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co-creation of energy transitions with citizens in the contexts of city and national politics

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Energy district Sydhavn – co-creation of energy transitions with citizens in the contexts of city and national politics

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Abstract

The provision of heat and electricity are for many citizens, small shops and enterprises a concern when paying the bills but are at the same time not something that they easily understood and approached in technical terms. Neither is the current need for a transition toward a renewable based integrated and flexible energy system well understood though the icons of renewable energy such as wind turbines, solar cells and heat pumps often are well known and supported. The involvement of local heating managers and dwellers and the change of everyday practices is at the same time crucial to reach the goals for energy savings.

The project: Energy Forum Sydhavn has the purpose of making energy savings and transitions become real beyond the actual results from energy renovations of buildings. In projects involving utilities, building owners, operators, tenants, shops and companies including also technology providers we set targets and organize socio-technical change agendas and structure project that make these changes become real. In the project, we operate with concepts for how to involve actors and how to configure topics, goals and actor constellations.

This is reflected in the energy systems transition literature with the focus on local, engaged ownership as well as cities and regions as drivers of a new wave of change. At the same the organizational obstacles, the existing energy institutions routines and practices and a lot of visionary window dressing from the side of city and government authorities tend to reduce the real impact of the transition. This is often even hidden behind attempts to recruit citizens and politicians to trust in short term market based solutions and privatization. While the ideal type sustainable energy transition is well outlined in models of future renewable energy bases societies the transition processes include controversies and a continued need to change the visions and actor constellations that drive the transition.

Introduction

To make a transition towards a fossil fuels free future real within the time span of countering the observable climate changes mitigating measures are needed, not in a distant future, but now. As you are reading this, both sea-ice in the Arctic sea and the ice that used to cover Greenland is melting rapidly and local weather conditions are providing for increased instability.

In this paper, we focus on our efforts, as researchers in the field of STS, to contribute to the transition to a fossil free future at the city level – more precisely in Copenhagen with emphasis on the South Harbour district. The district characteristics include a low-income population as well as older residential buildings constructed in the 1910s to 1940s and company buildings constructed in the 1950s to the 1970s. We argue that locally integrated community energy systems are an essential part of the energy transition. We base our argument on four pillars of which the fourth is the central part of this paper:

1. Recent research dealing with and arguing for integrated community energy systems;
2. Past experiences with creating local energy cooperatives in Denmark and their relevance to policy changes and actions in earlier phases of the energy transition:
3. The push towards integrated community energy systems as included in recent though contradictory EU energy policies; and

4. Our experiences of preparing for local integrated community energy systems in the local district in which our university is situated.

Community energy in recent research on transitions

'Power to the people: local community initiatives and the transition to sustainable energy' (van der Schoor and Scholtens, 2015) describe how local communities in different parts of the world are challenging their traditional role as passive consumers and are becoming active prosumers who both consume and produce. Local energy systems have once again attracted attention – in parallel with the ongoing discussion of 'smart' energy systems. Based on a careful review of recent research, Koirala, Koliou, Friege, Hakvoort and Herder (2015) identifies key issues and trends shaping integrated community energy systems. They identify five trends changing the energy landscape: increasing electrification, rising distributed energy resources, towards a carbon-neutral energy mix, changing utility business models and increasing customer engagement. Koirala et al. stresses that a number of research projects points at the local community as a fundamental component of integrated community energy systems.

One might argue that in locally based systems those tenants and other actors who are engaged in their local energy consumption and act on improving and adding local energy production, storage or conversion technologies are not only to be regarded as customers, they are much more than that. Smith, Hargreaves, Hielscher, Matiskainen and Sevfang (2015) analyses the community energy in the UK. They apply three distinct analytical perspectives on grassroots innovation in their study: strategic niche management, niche policy advocacy and critical niches. The two first perspectives explains policy influence in grassroots innovation but at the same time, excludes perspectives that are more transformational. Smith et al argues that, if grassroots innovations is to realise its full potential, the critical niche perspective needs to be pursued and more socially transformative pathways to sustainability needs to be discussed.

