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Urban utility companies: a key-actor for the resilience of energy systems in transition in federal countries

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Abstract: Energy sectors in many European countries are turned upside down. Fundamental technological changes, debates on social justice and pressing global warming scenarios are only a few major challenges endangering the resilience of energy systems. In this contribution, we discuss how urban utility companies can support the resilience of transitioning energy systems on an urban level. First, we briefly portray urban utility companies which are key actors in federal energy governance systems. We then introduce the resilience thinking concept and how we applied it to sociotechnical energy systems based on the two key indicators diversity and connectivity. Finally, we explicitly elaborate on how urban utility companies contribute to social and technical diversity and connectivity, which we consider the fundamentals for urban energy system's resilience in transitions.

Keywords: energy; transition; sustainability; resilience; sociotechnical system; diversity; connectivity; urban utility companies; federal governance; Germany; Switzerland;

Currently, the energy sectors are turned upside down in many European countries. The electricity grid´s robustness is challenged due to the fluctuating production of renewables. Large traditional energy producers see their business models endangered. The phase-out of fossil fuels is leading to critical, and sometimes violent societal debates (see the recent case of the "Hambacher Forst"), circling around the economic costs of the energy transition and challenging fundamental societal values such as social justice (see e.g. Grösche & Schröder 2013). But above all, global warming

is pressing the energy sector to decarbonise and change fundamentally in the way it is built up and the way it functions.

The energy system is a critical infrastructure system, catering for the basic need of energy. Real disruptions, which cause blackouts or endanger the heat supply, are socially not acceptable. While dealing with fundamental technical and social changes, the energy system thus needs to remain functional, reliable and affordable. We contribute to the debate how to achieve these conflicting goals by discussing the role of urban utility companies (UUCs) in the energy transition and showing how UUCs- as particular actors in federal energy systems - help support the resilience of the energy system in transition.

1. "A particular species" – Characteristics of European urban utility companies

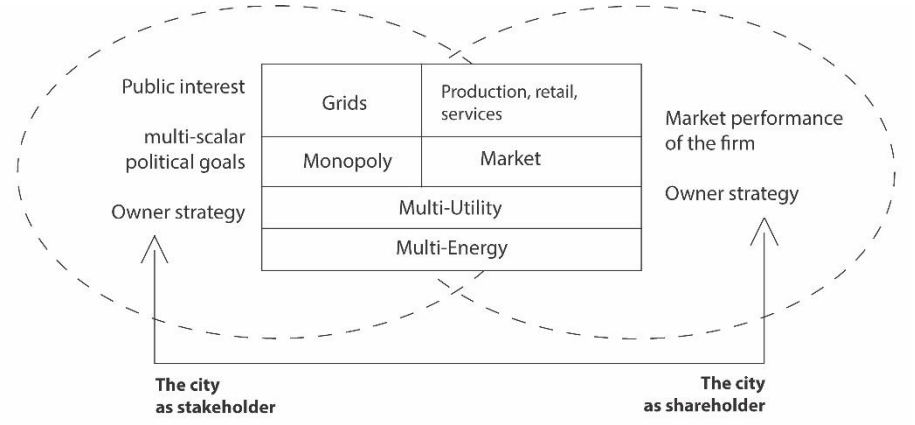
In the federal energy governance context of Germany, Austria and Switzerland, but also in Scandinavia and parts of the north-eastern USA, UUCs are in charge of the management of energy provision and infrastructures on a municipal level. They play a key role as local energy producers, providers and distribution grid operators. While reflecting the bottom-up organisation of the energy system so often called for, UUCs are up to now not really taken into account in the international debate on urban self-governance and management for resilient systems in transition.

Both in Germany and Switzerland, urban utility companies have a long history. They were often established at the end of the 19th century to cover different activities: the production of different energy sources (electricity and heat = multi-energy), distribution, trade and selling of energy (vertically integrated firm). Further on, they were assigned with the management of other critical infrastructures of the city and the provision of basic services to the citizens (multi-utility): water supply, waste management or public transportation (see figure 1).

Traditionally, urban utility companies were 100% publically owned by the municipality. The local public ownership allowed for democratic control over the critical urban (energy) infrastructure in order to ensure supply security, accessibility and affordability of the public services. In recent years, the EU integration and liberalisation have challenged this local public ownership, causing waves of privatisation and re-munipalisations (for example in Berlin and Hamburg).

