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Exploring Limited Capacity in the Grid: Actors, Problems, and Solutions

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An extensive and reliable electricity grid is essential for all the sectors of society. In parts of Sweden, the electricity grid has been suffering from a lack of capacity. This is something affecting all the sectors and all the people in these regions. The capacity problems have, however, so far, mainly been analyzed from a technical system perspective, focusing on incumbent actors, whereas other actors have been less researched. This article aims to fill this gap and include a variety of perceptions of Swedish actors' on the lack of electricity grid capacity. It is, however, a challenge to capture the views of others than the professionals working in the area because the electricity grid is not something people, in general, reflect upon. The article takes an explorative approach to the subject by analyzing the problems and the solutions raised in four arenas: the regulative, the media, the technocratic, and the user. It also focuses on the city of Malmö in Sweden and two projects where the lack of grid capacity has been discussed. Sweden's lack of capacity concerns that, although electricity is available, the energy grid cannot transmit the required amount of electricity to all parts of the country. The article concludes that the electricity grid has been developed within a technocratic frame, with a few professionals dominating the agenda, which has led to convergence of perspectives and narrowing options. In the regulative arena, which often decides what issues are prioritized and in the end implemented, there is a focus on investment in transformers and lines rather than demand-side solutions and user flexibility. Technological and economical values are dominating all arenas, and other values, such as user engagement and ownership, are marginalized.

Keywords: power grid, electricity system, lack of capacity, user flexibility, stakeholder, actor

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INTRODUCTION

An extensive and reliable electricity grid is essential for all the sectors of society. Electricity has no close substitute for many functions. In many western societies, sectors, such as health, education, and communication, are dependent on the transmission and distribution of electricity. At the same time, the existing electricity grid is facing many challenges to continue providing a stable supply in the future (IEA, 2019b). One such challenge is the classical energy trilemma (World Energy Council, 2011), with conflicting demands on sustainable, affordable, and reliable electricity systems. Another challenge is the increasing call for public engagement in decision-making, recently advocated in the Green Deal and the "Clean Energy for all Europeans" (European Commission, 2019). For many countries, the increased electrification of various sectors, together with increased use of intermittent power generation sources and aging electricity infrastructure, is a challenging factor (Mateo et al., 2017; IEA, 2019b; Warneryd, 2020). In approaching those challenges, governments have searched to find new arrangements for stakeholder participation to gain acceptance of infrastructure projects (Cowell and Devine-Wright, 2018), such as how to develop a sustainable and reliable grid. Earlier research on stakeholder engagement has had a major focus on how and who are engaged in decision-making processes and when, but less focus has been given to what issues are on the agenda. This article mainly focuses on what issues have been put forward in discussions on the lack of electricity grid capacity. A case study from Malmö, Sweden, will be used.

The Swedish energy grid faces the same challenges as described above, with conflicting demands for sustainable, affordable, and reliable electricity systems. The Swedish grid also needs to deal with a 15,000 km high voltage transmission network, running from the north, where the hydropower and most of the wind power are located, to the south, where most of the consumption occurs. To maintain the energy sustenance, Svenska Kraftnät (SVK), the Swedish Transmission System Operator (TSO), must increase the north-south capacity, the regional capacity, as well as the cross-border capacity (IEA, 2019a). In 2018, it became a fact that the south region in Sweden, Skåne, and, especially, the Malmö area, was facing a growing capacity problem (Region Skåne, 2020). Skåne has been heavily dependent on electricity generated outside the region ever since Barsebäck's two nuclear power reactors of 600 MW were shut down, the first in 1999 and the second in 2005. Skåne has since then lacked large-scale and dispatchable electricity generation and relies heavily on the transmission of electricity from, especially, northern Sweden. If the transmission capacity is insufficient, there is a lack of capacity in the electricity grid, and Skåne has been suffering from this (Region Skåne, 2020). A well-functioning power grid is important for a reliable power supply (Schweizer and Bovet, 2016) and for sustaining a welfare state in times of a growing population and the increased electrification of societal sectors. Lack of capacity in the electricity networks has led to restrictions of new connections of consumption facilities, and existing grid customers have not being able to have a fuse upgrade (see, e.g., Törnwall, 2019).

A commonly used framework to understand transition processes like the one the electricity grid is facing has been the multilevel perspective (MLP) (Geels, 2004). MLP presents a systemic view on transition, with three interconnected levels: nice, regimes, and landscape. This perspective has, however, been challenged by Jørgensen (2012), who states that actors are seldom attached to only one level. In empirical terms, actors are engaged in transforming at all levels (Jørgensen, 2012). Instead, Jørgensen put forward an alternative approach, with arenas of development where the actors and their ways of interpreting context are in focus. Accordingly, this article analyzes how the grid capacity issue has been framed at different arenas.

