Smart grids, smart households, smart neighborhoods - contested narratives of prosumage and decentralization in Berlin's urban Energiewende

Quitzow, Leslie

Innovation: The European Journal of Social Science Research

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/ciej20

Smart grids, smart households, smart neighborhoods – contested narratives of prosumage and decentralization in Berlin's urban Energiewende

Leslie Quitzow

To cite this article: Leslie Quitzow (2023) Smart grids, smart households, smart neighborhoods – contested narratives of prosumage and decentralization in Berlin's urban Energiewende, Innovation: The European Journal of Social Science Research, 36:1, 107-122, DOI: 10.1080/13511610.2022.2057934

To link to this article: https://doi.org/10.1080/13511610.2022.2057934

Published online: 18 Apr 2022.

Innovation: The European Journal of Social Science Research, 2023
Vol. 36, No. 1, 107–122, https://doi.org/10.1080/13511610.2022.2057934

Smart grids, smart households, smart neighborhoods – contested narratives of prosumage and decentralization in Berlin's urban Energiewende

Leslie Quitzow*

WZB Berlin Social Science Center, Berlin, Germany

(*Received 17 November 2021; final version received 21 March 2022*)

Imagined futures implicitly shape how a city's infrastructure develops in the present. Because smart grids are still in the making, it is important to understand which urban futures are being associated with them. This paper asks how urban smart grid futures are being imagined through narratives and material practices in the city of Berlin and which notions of urban community these imagined futures stand for. Drawing on the concepts of socio-technical imaginaries and discourse, the paper unravels how relevant actors envision Berlin's smart grid future, focusing especially on the role of urban "prosumage" and micro-grid-neighborhoods in the everyday production, consumption, and management of electricity in the city. The paper concludes that while one dominant imaginary prevails, this dominant imaginary is built on competing and in part contradictory narratives about the role of households, neighborhoods and the city in urban energy transitions. The analysis is based on a case study of three so-called urban laboratories for the development and implementation of smart grids in Berlin. It draws on policy documents and interviews with relevant stakeholders from Berlin's energy, ICT, and urban development sectors, including representatives of incumbent utility companies, small energy entrepreneurs, public authorities, the research community, and civil society organizations.

Keywords: smart grids; imaginaries; decentralized energy management; urban futures; urban labs

Background

Smart grids are being hailed as means to achieve urban low-carbon transitions while fostering high-tech development, increasing global competitiveness and attracting well-paying jobs. These compelling visions of an ecologically sustainable and economically thriving urban future are driving smart grid development in cities across Europe. Municipal governments all over the continent are forming alliances with private businesses and research institutions to foster the development of smart grids and position themselves as technological and environmental leaders. This development is being driven by a strong, seemingly uniform imaginary of smart grids as desirable innovation and technological mediator between the local environment, the global economy and "prosumage". Among

*Email: leslie.quitzow@bundesstiftung-bauakademie.de

others, this imaginary revolves around the transition to an energy system based on renewables that facilitates the establishment of highly interconnected, distributed, heterogeneous, and small-scale units of energy generation decentrally feeding into power grids that are upgraded by various ICT-based interfaces. The idea of decentralized energy systems is closely connected to the idea of empowering private individuals and enabling their widespread participation in energy markets. Through smart grids, private individuals are envisaged to produce, store, use and trade their own energy within small-scale, heterogeneous urban units, comprised, for example, of interconnected individual households, buildings or neighborhoods. Especially in the urban context, smart grids are therefore commonly associated with notions of micro-scale prosumage. Taken together, there is a strong belief in the ability of smart grids to advance urban energy systems in an economically sound, socially progressive and environmentally sustainable way, raising high expectations in their capacity to enable generally "better" urban futures.

This article investigates these imagined futures in more detail. It builds on a small, but growing body of social science research that has investigated the relationship between smart grids and the future. Most of this literature has criticized that smart grids are promoting one-sided and techno-optimistic fantasies of sustainability, democracy, security or transparency (Ballo 2015; Wentland 2016; Skjølsvold, Ryghaug, and Berker 2015; Palensky and Kupzog 2013). Only few have engaged with the nuances and contradictions inherent in these visions (Hielscher and Sovacool 2018; Levenda et al. 2018). As smart grid projects gain popularity and scale, a number of scholars have also found that the realities of smart grid implementation have failed to live up to, or even undermined the promises originally associated with them (Lovell 2018; Schick and Gad 2015). They point to an apparent disconnect between envisioned futures and their actualization. Given the power of a seemingly ubiquitous smart grid imaginary to shape urban policies and business activities today (Jasanoff and Kim 2015; Beckert 2016), it is worth asking where this disconnect comes from, and whether imagined smart grid futures are possibly more complex and varied underneath overarching promises of high-tech, low-carbon development. Moreover, most social science literature to date has focused on national level concerns, leaving the relationship between smart grids and the city largely out of view (for exceptions see McLean, Bulkeley, and Crang 2015; Bulkeley, McGuirk, and Dowling 2016; Levenda 2018). This article seeks to close these gaps by investigating the more nuanced and partly inconstistent narratives within a seemingly overarching imaginary of smart grid futures in an urban context.

Conceptual approach – narratives and socio-technical imaginaries

Using the concept of sociotechnical imaginaries as a starting point, I analyze the multiple and varied narratives underlying the seemingly uniform imaginary of smart grid futures in Berlin. According to Jasanoff and Kim, sociotechnical imaginaries are "collectively held, institutionally stabilized, and publicly performed visions of desireable futures, animated by shared understandings of forms of social life and social order attainable through, and supportive of, advances in science and technology" (Jasanoff 2015, 4). Yet my analysis of the Berlin case shows that in spite of a seemingly universal agreement on the general necessity and desirability of smart grids, various contested narratives exist of what smart grids actually entail, and how this could and should play out for the future of energy in the city. In particular, my analysis shows that smart grids are connected to diverging notions of urban energy neighborhoods and urban energy households. On a conceptual level, the paper therefore argues that socio-technical imaginaries are not necessarily hegemonic and

all-encompassing, but can be contested and diverse, even within the context of a single city and policy context.

