena of strategy implementation are highly complex, containing several often conflicting sectoral domains influenced by different spatial levels that are beyond municipal ambit. Due to the lack of a guiding framework, the energy strategy development was based on local normative or cultural-cognitive processes, which made procedural deficits in conjunction with the two first reasons almost unavoidable. Due to the 'municipal voluntarism' (Bulkeley & Betsil, 2005) in strategic energy planning different local contexts, the access to knowledge and financial resources become crucial factors as Granberg & Elander (2007) demonstrated for local climate mitigation policies in Sweden.

Third, in consequence an improvement of the quality of energy strategies requires the consideration of possible implementation challenges already in strategy production through a broad engagement of public and notably private stakeholders. Since this exceeds the competencies and resources of many public administrations, national funding schemes to support municipalities and municipal energy strategies by legal obligation are desirable. This would have to go hand in hand with an alignment of local to national administrative structures and political prioritization, which has been acknowledged in the literature.

Bulkeley & Betsil (2013), Vogel (2015) and van der Schoor et al. (2016) emphasise the importance of aligning actors from multiple levels and overarching networks to build the required capacity for the British, Danish and Dutch context as key issues for a successful local energy planning. Allen et al. (2012) suggest the use of existing partnerships and policies to ensure that the sparse municipal resources are applied efficiently and to enable a multi-stakeholder engagement. The required technical

competencies can often be found in the local utilities that are in Denmark often municipal-owned. The deployment of their competencies would require an active ownership policy, as it can be seen in many German municipalities in recent years with a trend towards a remunicipalisation of utilities to achieve public energy targets (Berlo & Wagner, 2011). Further, the successful integration of bottom-up planning processes and grass-root initiatives in municipal energy policies in Germany (Li et al., 2013) or the Netherlands (van der Schoor et al. 2016) are examples on how to include a broader range of actors, integrate local knowledge and to adapt energy strategies to the local context. However, this requires a basic understanding of local communities and their inherent challenges. Wirth (2014) treated the community as individual institutional order which shapes decisions. In line with this we have introduced a taxonomy of implementation challenges, taking the perspective of communities, since they form the arena where the energy transition unfolds spatial implications and the implementation trajectories of energy strategies are negotiated.

This comprehensive overview illustrates the relativity and variability of challenges from a practitioner's point of view, which demonstrates that all challenges have to be considered when applying energy strategies at the local level. Here, the taxonomy can be used for a first self-assessment by municipalities to map contextual factors that have to be considered during strategy production.

Nevertheless, the taxonomy provides only an overview and can only sensitize for challenges. The identified implementation challenges are not to be seen as finite, since their classification is based on a limited selection of national cases. In studying the municipalities that already enacted energy strategies – thus, the ones that can be considered as progressive – the other half, and their challenges in even producing an energy strategy, have been neglected. However, the identified challenges are congruent to findings from barrier literature within the sectoral domains and can be recognized in international experiences. Further research should address each of the identified domains of implementation challenges in detail to refine the taxonomy into an analytical framework that supports municipalities working with the implementation of energy strategies at community level. A second field that requires further research is the required competencies besides contextual knowledge to manage the implementation of energy strategies, and which role of the public planners have in the successful negotiation of multi-leveled and multi-stakeholder interests.

Acknowledgments

The author thanks all interviewees who provided insight and expertise that greatly assisted the research. The author would also like to thank the two anonymous reviewers for their valuable comments and suggestions to improve the quality of the paper.

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