Our methodological approach

We view the ongoing energy transition as a series of matters of concern forming arenas of development (AoD) that frame the controversies and initiatives taken by a variety of actors and objects involved in the energy transition. This perspective and approach leads us to view actions taken by actors engaged in and navigating on specific arenas as specific forms of performances that contribute to change and can both reframe the boundaries of an arena and push developments further in already defined ways.

The approach emphasises how actors operating within different networks (e.g. at a local, national and international scale) hold different and sometime conflicting understandings of the focus and boundaries of the socio-technical system. In line with e.g. Smith and Sterling (2007) as well as Shove and Walker (2007), Jørgensen (2012) thus claims that any definition of a socio-technical system is the outcome of politically motivated sense-making processes that 'operates by constructing boundaries, purifying dynamics and assigning agency'. This research approach claims that continued processes of actions on temporarily stabilised arenas as well as re-alignments of these arenas modulate transitions.

In terms of studying arena dynamics, Jørgensen (2012) argues for a focus on actual events and actor performances that are constitutive for the matters-of-concern on an arena. Such performance may involve interactions (for example in the public debate), demonstration projects, and other ways of creating presence in relation to other actors (e.g. visions, policy interventions, sense making or materialized interventions). The observation of actions and their alignment respectively juxtapositions provides the empirical grounding for the identification of arenas.

Arenas exist as empirical entities (in a similar way as e.g. institutions), but they function at the same time as the researcher's tool to structure and magnify the processes involved in the development studied as well as to handle the complexity of transformative processes. Thereby the AoD approach appears as a scalable tool

for detailed studies of changes in socio-technical systems as well as broader cross-sector and international changes, which are in focus in this article. It also offers an approach that emphasise processes that weaken dominant arenas by interactions with other arenas having at the outset quite different matters-of-concern but colliding on specific parts.

Earlier Danish experiences with local initiatives and engagements

The Danish movement for sustainable energy developed in parallel with the organization protesting against nuclear power in Denmark in the early 1970ies. Hundreds of people experimented with developing different types of renewable energy, especially wind turbines and thermal solar energy. Out of this rather anarchistic experimental environment grew a number of small industries. Eventually the wind turbines generated energy for not just one family but a local community. Thousands of local energy cooperatives were established in villages and small towns in Denmark in the 1980ies. Some dreamt of becoming totally independent – being able to go off-grid. Establishing energy cooperatives built on a very well established tradition of forming cooperatives in order to solve societal problems (Elle et al 2015; Avelino et al 2015)

The analysis in the following draws on an article by Jørgensen et al. (2017) that provide a long term historic assessment of the shifting arenas of development and the shifting matters of concern that can be observed in earlier phases. We will in the following focus on the arenas that characterise the recent phase of the Danish energy transition and how locally integrated solutions – including energy communities – can play a role in the transition, but also how different arenas stage controversies over the direction and questions of ownership in the energy transition.

The contemporary Danish energy transition context

The radical, strategic policy goal set by the Danish government in 2005 to become independent of fossil fuels in 2050 is a significant marker that has the potential of guiding other policy measures to become a coherent policy mix and set the stage for other societal actors by narrowing future options and providing a stable investment horizon. At the same time, the goal for 2050 opened for a number of questions concerning the design of the future energy system (Jørgensen et al, 2017). Actual questions and challenges are: which fuels are to be accepted, how should an integrated energy system look like, which actors are core to performing the transition, which policy measures and investments are needed?

The contemporary phase of the energy transition embeds controversies concerning the future role of wind energy and its integration in the energy system, the future role of bio-mass that has almost taken over from coal and oil in all co-generation plants in an attempt to make these CO_2 neutral reflecting governments official classification of wood pellets.

Today's energy supply from wind power provides on average 50% and in peak periods more than 100% of Danish electricity consumption and in contrast nothing is provided from wind turbines in short periods, which especially during the winter season move to the fore the question of balancing production as a core matter-of-concern. With slightly different time profiles, this is also the case for solar cells, but in addition they are not nearly as efficient during the winter season as the rest of the year. This has for-fronted the challenge of the policies regulating the balance of power with utilities now focused on economic outcomes and not energy efficiency showing the impact of the *inner market arena* pushed by EU regulations but also by commercial energy users with its general focus on commercialisation and commoditisation of supplies. This international policy arena contributes to the framing and transformation of the *renewable energy arena* that involves actors from both policy, utility and local communities. The still dominant focus on regulating the short term electricity market has introduced a *power balancing arena* with the task of avoiding critical overflows and blackouts.