Unlike many of the historical examples analyzed by Jasanoff and Kim, smart grids and the imaginaries they inspire are currently still in the making. This means that different narratives, material representations and performative acts are promoting slightly different urban futures. For a dominant imaginary to take root, these various underlying narratives need to converge to create a coherent storyline.

Methodological approach

Sociotechnical imaginaries come alive in discourse. They are communicated in written and spoken words, perpetuated by popular practices, institutionalized through laws and regulations and made tangible in material representations or artefacts. I therefore use discourse analysis as basis for my examination. Specifically, I use the sociology of knowledge approach to discourse (SKAD), which understands discourses as narrative and material processes of sense-making involving language, as well as actions, performances and materializations (Keller 2011).

To understand how smart grid futures are being imagined in Berlin, I analyzed the smart grid related discourse in policy and implementation circles. My research involved three major units of analysis: the city level, three urban development sites, and three pilot projects or "urban labs" for developing, testing and publically demonstrating smart grids to a broader public. These pilot projects are located at EUREF Campus, Technology Park Adlershof and TXL Urban Tech Republic.

The data was collected over the course of three years (2015–2018). It reveals how important stakeholders such as the administration and the network operator are currently thinking and talking about smart grid technologies, and at the same time shows how smart grids are being thought and talked about by those actually implementing pilot versions of them on the ground. The analysis includes 42 publicly available policy documents and gray literatures such as laws, strategy papers, reports, policy briefs, company websites, advertisements and informational brochures, as well as 16 in-depth, semi-structured interviews that lasted approx. one hour each. Interviews were conducted with key stakeholders from Berlin's energy, ICT and urban development sectors. Overall, the data covers material from city government and administration, the electric grid operator, the newly founded public services company, two civil society organizations, the local energy agency, two electronics companies, two project development companies, and various research institutions.

Smart grids and imaginaries of decentralization and prosumage in Berlin's urban *Energiewende*

In Berlin, the idea of smart, low-carbon urban futures circles around a vague and seemingly uniform imaginary of decentralization and prosumage, or the small-scale production, consumption and storage of energy from renewable sources at the local level. Especially in the German context, notions of decentralization and prosumage have gained widespread attention since the country's *Energiewende* policies have made small-scale renewable energy generation hugely popular throughout the country. Since the government's policy turn-around in 2011, distributed renewable energy generation has experienced a steep increase from approximately 62,000 MW of installed capacity to over 120,000 MW in 2020 (Bundesnetzagentur 2019). Homeowners and small

energy cooperatives throughout the country have invested huge amounts of private capital into solar panels and wind energy generation plants, and thus demonstrated their willingness and potential to contribute to Germany's clean energy transition. The distribution of (renewable) energy generation between many private households instead of few large electricity companies is viewed as one of the *Energiewende* policies' major achievements and reason for its continuous popular backing. In the German context, decentralization and prosumage are therefore commonly viewed as backbones of the country's future energy system (Agora Energiewende 2017).

Smart grid imaginaries in policies and programs

In line with this, Berlin's current (left-wing) municipal government has put a high priority on public participation and civic engagement in its energy agenda. In its coalition agreement, it states that Berlin's *Energiewende* can only succeed with the participation of its inhabitants, and that the government therefore builds on active "energy citizens" (Berlin Senate 2016a, 61) (*Bürgerenergieakteure*) and "prosumer solutions" (Berlin Senate 2016a, 64). Among others, these solutions are being pursued through a Masterplan Solar City that was launched by the municipal government, and which aims to make rooftops and façades available for the generation of renewable electricity. The masterplan seeks to increase the production, use and trading of renewable electricty within small-scale urban building units. Apart from this, the city government also recently regained public ownership of the city's electricity grid in order to "offer Berliners an opportunity to engage in the concrete implementation of the *Energiewende*" (Berlin Senate 2016a, 65). Moreover, the municipal government has committed to transforming the city's energy supply system into a "completely decentralized and renewable energy system" (Berlin Senate 2016a, 63). This endeavor is backed by an independent energy commission that recommends the continuous integration of "decentralized supply" (Enquête-Kommission 2015, 16) into Berlin's grid structures, and the city's Energy and Climate Protection Program (*BEK 2030*), which promotes the use of "decentralized facilities of energy production" (Berlin Senate 2016b, 14) in a "smart, decentralized energy market" (Berlin Senate 2016b, 28). Among other things, these urban policy documents promote decentralized energy production and trading on the basis of what they call "micro-scale prosumage" (*Kleinstprosumer*) (Berlin Senate 2016b, 28).

Smart grids are viewed as important tool for enabling decentralization and prosumage in the city. They are supposed to link energy generation, consumption and storage by providing real-time information about capacities and needs, and automatically directing energy flows accordingly. In the urban context, prosumage is imaginable at various levels, from individual households all the way to neighborhoods or entire districts. Yet distributed energy generation and prosumage are still marginal phenomena in the city. In Berlin – as in other German cities – this is in large part due to the high proportion of tenants (as opposed to home owners) without access to rooftops for installing solar panels. In 2019, only approximately 18% of Berlin's inhabitants were homeowners, while the vast majority were tenants (Voigtländer and Sagner 2019). Berlin's Masterplan Solar City therefore targets rooftops on public buildings as a first step towards more urban renewable energy generation. Moreover, the regulation guiding Germany's liberalized and "unbundled" electricity market prohibits combined electricity production and trading and has thus kept private building owners from potentially selling rooftop solar electricity to their tenants. This obstacle was removed with the federal "Landlord-to-Tenant Electricity Supply Act"