Today, most urban utility companies are independent firms, with major local public ownership. This allows them to act in a competitive, market-based environment while still ensuring a certain level of democratic control by the city, making them a very specific type of actor in the context of (urban) energy system management (see figure 1).

Figure 1: Key characteristics of urban utility companies



(Mühlemeier 2018a)

Building on the key characteristics of a resilience energy system, we will elaborate on the contribution of UUCs in building the energy future, given their specific organisation and their role for the functioning of the energy sector in federally organised energy governance systems. Examples we have studied in detail are Munich, Hannover, Cologne in Germany and Zurich, Geneva and Basel in Switzerland (for further information on their characteristics, challenges and strategic answers to the energy transition see Mühlemeier 2018a, Mühlemeier 2018b).

2. The resilience concept – robustness, adaptive capacity and transformability

Resilience is a key characteristic of critical infrastructure systems (Zabrowsi & Sage 2017). It basically describes that a system, no matter on which scale, needs to have two key abilities: robustness and adaptive capacity. Based on these abilities, it can withstand external shocks and remain functional. Very much like a tree in a storm, whose trunk and branches are bending and adapting to avoid to be broken by the wind, whose roots, however, remain robust to keep the tree stable (for further examples see e.g. Resilience Alliance Database).

Figure 2: A resilient tree in the storm

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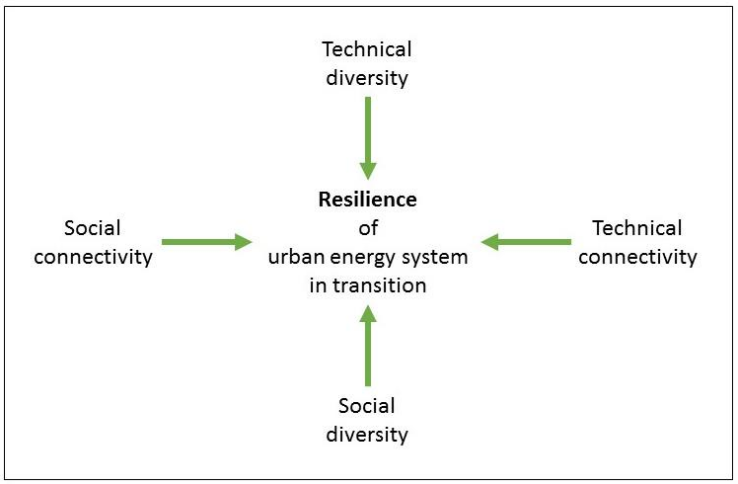
In human-driven systems, the notion of deliberate change is central. Humans can actively transform their way of living and the social structures they live in (Luthe & Wyss 2015). In doing this, humans can actively transform themselves and their environment. Resilience scholars therefore have emphasised the importance of "transformability" as a third key ability of a resilient socio-environmental system, besides robustness and adaptive capacity. By actively

coping with external shocks and trying to maintain the functionality of their society, a human-influenced system can change in order to maintain its identity and function. This has led to the "resilience thinking" concept (Folke et al. 2010). Applied to the "deliberate", human-driven transition of the energy system, a resilient system needs to remain robust to allow for functionality, while at the same time having to adapt to changing framework conditions and transforming itself to allow for the politically set transition goals to be reached.

3. Investigating resilience of energy systems – diversity and connectivity

In studies on urban and regional energy infrastructure, diversity and connectivity have been considered key structural factors to support resilience (Sharifi & Yamagata 2016, Binder et. al. 2017). A resilient energy system needs to be diverse and well connected to allow for robustness, adaptability and transformability with regard to the technical infrastructure, but also in the related social governance system. We applied these indicators to several regional energy systems to assess both the social and technical sub-system structure during the transition process (for more detail see Wyss et al. 2018, Mühlemeier et al. 2017). From these studies, we can conclude that currently, energy systems in transition need more local connectivity in both the social and the technical sphere in order to balance the increasing diversity of technologies and actors and therewith support the further transition of the system. Examples like auto-sufficient quartiers or peer-to-peer trading pilots are already going in this direction. In the future, the management of the energy system on the local level will become increasingly critical in order to allow for functional renewable energy systems, which are supported by local residents.

Figure 3: Diversity and connectivity – key characteristics for resilient systems in transitions



(author's own representation)

In the following section, we exemplarily show how urban utility companies contribute to diversity and connectivity and therewith support the resilience and transition progress of the energy system.