Instrumental in establishing the *power balancing arena* was that Government in 2005 created a new institution, the system manager 'Energinet', responsible for balancing the nationwide power system and maintaining backup capacity as well as handling the gas infrastructure. This task had hitherto been the joint responsibility of the publicly owned utilities, but was through government's intervention now delegated to a separate regulating institution staging future's transition process. At first, this resulted in an increased focus on market formation and cross border power trading in relation to the energy market Northpool. 'Energinet' has in its day-to-day practices huge influence on the power providers ranging from large-scale co-generation units to a variety of small-scale cogeneration units, single wind turbines and an increasing number of offshore wind turbine parks as other core actors. In strategic terms, this leaves open the conclusion to the arena controversies concerning the choice between three different pathways for future's transition:

1. To establish a smart grid system with transparent price information that can limit peak loads and balance production and consumption, supported by actors like the grid operators and utilities.

2. To use and not least expand international grid connections extending the exchange of electricity that in the perspective of 'Energinet' and government could provide market flexibility.

3. Or to expand the local alternatives to use fossil fuel, gas or bio-mass heated thermoelectric utilities in most cases operated as flexible cogeneration facilities as back-up capacity supported by actors arguing for a need for flexibility within the Danish energy system to meet the 2050 targets.

Following the neo-liberal market logic the third pathway, a smart grid system, received at first most attention. The idea being that a more intelligent, smart meter supported, and price transparent electricity infrastructure would enable households, companies and other institutionalized consumers to respond to short term price signals by locating consumption outside peak load periods and to install other storage or supportive facilities that can balance the production and consumption of power. Instead of engaging households, building owners and companies as active agents, the delegation of agency to prices missed these potentials and resulted in utilities taking over the management of consumption delegating passive roles to the consumers.

The second pathway with its focus on international grid connection has through the efforts of a.o. 'Energinet' gained much attention on the *power regulation arena*. They are supposed to balance the varying power production from wind and solar cells through a regulation combining short-term market prices and contracts on energy supplies in situations with low output from renewable energy sources. This makes sense with a combination of hydropower and base-load production of power from inflexible power utilities like nuclear and traditional thermal co-generation plants, but depends on the capacity of neighbouring countries with a different temporal power production pattern than the Danish. In line with the experiences with the first ideas of smart grids also this pathway is contested which will result in growing controversies within the power regulation arena asking for new solutions and raising questions to how the energy markets are designed and operate.

As long as the large co-generation utilities are still in operation in Denmark the wind penetration can continue to grow, but new institutional and market concepts are needed to handle the challenges [40] going beyond the existing and dominant actors and policies on this arena. Within the arena, the dominant plans still operate with international grid investments and short-term market regulations as their primary type of interventions in recent years even supported by continuously lowering prices for power produced by new wind turbine installations. But as shown in a study of the wind energy production across Europe there is not much gain from exporting surplus power from high and low wind periods as their time pattern overlap across countries.

However, while CO_2 charges, markets for CO_2 quota or energy taxation have not in recent decade furthered the energy transition towards meeting the strategic goals for 2050 government continue to view lowering prices on wind power and markets to be the optimal allocators of investments. This is clearly expressed in the recent government's inaugural foundation: 'We now need to harvest the achievements of 40 years of ambitious energy policy and argue for "green realism" when prioritising short-term price competition before strategic transition goals and investments. This demonstrates that policy aims and actual policy instruments not per se are cohering, while the goals operate as visionaries that perform like other interventions in arena controversies.