(*Mieterstromgesetz*), which was passed in 2017 with the specific goal of turning urban rooftop owners into actors on the electricity market and agents of Germany's urban *Energiewende*. Yet in Berlin, this Act has not had the sweeping effect initially expected. Instead of reaching small-scale private building owners, it has mostly spurred the initative of few large housing companies. As of January 2021, the public service company Berlin Energie only counted a total of 69 so-called "landlord-to-tenant"-facilities (https://berlinerstadtwerke.de/mieterstrom). Inspite of the Solar City Masterplan and the Landlord-to-Tenant Electricity Supply Act, as of 2019 only approximately 1% of Berlin's total electricity consumption was covered by solar power (Länderarbeitskreis Energiebilanzen 2019). All in all, the amount of renewable electricity being generated within the city of Berlin amounted to only about 5% of the city's total electricity generation in 2017 (Amt für Statistik Berlin-Brandenburg 2019). In terms of distributed storage (the remaining component of prosumage), the city faces a similar picture. The Berlin government has set out to integrate the extensive existing electricity, gas and district heating networks, and connect them to prosumage households (Berlin Senate 2016b, 14). It envisages electricity storage as decentralized component of a smart energy management system that increases grid stability and fosters small-scale prosumage (Berlin Senate 2016b, 14). Among others, it seeks to develop the use of power-to-heat and power-to-gas technologies for converting locally produced (excess) electricity into heating and gas, and thus increasing energy-efficiency and fostering local prosumption (*Eigenverbrauch*). In addition, the government has set out to expand the small-scale use of combined heat and power plants (CHP) in private homes and rental complexes. Taken together, these measures all represent a strong effort towards realizing ideas of decentralization and prosumage in the city. The Berlin government is seeking to involve its citizens in the creation of a participatory, inclusive, and distributed future energy system. Nevertheless, in terms of implemented capacities, the small-scale decentralized production, consumption and storage of renewable electricity is not yet a relevant building block of Berlin's urban *Energiewende*.

Smart grids at Berlin's future sites

Against this backdrop, the city has put high hopes into the devepment of smart grid systems in three urban laboratories. The pilot projects being advanced at EUREF, Adlershof and TXL are part of its strategy for progressing towards more decentralized prosumage in the city. All three projects are pursuing the connection between renewable electricity production, flexible electricity consumption and small-scale decentralized electricity storage, and thus publically promoting and reinforcing the city's imaginary of a decentralized and prosumage-based urban *Energiewende*. They circle around questions of micro-scale energy management and control, and aim at finding smart grid solutions for replication in the broader context of the city of Berlin. At the same time, this research shows that what decentralization and prosumage actually mean for different actors and within different contexts in the city – whether inside or outside these urban labs – can vary substantially.

The smart grid project at EUREF Campus primarily revolves around integrating an electric vehicle fleet into the envisaged prosumage cycle. For this purpose, a solar PV plant is connected to approximately 15 vehicle charging stations, a battery storage facility and a small refurbished garage that has been turned into office spaces. At any moment in time, an automated energy management system equipped

with sensors and control mechanisms senses how much electricity is being produced in the PV plant, how much is being used by the office space, how many vehicles are conntected to the charging stations, and how full the batteries in the storage facility are. It then directs electric loads according to a predefined algorithm, i.e. according to demand. All loads and flows being directed through this micro-smart grid system are constantly visualized in a showroom, so that visitors can view and relate to the project. In fact, the EUREF project is frequently visited by delegations of interested students, researchers, politicians and business people from across the world. They are guided across campus by members of the project consortium, which comprises a total of 36 institutions and is headed by Berlin Technical University. Its six project teams involve researchers from the engineering and the social sciences, as well as large international IT, energy and car companies, small energy and e-mobility start-ups, local utilities, the national railway company, civil society organizations and the project development firm that owns the project site. By developing, testing and implementing a micro-smart grid at EUREF, the project consortium has set out to contribute to a combined "energy and mobility transition" that will "radically transform" the structure of the electric grid into an "increasingly decentralized" system (Technische Universität Berlin 2012, 4). The project explicitly targets urban areas and seeks to multiply and up-scale its results throughout Berlin and other cities. There is an acute awareness that the project's premises "put the social practices that guide people's everyday lives and everyday routines into question" (Forschungscampus Mobility2Grid 2016). Even though private households are not involved in the project, the imaginaries being pursued and reinforced by it revolve around the future of decentralization and prosumage for individual households, urban neighborhoods and entire cities.

At Technology Park Adlershof, a smaller smart grid project called *Energienetz Adlershof* is pursuing a similar goal in a different context. This project seeks to create a smart and renewable cooling network for a laboratory complex. It aims at reducing the enormous amounts of cooling energy needed to operate the laboratory processes and maintain the laboratory buildings. Its primary objective is to reduce the lab's energy related emissions and energy related costs. To this end, the project seeks to introduce a flexible and clean energy management system that coordinates renewable electricity generation from a solar PV plant with an aquifer for geothermal cooling, a brine based cooling network, an ice repository as low-temperature storage facility (*Eisspeicher*), and the highly heat sensitive laboratory complex. In doing so, the project addresses an issue that is relevant for many other labs and businesses in the area, whose cooling energy demand accounts for approximately 10% of total energy demand across campus (www.energienetz-berlin-adlershof/kaeltenetz). The *Energienetz* project therefore forms part of a greater effort to introduce an instrument for energy related urban development planning (*Energieleitplanung*) on the broader Adlershof campus. With the help of small-scale model projects like this one, the campus facility management company seeks to reduce the overall campus's primary energy demand by 30% (www.energienetz-berlin-adlerhof-de). Unlike EUREF, the Adlershof campus therefore hosts various smart grid projects that deal with diverse issues such as electric mobility (*FlexNET4E-mobility*), power-to-x technologies (*P2X@BerlinAdlershof*), and low-temperature heating networks (*Wohnen am Campus in Adlershof*), and which served as secondary sources of information for this research. To bring them together, the examined *Energienetz* project consortium heads a so-called *Smart Grid Alliance* aimed at integrating more and more campus

facilities and businesses into a smart grid system. As head of this alliance, the project seeks to replicate and scale its results throughout campus and across the city. The relatively small project consortium is headed by Berlin Technical University, and involves two teams of researchers from the engineering and the social sciences that collaborate with an IT company, an engineering firm, and the campus facility management company (WISTA Management). Here, too, decentralization and prosumage play major roles in visions of a future sustainable energy system (www.energienetz-berlin-adlershof.de/news, April 2018). Households, neighborhoods and the city are viewed as potential units for flexible load management.