4. Urban utility companies' contribution to diversity and connectivity for resilience in the energy transition

Social diversity: UUCs cater products and services for private households in different milieus, small and middle-sized companies as well as large industries or public entities, such as schools. All these actors have different expectations and needs with regard to the supply of energy. While

some consumers want to actively contribute to the energy transition as prosumers, other households or businesses just want the lowest energy prices possible. The social diversity of the urban system is also reflected in the diversity of the expectations of the UUC's owner – normally the city. City administrations follow different, often conflicting goals (e.g. in different political parties: the left-wing and green party who are pro change vs. the more conservative parties). Urban utility companies are used to working and coping with this diversity of urban actors and are able to help maintain this diversity in the long-term.

Technical diversity: UUCs have traditionally managed different energy sources at the same time, maintaining different networks to supply electricity and heat to the city (the electricity grid, the gas grid or district heating networks). Thereby, it has been their key task to find the best technical solution for the different city districts and consumer needs in their urban area. Based on their public ownership, UUCs can often more easily invest in pilot projects for energy efficiency, renewable energy sources and systemic solutions (such as participative PV power projects, new storage technologies or pilots of local smart grids) than their privately owned counterparts, with their owner strategy even obliging them to do so. Urban utility companies herewith actively contribute to technology diversification. Compared to large electricity producers, who might specialise in particular solutions and search for markets internationally, the UUC is in charge of a local system for which it needs to employ a diversity of technical solutions and services, adapted to the local context. UUCs are therefore technology all-rounders and incorporate a broad body of locally specific knowledge and competences within the firm.

Social connectivity: The UUCs are at the interface between the technical energy system and the local society. They can link actors to technology e.g. by supporting energy cooperatives or peer-to-peer trading pilots. They also have an important coordination function in the local energy system. Being a grid operator, but also an energy producer and supplier, they have contact to all local actors and coordinate them in order to guarantee for a smooth functioning of the local energy system. They also connect and balance the consumer needs on the one side and the owner goals and expectations on the other. Finally, their costumer – the citizen – is at the same time, indirectly, their owner. They have a tradition of maximising the economic value for their owner by supporting local value creation, offering public services to the inhabitants of the city and providing the basis for a good standard of living, though often at higher-than-market prices.

Technical connectivity: UUCs manage the different infrastructure networks of the city and can combine them by means of sector coupling and grid convergence, e.g. by using the telecommunication grids for smart grid solutions or by pushing electrification of private transport by building car sharing infrastructure. Since UUCs still have their own, often local energy production and manage an increasing share of prosumers in their grids, they can link central and decentral energy production in order to manage local grid stability and guarantee supply security (virtual power plants). However, EU regulation, requiring the separation of the grid management (regulated monopoly of the city) from the energy production and supply (in competition), is causing difficulties here. This poses questions on how a stabilisation of the grid can be guaranteed if there are several (private) actors offering flexibility services (e.g. demand side management) and the distribution grid operator does not have full system knowledge.

5. Concluding remarks

In federally organised countries, such as Germany of Switzerland, UUCs contribute to social and technical diversity and connectivity in the urban energy system. In the technical domain, they are "innovation facilitators", who help to integrate new solutions while managing the system resilience in the background. In the social domain, they are the "social workers" who ensure service provision to all citizens while contributing to a democratic and equitable energy transition.

The case of UUCs provides an interesting example how the management of design and operating processes for a resilient energy infrastructure could be organised at an urban level. UUCs help manage the energy system efficiently in federal contexts, since they coordinate different technologies and actors on the local level and have the required expert knowledge and resources to ensure functionality and supply security. At the same time, the local public ownership allows the citizens to keep democratic control over "their" critical infrastructure, with city authorities defining the owner strategy and goals. If well managed, UUCs support a holistic, long-term oriented management of the urban infrastructure, which works efficiently and beneficial for the local society. They can help support the resilience of the energy system, which is undergoing a fundamental transition – if their owners, the city authorities, and ultimately the citizens of the cities – set their owner goals accordingly.

6. Further reading

- For a good overview on resilience theory and its application to urban design see e.g. Wu & Wu 2012
- For a very interesting book on municipalisation of public services with many international examples see Kishimoto & Petitjean 2017

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Conflict of Interest

The authors declare no conflict of interest.