Systems integration and new distribution of roles

With the continued increase in energy from wind and solar the challenge goes beyond balancing power production. Instead, a reconfiguration and integration of the energy system requests new roles to be assigned to institutions and technologies to build an integrated, flexible energy system resulting in the emergence of a new *system integration arena*. This arena involves actors from policymaking, organisations from the energy sector, university researchers and energy consultants and has as its first main instruments the building of future models and scenarios for the overall energy system and its transition. At the same time the controversies of the future structuring of the energy systems, their interdependencies and the changes in policies, institutions and technologies needed in the transition process are and will in the future increasingly inform and frame the actions on the existing energy arenas through specific interventions. The agenda for an integration of the energy system was already articulated in the 'Visions for futures energy system' published 1999 as a foresight into Danish energy futures organised by the Danish Society of Engineers. Followed up by a series of scenarios the energy modelling work was in 2015 followed by a new and updated set of energy scenarios from the Danish Society of Engineers, the 'IDA Energy Vision 2050'.

The agency delegated to 'smart grids' and short term price mechanisms with 'smart meters' assumed to support further transition of the energy system at large has – as argued above – turned out not to provide the needed transition. Instead the meaning of a 'smart' was redefined to be: 'A smart energy system is a cost-effective, sustainable and secure energy system in which renewable energy production, infrastructures and consumption are integrated and coordinated through energy services, active users and enabling technologies'.

A coherent set of policies are yet not established demonstrating the conflicting interests the energy arenas are working in different directions. This has recently resulted in government accepting the need to reform energy taxations and charges that still targets power and fuel saving – now often with taxes higher than the price of the raw energy – and without differentiating whether the source of energy is renewable or fossil. This seriously hampers the integration of excess heat from commercial processes and buildings as well as new energy conversion facilities like heat pumps and storage facilities making a reform of energy taxes and charges as well as specific investment support policies and market adjustments government priorities.

At the same time the importance of place and space in improving the overall energy system performance needs more focus as e.g. municipalities are promoting heat storage, heat pumps, solar cells and energy efficient buildings. This point to regions, cities, and local communities as important actors in the future energy transition to support local initiatives related to transportation and local sites coordinating energy infrastructures by building new institutional measures able to govern the needed flexibility as facilities need to be in operation due to the overall need and not as separate economic entities. This is not least in contrast to the belief in a market orientation of energy provision with price competition between single energy providers and carriers like power, heat and gas. This makes controversies over new forms of ownership and new forms of contractual agreements a centrepiece for policy to coordinate investment practices and re-locate benefits to actors that provide storage and conversion facilities.

Energy communities in the forthcoming EU energy directives

While EUs Energy Directives have been instrumental in pursuing a commercialisation of the power sector across Europe the controversy between the need for national schemes to support renewable energy and the cross country trading and utility mergers has been obvious in the two sets of policies this has entailed. The recent revision of the EU Energy Directives introduced in the 'Winter-package' continues to include such controversies in regulations that promote different policy strategies. Besides a quite general belief in using market mechanisms to regulate the energy sector and facilitate consumer interests the new policy outline includes a new element called 'energy communities' that provide individual and collectives of consumers as well as NGOs with less that 18 MW of energy production to act on the market as 'prosumers' on the same premises than larger utilities and industrial actors. While this is linked to the general idea that consumers are supported by individual choices among competing providers which hitherto has shown quite problematic due to oligopolistic market structures and the tendency that energy infrastructures perform as natural monopolies the introduction of energy communities reflect the fact that historically collective use of energy production and distribution has demonstrated its social and democratic potential.

The new EU policies to be installed in the coming years transform the inner market arena and its regulatory impact through framing national policies and staging new actors entrance will open for tweaked and contradicting ways and pathways in the energy transition building on different concepts of what constitute a community that create the basis for an energy community in relation to the EU regulations. On one side new market visions building on non-hierarchical exchanges of energy as a commercial commodity will surface where the community is defined by its engagement in specific trades while other community form will continue the ideas of cooperative ownership or will build on existing common and local engagements as seen in housing cooperativesnand other forms of sharing common facilities.

Navigating on the arena of local energy transitions and communities

In order to realize locally integrated solutions, including energy communities, we need to develop a real life experiment, a pilot project, in an existing part of the urban fabric. Experiments relating to new, specially designed urban districts and specially designed buildings will not provide sufficient speed of the necessary transition.