The third smart grid project is being pursued at Berlin TXL, the designated redevelopment area currently occupied by Berlin's Tegel airport. It is the only one of the three pilot projects that hasn't been implemented yet, and thus exists only in claims and on plans. The entire redevelopment area of Berlin TXL comprises approximately 220 hectares for an industrial park called *Urban Tech Republic,* approximately 50 hectares for a residential neighborhood called *Schumacher Quartier,* and another 200 hectares of green space, and is therefore the largest of the three future sites. TXL Urban Tech Republic is envisaged as a high-tech industrial park for research institutions and industrial firms in the field of so-called future technologies. Both the Urban Tech Republic and the Schumacher neighborhood are supposed to be serviced by a smart grid system that primarily circles around heating and cooling provision, and is combined with renewable energy production and storage in a so-called "Low-Exergy-Network". According to a press release, this low-exergy network will be the largest in the world (Koopman 2018). The network is supposed to connect various on-campus renewable energy sources, including surplus heat from industrial processes, geothermal energy, solar thermal energy, solar electricity, a biogas powered CHP plant and electric vehicles. At its core, a so-called "Smart Grid Platform", an openly accessible digital information hub, is supposed to serve as local market place for heating and cooling energy (Tegel Projekt GmbH 2018). Prosumage at TXL therefore also encompasses small-scale energy trading and direct peer-to-peer interaction. Unlike the pilot projects at Adlershof and EUREF, the ideas for TXL's smart grid systems are being developed by a city-owned project development company rather than research consortia. The company was created by the Berlin Senate in 2011 as a subsidiary of the campus facility management company that operates at Adlershof. At TXL, smart grid implementation is therefore not a matter of research but has been commissioned to private firms on the basis of public calls for tenders. Even though the TXL project site is still not accessible, concessions for configuring the smart grid platform and operating the Low-Exergy Network were awarded to private firms in 2016 and 2018 respectively.

At all three urban labs, smart grids are being developed as components of a decentralized future energy system and for prosumage solutions. On the surface, the imaginary being produced and reinforced here responds to the German *Energiewende's* leading notion of a localized and citizen-centered urban energy future. However, this article shows that these notions are by no means consensual. Close scrutiny of smart grid initiatives at the local level reveals that they build on varying, if not contradictory, narratives of future smart grid households, future smart grid neighborhoods and the future smart grid city. These narratives oscillate between notions of self-sufficiency and independence on the one hand, and collaboration and sharing on the other. They also alternatingly involve empowered and responsible "active energy citizens" on the one hand, or incapable, disinterested users on the other.

Contested narratives of decentralization and prosumage

In Berlin, smart grids stand for a vague and enticing imaginary of a micro-scale, citizen-led low-carbon energy transition. Yet, upon closer look, the narratives behind this imaginary vary. While in public communications and appearances, the local government promotes a narrative of close-to-home, citizen-empowering smart low-carbon urban futures, other important actors in Berlin's smart grid community portray a more nuanced and differentiated picture. These actors include incumbents and start-ups, researchers and business people, municipal administration and NGOs. Instead of portraying households as intrinsically motivated, powerful backbones of Berlin's urban *Energiewende*, they portray them as unnecessary, disinterested and disempowered energy users.

Households between empowered prosumers and disinterested users

The local government's narrative of smart grid enabled prosumage is connected to the widespread idea of decentralized or distributed energy responsibility either within individual households or neighborhood size micro-grid communities. Berlin's city government promotes an imaginary of prosumage that portrays the urban *Energiewende* and local smart grid systems as highly participatory, with an active role for citizens in energy markets that work to their benefit in a variety of ways. By and large, the local government portrays decentralized prosumage as opportunity to save money and energy, actively manage energy, to be more informed about and aware of energy, and to become increasingly free to choose between various energy sources. Berlin's Energy and Climate Protection Program (*BEK 2030*), for example, builds on prosumers as "active agents of the *Energiewende*" (Berlin Senate 2016b, 64). Among other things, it aims at "strengthening the role of micro-prosumers in the electric grid" (Berlin Senate 2016b, 28). The same is true for the independent commission's "New Energy for Berlin" report. As active members of the energy system, this report refers to prosumage households as "grid participants" (Enquête-Kommission 2015, 37). These active grid participants are envisioned as highly flexible market actors that take on alternating roles as electricity producers, consumers and suppliers. To strengthen their role as electricity suppliers and system stabilizers, the Berlin Energy and Climate Protection Program (BEK) encourages local grid participants to make their "intelligent" household appliances accessible for centralized load management (Berlin Senate 2016b, 28). Prosumage households are therefore not only envisioned to benefit themselves, but also to take over responsiblity for stabilizing the grid and benefitting the system. The local government seeks to increase their "ability and willingness" to perform grid stabilizing duties (Berlin Senate 2016b, 28), and to adapt their electricity consumption to the volatility of renewable energies (Enquête-Kommission 2015, 17). Among other things, it points to the possible integration of private refrigerators, washing machines or other relevant electric appliances into an ICT enabled energy information system:

> The digitization of networks and appliances offers substantial potential for increasing the energy-efficiency of private households. Combining smart home solutions with informative energy billing can provide pathways for substantially increasing energy-efficient behavior. (Berlin Senate 2016b, 136)

According to this document, smart grids and related energy information systems will empower private households to act responsibly and control their energy consumption. Even regular households that don't (or can't) act as prosumers or grid participants

are portrayed as potentially interested, flexible and actively engaged in managing their electricity consumption. In its Smart City Strategy the city government underlines that the information made available through smart grids (and meters) will motivate and enable these households to adapt their electricity consumption according to system needs (Berlin Senate 2015, 31). By providing information about peaks in the overall energy system and about individual consumption patterns, the government assumes that households will increase their system awareness and adapt their consumption behavior:

> In the next two decades, Berlin needs to install smart energy infrastructures in all areas of urban consumption (housing, transportation, economy, administration, leisure etc.), which will enable consumers to increase their energy-efficiency on the basis of transparency and controllability. (Enquête-Kommission 2015, 16)

The government expects that households have an inherent interest in flexibly adapting their routines to reduce electricity consumption either for reasons of climate protection or for financial benefits. In fact, the city's climate protection program presumes that the main obstacle to this kind of flexible energy management is currently a lack of financial incentives, not a lack of inherent motivation (Berlin Senate 2016b, 28). The local government's narrative of intrinsically motivated, flexible, and environmentally conscious prosumage households is reinforced through the public communications surrounding Berlin's urban labs. This is especially true for TXL, which hardly exists outside the realm of communications. As the director of TXL's project management company states in a public interview:

> In the end it's all about people. It only becomes interesting with people! […] The users should have a say in what happens here. (AusserGewöhnlich Berlin 2017)

This narrative of a participatory urban energy future is underlined by the term Urban Tech *Republic,* which was chosen as a provocative, fun and slightly tongue-in-cheek way of emphasizing the importance of citizen engagement at TXL (AusserGewöhnlich Berlin 2017). The term *republic* also stands for automony and democracy, i.e. for the notion of an independent and self-organized future energy system, in which free and informed energy citizens contribute their share to a functioning overall energy community. It rings of well-behaved debate, of compromise, and of individual service to the higher common good. This narrative gives the impression that becoming a prosumage household is not a matter of individucal preferences but of moral obligation. It obviously speaks to a certain class of energy households. As a leading employee of Tegel Projekt GmbH confirms when asked about the kinds of people that might become part of the TXL campus: "I believe in self-selection" (personal interview TXL, 2017). At the same time, this leading employee reveals an underlying concern about attracting these potential prosumers:

> And of course we will try to work towards attracting […] the right people, that fit into the Urban Tech idea, […] that are intrinsically motivated and maybe interested in connecting and taking part in such a higher-level energy production; and maybe even becoming a driver in the whole thing. (personal interview TXL, 2017)

Here, the narrative of actively engaged prosumage households seems less certain. Instead, it sounds like work needs to be done to attract a rare species of specialized energy clients

rather than relying on the intrinsic motivation of regular urban households. It shows that participation and inclusion in energy issues might not be as simple and attractive as promoted in narratives, and that urban households willing and able to engage in prosumage activities might actually be hard to find.

In fact, the narrative of flexible, intrinsically motivated and active prosumage households is not mirrored by many other actors in Berlin, especially not by those involved in smart grid development and testing. Their notion of decentralization and prosumage is not one of inclusion, participation or empowerment, but rather one of disillusionment and convenience. There is a gap between the narrative being promoted by policy documents, research proposals, company websites, and public communications and the narrative actually fostered by the experts involved in smart grid implementation themselves. While participation and empowerment feature prominently in the narrative of decentralization and urban prosumage that is being advanced in public, these notions are much more brittle and doubtful on the individual expert level. Many even doubt the system relevance of household prosumage altogether. Two researchers at Adlershof call into question the benefits of household prosumage for the energy system:

> In the beginning that might be exciting, but in the end […] that's just fooling around a little, and the practical advantage is really marginal. And that's why […] in private households, I'm not convinced. (personal interview, business person at Adlershof, 2018)
>
> Smart grids in households, of course that's imaginable; the only question is how high their potential really is. (personal interview, researcher at Adlershof, 2018)
>
> After I open the refrigerator, it has to keep on cooling, otherwise my sausage could get warm, and I wouldn't want that to happen [… .] the washing machine, I'm also sceptical about that. I mean, to have the laundry lie half wet in the machine for eight hours, nobody wants that. (personal interview researcher at Adlershof, 2018)

These researchers don't view private households as actively engaged citizens that are driven by an inherent climate-consciousness or an interest in saving energy, but simply as driven by their everyday routines and by convenience. They view future energy households as relatively disinterested in energy issues, and more concerned about their comfort than their efficiency. Prosumage households, in their view, are not eager to take part in Berlin's urban *Energiewende*, but rather concerned with maintaining their everyday routines. This assessment is shared by a representative of the local network operator who is also involved in the EUREF project. This person is highly sceptical of peoples' willingness to change their energy related behavior:

> The German mentality simply isn't like that. You know, in Italy, they use so-called *breakers*, like an extra fuse; they tell them they can't use the washing machine and the water boiler and the stove and the dishwasher at the same time; they cut the power off, the fuse breaks and that's it. To give up your comfort like that would never be possible in Germany. (personal interview Stromnetz Berlin, 2018)

In this expert's view, future energy households are even highly inflexible: "society's inertia is extremely high […] that's why I wouldn't say that once we have a smart grid, everyday life will change" (personal interview Stromnetz Berlin, 2018). Contrary to the overarching imaginary of smart grids as technological basis for "openness, participation and connectivity" (https://www.stromnetz.berlin/fur-berlin/smart-city), which is being promoted on the company's website, this representative of the network operator nourishes a narrative of Berlin's future energy households as passive and disinterested rather than

open, passionate and engaged. There is an obvious discrepancy between what is being publically promoted and what Berlin's experts actually believe. An employee of an energy start-up at EUREF speaks of a similar experience:

> [Smart grids] need to be turned into products. And that's the hardest part, you see? How do you sell a smart grid? There is no such thing as a micro-smart grid, and there aren't any customers either. Nobody says 'hey, I'd like to buy a smart grid'. (personal interview, energy start-up EUREF, 2016)