Integrated community systems can be conceptualized and categorized in a number of different ways (Koiraja et al 2016). Especially the difference between communities of interest and communities of locality is quite interesting, as described by Walker (2008). Non-localized communities of interest often focus on creating a market for energy, making it possible for individual prosumers to sell and by energy from each other independently of the regular market and the utilities. The members of the community of interest might not have met each other in real life. The focus on creating a market is well aligned with the neo-liberal ideology. The idea of using block-chain technology makes it attractive to some.

The locally based integrated community energy system relates, as we see it, to the early days of renewable energy in Denmark when 100.000 local energy co-operations were established in Denmark, especially in villages and smaller towns. This was an essential part of the first phase of the transition and did not only provide energy but also a boost of the social capital and an interest in renewable energy in the villages and small towns. Walker et al (2009) concludes:

Our research shows that trust does have a necessary part play in the contingencies and dynamics of community RE projects and the outcomes they can achieve. Trust between local people and groups that take projects forward is part of the package of conditions which can help projects work and for local people to feel positive about getting involved and about process of project development. As the Gambleby case study demonstrates (almost to perfection) 'ideal cohesive communities with reservoirs of 'thick trust' (Williams 1988) do exist and can be enrolled into a strongly participatory, cooperative and consensual

process of project development and realization. In this case, there is also evidence that that the process adopted was able to contribute to the further building of social capital, developing capacity and enabling experimental learning so that future cooperative activities involving sustainable energy could be pursued. (p 2662)

Energy District Sydhavn

Energy district Sydhavn is a partnership between Aalborg University, City of Copenhagens Climate Secretariat, the Integrated Urban Renewal Project Sydhavn and the Local District Committee Kgs. Enghave. Much of the old part of Sydhavn is social housing. The Danish Social Housing Sector is not an organization for the few in special need of public housing. Almost 1 million Danes live in social housing. About 530 social housing organisations are managing approximately 7000 housing estates. Every housing estate has local board of tenants taking all relevant local decisions concerning the tenants and the buildings. Typically, these boards organizes a number of different local social activities strengthening the local social capital. They are used to run difficult projects – for instance relating to the maintenance of the buildings, energy renovation etc.

The first social housing in Sydhavn was built in 1913 as large healthy modern apartments for working class families, typically around 55 m2. Especially one social housing company dominates the district: AKB (Workers Cooperative Housing Company), locally organized in more than 10 housing estates with professional caretakers not only working in the boiler rooms but also in the boardroom.

In order to prepare the road for developing a local integrated energy community in Sydhavn, we have been working with a number of different projects:

- Heating flexibility in existing buildings – in collaboration with Hofor. Describing why heating flexibility is an essential feature in relation with the locally integrated solutions, the technical part, the measurements as calculative devices, the collaboration with the residents, comfort and reduced costs, (I can write a draft of this tomorrow)
- The heat pump project
- The shop cooling/heating project
- The network of related industries and businesses

Heating Flexibility in existing buildings

Flexibility is a key challenge for the future energy system with a fluctuating energy production from wind turbines, photo-voltaic installations, thermal solar, etc. all depending on the wind to blow and the sun to shine. In the electricity system production and consumption has to match within a few seconds – if not the system breaks down. Furthermore, when the power is cut, the lights go out immediately.

Heating is a completely other game. There is a lot of storage capacity in the system. Well-insulated buildings made from materials with a large thermal mass like bricks or concrete can function as storage in the heating system. Tanks for hot water can also be used for storing heat at the right time. Most heat is used in the morning, the morning peak becomes very high is the heating of rooms are turned down at night and turned on at almost the same time as people are having their hot morning showers (Østergaard Jensen et al, 2017).

Experiments have been carried out with a number of specially designed new buildings, for instance 'Energy Office of the Future' built in 1996-97 by the British Research Establishment (BRE) in Watford. Buildings built after the same principles are part of the experimental area in Copenhagen's North Harbour. These are new, special buildings – seen in a real transition perspective, existing buildings are much more interesting. A experiment with automatic lower temperature at night carried out by the Danish Building Research

institute in 200 existing single family houses indicates that traditional Danish buildings are rather well insulated and – not the least – have a large thermal mass that makes the temperature very stable despite hours of no heating supply (Jensen 2016) .