Instead of encountering ready customers, this person has obviously encountered frustration. For a representative of the Senate Department of Economics, Energy and Public Enterprises (SenWEB), the role of households seems at most uncertain. When interviewed, a Senate Department representative states that „some people will [install smart grid systems], because they are either (a) technologically interested or (b) environmentally conscious or both [. . . .] But a large portion of society certainly won't do it" (personal interview SenWEB, 2018). A representative of the Berlin section of Friends of the Earth Germany shares this opinion:

> If you break it down to the household level there's always this thing with the controllable refrigerator, and I don't buy it. (personal interview BUND, 2018)

In sum, my analysis shows that despite an overall agreement about the necessity of advancing smart grid systems in Berlin, the narratives portraying the role of urban households in these systems remains varied and in part contested. The narrative of participation and empowerment on the one hand and that of disinterest and incapability on the other reveal a disconnect not only between political and other actors, but also between abstract political programs and the reality of implementation.

Neighborhoods between self-sufficiency and collaboration

Similarly, decentralization and prosumage feature prominently in imaginaries of smart grids, even though there is vagueness and unclarity about the degree of decentralization and hence the scale of prosumage. Like the term "smart grids", the term "decentralization" has become a buzzword in the German *Energiewende* discourse. Apart from prosumage households, another dominant narrative in this discussion sees a new role for prosumage *neighborhoods*. This narrative circles around smart grids as tools for creating self-sufficient neighborhoods that are largely autonomous of energy utilities and large-scale networked infrastructures. These prosumage neighborhoods are often portrayed as locally delimited, small-scale energy cells that defy the "old" system order, and stand for a new distribution of responsibilities and power in the energy system. This narrative evokes notions of ownership and self-determination, in which urban neighborhoods stand for themselves and form largely autonomous energy "islands". At the same time, smart grids are being portrayed as highly complex and integrative systems that create and require extreme interdependencies, not only within neighborhoods, but within a city-wide "network of networks" (personal interview energy start-up EUREF, 2016). In the neighborhood context this narrative rings not of autonomy and empowerment but of control and (inter-)dependence. These two arguably contradictory narratives are both being promoted to foster the development of smart grids and make them attractive for cities.

In Germany, the narrative of small-scale energy cells is being promoted by institutions from the federal to the local level. In 2015, the German national association of electronics

(VDE) published a report called "The Cellular Approach", which describes a future energy system based on self-sufficient energy "cells" – or micro-smart grid systems (Benz et al. 2015). These are envisioned at various scales and can consist of individual households, streets, neighborhoods, towns, or entire cities (Benz et al. 2015, 29). Small-scale energy neighborhoods are also envisioned by the think tank Agora Energiewende, which concludes that decentralization fosters identification with local or regional electricity "products", and local prosumage is based on a wide-spread "do-it-yourself" mentality (Agora Energiewende 2017, 142).

In the city, the idea of energy cells is built on a narrative that describes neighborhood-sized units that function as zones for producing, using, trading and storing electricity independently. Within these zones, smart grids make sure that renewable energy production and demand are synchronized, while local storage units ensure that surplus energy is kept in the neighborhood system, and peer-to-peer transactions ensure that energy is traded within a local market. These narratives build on dedicated prosumage households, and on small-scale energy infrastructures such as solar panels, CHP plants, battery storage facilities etc. at the neighborhood level. All in all, the neighborhood scale as inherently urban unit is evoked as independent energy management zone. These energy neighborhoods are viewed as key for reaching Berlin's energy and climate goals, and micro-smart grid systems are viewed as catalyst for private investments into infrastructures and private commitment to prosumage (Erbstößer and Müller 2017, 9–11). To underline the importance of neighborhoods for the urban *Energiewende*, the local technology foundation has hosted a workshop series called "networked energy within neighborhoods" since 2016 (*Vernetzte Energie im Quartier*). Among others, it views micro-smart grid neighborhoods as important future market places for peer-to-peer energy trading (Erbstößer and Müller 2017, 11). The city administration envisions future smart grid neighborhoods as networked islands, especially in newly built areas of the city (personal interview SenWEB, 2018). The Enquête-Commission seeks to build on existing neighborhood structures and envisions the parallel refurbishment of buildings and the establishment of micro-smart grids therein. It envisions energetically refurbished micro-smart grid neighborhoods, in which various neighboring buildings are combined to form virtual power plants (Enquête-Kommission 2015, 79). Local smart grids are viewed as indispensable for the use of surplus electricity and the combination of sectors (Enquête-Kommission 2015, 153).

The idea of independence, empowerment and self-sufficiency is influenced by the country's surge of (mostly non-urban) energy cooperatives that have brought new voices into the energy discourse and distributed responsibility away from large energy companies. These narratives of independence and self-determination are being conjured in clear contrast to the one-size-fits-all national monopolies that prevailed in the "old" energy system.

EUREF, TXL and Adlershof all emphasize the idea of increasing neighborhood-scale energy independence. The smart grid project at EUREF, for example, is based on visions of a "polycentric" future energy system enabled by a smart and highly complex electricity grid (Technische Universität Berlin 2012, 4). This idea of "polycentricity" is strongly connected to the idea of independence of the overarching grid. As a leading researcher at EUREF states in an interview:

> We imagine a densely built industrial neighborhood that organizes 100% of its own energy on-site on the basis of renewables – wind, solar – and even in the areas of electricity, heating and transport. (personal interview, researcher EUREF, 2017)

> of course [EUREF] also stands as a symbol for urban development, that can pick up this decentralization idea, and maybe the city as a whole can reinvent decentralized facilities. (personal interview, researcher EUREF 2017)

Berlin's future sites are promoting an imaginary of largely independent energy neighborhoods that is supposed to be reproduced throughout other neighborhoods in the city. Here, micro-smart grid systems are being developed with the explicit goal of managing energy outside the overarching network, and of creating largely independent micro-smart grid solutions for replicating and scaling.

> If I operate a photovoltaic plant, for example, I imagine that a smart grid could help me increase my own consumption and make me a little more self-sufficient. (Personal interview researcher Adlershof, 2018)

On the other hand, a contrasting narrative evokes notions of smart grids as verhicles for collaboration and sharing. According to this narrative, smart grids are instead technologies for building collaborative communities.

> The users are supposed to participate. They are supposed to contribute, and we hope to create a form of community that helps us move forward. (AusserGewöhnlich Berlin 2017)

Among others, this narrative portrays smart grids as potential pillars for the creation of virtual power plants, i.e. interconnected energy generation, storage and distribution systems that rely on flexible trading within a (neighborhood) network. Instead of fostering independence of the grid, virtual power plants are designed to balance the grid. The Berlin Senate therefore also speaks of neighborhoods as "services to the grid" (Enquête-Kommission 2015, 69). According to this narrative, smart grid neighborhoods play an important role in leveling peak loads and stabilizing the overarching grid not least by allowing external steering mechanisms to manage flows into and out of their networks, and thus reducing independence instead of increasing it. The Berlin Senate speaks of creating "synergy effects" (Berlin Senate 2016b, 35). This narrative of integration and aggregation stands in direct contrast to the idea of energy indepence or even autarky. A leading representative of the TXL project even sketches his vision of a neighborhood "sharing economy", in which neighbors not only sell, but donate or give away their excess electricity (personal interview, TXL 2017). Smart grid neighborhoods, in this view, stand for a new and attractive form of community building (personal interview, TXL, 2017).

In sum, Berlin's smart grid discourse is comprised of two at best complementary narratives that highlight the independence and self-sufficiency of future energy neighborhoods on the one hand, and their integration and subservience to the surrounding city on the other. Decentralization and prosumage feature in both narratives, yet their qualities and social implications greatly vary.

Discussion and conclusion

My analysis shows that smart grid imaginaries of a decentralized and prosumage-based urban energy future are indeed shared by all actors involved in smart grid development in Berlin, be it at the administrative, the research or the implementation level. At the same time, my analysis shows that these imaginaries are not as coherent as they seem at first glance. My analysis of Berlin's smart grid discourse reveals that the

narratives underlying a seemingly uniform, uncontested smart grid imaginary are actually diverse and in part contradictory. Underneath the surface, diverging narratives of decentralization and prosumage are circulating and arguably competing for prevalence in the implementation of Berlin's energy future. These different narratives promote smart grids as vehicles for participative and community-centered energy transitions on the one hand, and independence and self-sufficiency-oriented energy futures on the other. While the first narrative focuses on empowering households and neighborhood communities to become conscious market actors in the city's energy system, the second narrative understands households as liabilities and neighborhoods as self-contained islands or disconnected hubs. There is little overlap between the two. Interestingly, these contradictory narratives don't follow the lines of actor coalitions, but run right through institutions, projects and even documents. This reveals an inconsistency and uncertainty about the roles and responsibilities of households and urban neighborhoods in future energy systems.

I conclude that the term "smart grid" is still primarily associated with technical possibilities rather than social change. While the term "smart grid" unequivocally conjurs positive, hopeful yet vague imaginaries of a low-carbon energy system, there is little agreement about how to design this socio-technical system. While the technical possibilities inherent in smart grids are clear to all actors involved, their social implications are much more ambiguous. Smart grids are primarily viewed as technical innovations that are associated with widely shared technical goals (such as the integration of renewable energies into the electricity system), while the necessary social changes remain secondary and are thus left to follow. For urban energy transitions to work out for everyone, I suggest discussing smart grids primarily as social innovations with associated social goals and letting the technical changes follow.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Notes on contributor

Leslie Quitzow is an architect and social scientist. Her research focuses on smart cities, urban energy transitions, urban infrastructure systems, socio-technical change, urban experimentation, visions and imaginaries. After managing a research alliance on energy transitions at WZB for eight years, she is now responsible for promoting circular thinking in the building industry as scientific advisor to Bundesstiftung Bauakademie.

References

Amt für Statistik Berlin-Brandenburg, ed. 2019. "Energie- und CO_2-Bilanz in Berlin 2017".

Agora Energiewende, ed. 2017. "Energiewende und Dezentralität: Zu den Grundlagen einer politisierten Debatte."

AusserGewöhnlich Berlin. 2017. "Eine Republik in Berlin: Tegel Projekt".

Ballo, Ingrid F. 2015. "Imagining Energy Futures: Sociotechnical Imaginaries of the Future Smart Grid in Norway." *Energy Research & Social Science* 9: 9–20. doi:10.1016/j.erss.2015.08.015.

Beckert, Jens. 2016. *Imagined Futures: Fictional Expectations and Capitalist Dynamics*. s.l.

Benz, Thomas, Jörg Dickert, Maik Erbert, Niels Erdmann, Christopher Johae, Burkhard Katzenbach, Wolfgang Glaunsinger, et al. 2015. "Der Zellulare Ansatz: Grundlage Einer Erfolgreichen, Regionenübergreifenden Energiewende." Studie der Energietechnischen Gesellschaft im VDE (ETG).

Berlin Senate. 2015. "Smart-City-Strategie Berlin: Stand 21. April 2015." https://www.stadtentwicklung.berlin.de/planen/foren_initiativen/smart-city/download/Strategie_Smart_City_Berlin_en.pdf.

Berlin Senate. 2016a. "Berlin Gemeinsam Gestalten. Solidarisch. Nachhaltig. Weltoffen. Koalitionsvereinbarung 2016–2021." https://www.berlin.de/rbmskzl/regierender-buergermeister/senat/koalitionsvereinbarung/.

Berlin Senate. 2016b. "Für Ein Klimaneutrales Berlin: Berliner Energie- Und Klimaschutzprogramm 2030." Umsetzungkonzept für den Zeitraum 2016–2021. https://www.berlin.de/sen/uvk/klimaschutz/klimaschutz-in-der-umsetzung/das-berliner-energie-und-klimaschutzprogramm-bek/machbarkeitsstudie-klimaneutrales-berlin-2050/.