This has led to one of the experiments supporting the possible development of local energy districts. We are measuring heating supply in 5 buildings in collaboration with the local housing association and the district heating utility HOFOR. Detailed measurements in the boiler rooms – carried out by HOFOR – are supplemented with detailed measurements in 13 flats in collaboration with the tenants. The measurements is not only allowing us to evaluate the thermal properties of the buildings. They act as a perfect interessement device in our dialogue with HOFOR and in the dialogue with the local housing associations and the tenants involved. Our preliminary results indicate that a local energy community can offer flexibility as a service to the energy system

The heat pump project

Bearing the flexible heating demand in housing in mind, heat pumps can be used for converting surplus electricity into district heating. Individual heat pumps are becoming more and more common in relation especial buildings in a rural context. The larger utility companies are generally discussing the implementation of very large, centrally located heat pumps. However, local heat pumps can be relevant in relation to local integrated community systems, creating a part of the necessary local flexibility. In relation to our project, we are trying to go from the very abstract to an actual design, looking into the actual details of the location of the district heating network and the properties of the buildings in question. Furthermore, the heat pump is thought to be a visual element in the district, a part of the narrative of Sydhavn as a local energy district.

The shop cooling/heating project

A number of different types of shops are situated in the district. The local supermarkets are using a lot of energy for cooling, creating surplus heat that could be utilized in the local heating system. The numerous small shops and cafés could be provided with an 'energy package', helping them to save both heat and electricity for lighting. We have an ongoing dialogue with the different relevant actors.

The network of related industries

We have been working with two types of related industries: One type is industries located locally that could become a part of future local energy solutions. One of the local industries are a distribution centre for pharmaceutical products. This industry is interesting due to at least two features. Firstly, it uses much energy for cooling storage rooms and could become a part of a local combined cooling and heating system. Secondly, it distributes products to pharmacies in the dense urban fabric of Copenhagen in rather small vans. It is likely that the City of Copenhagen will favour electric vehicles within a short span of time. Being close to the international highways and at the same time being a gateway to the central parts of Copenhagen could point at Sydhavn as location for redistribution centres.

The other type of network we are creating is relating to different types of businesses with a possible interest in creating a local integrated energy community: companies providing pumps, companies providing lighting solutions, companies providing advanced insulation of existing buildings

Creating a local integrated energy community in Sydhavn

The process started in 2015 with informal discussions between the Integrated Urban Renewal Project and us at AAU. The first step was to try to interest the people working with the urban renewal project in the idea of a local integrated energy district, trying to answer the question: What is in it for our local citizens? The vision of better energy comfort and a smaller energy bill made the project grow. While we had the

informal dialogue, we involved ourselves in several local activities, trying to demonstrate that we were not distant observers of local development, but actually caring about the districts and all its diverse inhabitants.

A group of bachelor-students tried to develop the ideas further during spring 2016 by getting in dialogue with local businesses and residents. This was part of consolidating the work. Late in 2016, the partnership between Aalborg University, City of Copenhagens Climate Secretariat, the Integrated Urban Renewal Project Sydhavn and the Local District Committee Kgs. Enghave applied for funding of partnership activities and got a grant for 2017 – 2018.

We have approached central actors: HOFOR (the district heating utility), RADIUS (responsible for the electricity grid) and AKB (housing and thus organizing a large part of the citizens in the district). The actors are more or less decisive to have on board in order to realize the local integrated energy community in Sydhavn. Creating good relations takes time, but little by little, meeting by meeting, the idea is being more accepted. Part of the process has also been crawling around in boiler rooms with members of residents' boards, local caretakers and one of our contacts in HOFOR.

Seen in the energy system perspective, the local integrated energy community can offer:

1. The necessary flexibility (at least partly), including the local organization and communication related to the flexibility, for instance communication about a short cut of district heating supply
2. The continuous development of the necessary local energy savings, both those relating to material constructions and those relating to changing energy practices.
3. The local production of energy for instance from local surplus heat and local photo-voltaic installations
4. Local conversion between different forms of energy, for instance by local heat pumps

The local residents get a better comfort and a lower energy bill. But what is most important, the local social capital will increase and the district will get a new positive identity: Energy District Sydhavn.

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