Bulkeley, H., P. M. McGuirk, and R. Dowling. 2016. "Making a Smart City for the Smart Grid? The Urban Material Politics of Actualising Smart Electricity Networks." *Environment and Planning A* 48 (9): 1709–1726. doi:10.1177/0308518X16648152.

Bundesnetzagentur. 2019. "EEG in Zahlen 2019." https://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Sachgebiete/Energie/Unternehmen_Institutionen/ErneuerbareEnergien/ZahlenDatenInformationen/EEGinZahlen_2019_BF.pdf;jsessionid=0AD42D3476F563BEC158C5DB13D1AF9E?__blob=publicationFile&v=4.

Enquête-Kommission. 2015. "Neue Energie Für Berlin: Zukunft Der Energiewirtschaftlichen Strukturen." Drucksache 17/2500. https://www.parlament-berlin.de/ados/17/IIIPlen/vorgang/d17-2500.pdf.

Erbstößer, Anne-Caroline, and Dieter Müller. 2017. "Vernetzte Energie Im Quartier: Berliner Lösungen Für Die Energiewende." https://www.technologiestiftung-berlin.de/fileadmin/daten/media/publikationen/Archiv/171218_Vernetzte_Energie_Web.pdf.

Forschungscampus Mobility2Grid. 2016. "Akzeptanz Und Partizipation." https://mobility2grid.de/wp-content/uploads/TF1_Poster_161215_DE.pdf.

Hielscher, Sabine, and Benjamin K. Sovacool. 2018. "Contested Smart and Low-Carbon Energy Futures: Media Discourses of Smart Meters in the United Kingdom." *Journal of Cleaner Production* 195: 978–990. doi:10.1016/j.jclepro.2018.05.227.

Jasanoff, Sheila. 2015. "Future Imperfect: Science, Technology and the Imaginations of Modernity." In *Dreamscapes of Modernity: Sociotechnical Imaginaries and the Fabrication of Power*, edited by Sheila Jasanoff, and Sang-Hyun Kim, 1–33. Chicago, London: The University of Chicago Press.

Jasanoff, Sheila, and Sang-Hyun Kim, eds. 2015. *Dreamscapes of Modernity: Sociotechnical Imaginaries and the Fabrication of Power*. Chicago, London: The University of Chicago Press.

Keller, Reiner. 2011. "The Sociology of Knowledge Approach to Discourse (SKAD)." *Human Studies* 34 (1): 43–65. doi:10.1007/s10746-011-9175-z.

Keller, Reiner, and Inga Truschkat. 2013. *Methodologie Und Praxis Der Wissenssoziologischen Diskursanalyse*. Wiesbaden: VS Verlag für Sozialwissenschaften.

Koopman, Hans P. 2018. "Hochinnovatives Energiekonzept Für Berlin TXL." News release. 2018. https://www.tegelprojekt.de/pressematerial/detail/hochinnovatives-energiekonzept-fuer-berlin-txl-4518.html.

Levenda, Anthony M. 2018. "Mobilizing Smart Grid Experiments: Policy Mobilities and Urban Energy Governance." *Environment and Planning C: Politics and Space* 35 (1): 239965441879712. doi:10.1177/2399654418797127.

Levenda, Anthony M., Jennifer Richter, Thaddeus Miller, and Erik Fisher. 2018. "Regional Sociotechnical Imaginaries and the Governance of Energy Innovations." *Futures*. doi:10.1016/j.futures.2018.03.001.

Länderarbeitskreis Energiebilanzen. 2019. "Energie- Und CO2-Bilanzen Der Bundesländer." http://lak-energiebilanzen.de.

Lovell, Heather. 2018. "The Promise of Smart Grids." *Local Environment* 20: 1–15. doi:10.1080/13549839.2017.1422117.

McLean, A., H. Bulkeley, and M. Crang. 2015. "Negotiating the Urban Smart Grid: Socio-Technical Experimentation in the City of Austin." *Urban Studies*. doi:10.1177/0042098015612984.

Palensky, Peter, and Friederich Kupzog. 2013. "Smart Grids." *Annual Review Environment and Resources* 38 (1): 201–226. doi:10.1146/annurev-environ-031312-102947.

Schick, Lea, and Christopher Gad. 2015. "Flexible and Inflexible Energy Engagements: A Study of the Danish Smart Grid Strategy." *Energy Research & Social Science* 9: 51–59. doi:10.1016/j.erss.2015.08.013.

Skjølsvold, Tomas M., Marianne Ryghaug, and Thomas Berker. 2015. "A Traveler's Guide to Smart Grids and the Social Sciences." *Energy Research & Social Science* 9: 1–8. doi:10.1016/j.erss.2015.08.017.

Technische Universität Berlin. 2012. *EUREF-Forschungscampus: Nachhaltige Energie- Und Mobilitätsentwicklung Durch Kopplung Intelligenter Netze Und Elektromobilität: "Mobility2Grid"*. Wettbewerbsbeitrag im Rahmen der Förderinitiative "Forschungscampus – öffentlich-private Partnerschaft für Innovation" (Vorphase): 1–121.

Tegel Projekt GmbH. 2018. "Berlin TXL – the Urban Tech Republic: Facts & Figures." https://www.berlintxl.de/fileadmin/10.0_Presse/pressematerial_en/20180301_Facts_Figures_UTR_EN_final.pdf.

Voigtländer, Michael, and Pekka Sagner. 2019. "Wohneigentum in Deutschland: Analyse Der Wohneigentumsbildung." Gutachten für die Schwäbisch Hall AG.

Wentland, Alexander. 2016. "Imagining and Enacting the Future of the German Energy Transition: Electric Vehicles as Grid Infrastructure." *Innovation: The European Journal of Social Science Research* 29 (3): 285–302. doi:10.1080/13511610.2016.1159946.