One important arena is the professional or technocratic arena. The electricity grid and associated capacity problems need expert knowledge to find solutions, and, as with many other technical systems, discussions and development of the grid tend to be dominated by professionals in the area (Cowell and Devine-Wright, 2018; Palm, 2020). Also, the electricity grid is not an issue people, in general, reflect upon, but it is often handed over to professionals (Walker and Hope, 2020). The importance of the electricity grid for society makes it, however, essential to capture more views than just those of incumbent actors, i.e., distribution system operators (DSO), TSO, and regulatory authorities (European Commission, 2019; Fink and Ruffing, 2020; Hardy and Mazur, 2020). Therefore, the arena approach is suitable, because it takes as its starting point the existence of a multitude of actors at different arenas, engaging in collective sense-making activities. In an arena, actors operate in networks that also include institutions, technologies, visions, and practices (Jørgensen, 2012). This article analyzes how the grid capacity issue has been framed in the regulative, media, technocratic, and user arenas, which will be described further below.

Depending on the arena studied, different parts of the electricity grid were emphasized, and different actors, problems, and solutions were identified. The article aims to analyze which problems and solutions are present in four different arenas and which actors are considered responsible for delivering solutions to the lack of grid capacity. How a problem is described, defined, and understood and by whom has implications for what solutions will be seen as prominent.

The outline of the article is as follows: first, the analytical framework with its four arenas will be described; second, the methodology guiding this paper is outlined; then, the results and analysis are presented; finally, the article ends with a discussion, conclusions, and policy recommendations.

ANALYZING ACTORS, PROBLEMS, AND SOLUTIONS IN THE ELECTRICITY GRID AT FOUR ARENAS

The analysis focuses on how problems, solutions, and responsible actors were understood in four arenas: the regulative, media, technocratic, and user arenas. The choice of which arenas to include is mainly empirical driven, which will be explained further below.

The reason to include the regulative arena is to capture the codified practices that validate or restrict certain actions and actors (Battaglini et al., 2012; Aydin, 2019; Sareen, 2020). In the studied cases, regulations were often present as an important background parameter for the discussions, explaining why an issue was implemented or not, and decisive if a measure was considered cost-efficient or not (compare also Agrell et al., 2013; Crispim et al., 2014). In the article, a narrow view of regulation will be applied, focusing on codified regulatory authority and responsibility, i.e., how responsibility for the lack of capacity in the electricity grid is reflected in the existing regulations (Scott, 2001). The Swedish electricity market was deregulated in 1996, and generation and trading of electricity have since then been subject to competition (Högselius and Kaijser, 2007). The electricity grid is a natural monopoly still regulated (Palm, 2008). Since the deregulation, different regulation methods have been implemented (Crispim et al., 2014), but since 2012 an *ex ante* revenue cap regulation has been used in Sweden. The regulator must decide on revenue caps of each network operator after a proposal from each company. The revenue cap should cover reasonable operational costs and a reasonable return on the assets used in the distribution and transmission (Council of European Energy Regulators [CEER], 2020). It is this regulation and the regulator, the Energy Market Inspectorate (Ei), that is in focus for the analysis and what consequences this regulation has for the grid investments.

The media arena is interesting to study since it has an important role in mediating society in itself. The media has a key role in reproducing storylines and future imaginaries (Hielscher and Sovacool, 2018), and the media arena is here used to reflect the public opinion. Media constitute an arena of debate for both public and private actors who want to gain control over how a subject should be interpreted (Gillespie and Toynbee, 2006). During the studied period, local and national media has started to report on the challenges the lack of capacity in the grid poses to society. Media contribute to shared visions, call for action, and influence policy decisions, but give also voice to diverging perceptions and competing interpretations (Ballo, 2015; Leipprand et al., 2017). The analysis focuses on the initial phase of the debate on the grid capacity in the region of Skåne.

In the technocratic arena, the practices of, mainly, the DSOs as technical experts and how they frame problems of electricity grid capacity and its solution will be considered. The DSOs are responsible for maintaining electricity quality and security of supply by building and investing in current electricity distribution systems (Johansson et al., 2020). The technocratic arena is the traditional arena, where the development of the grid, traditionally, has been discussed (Cowell and Devine-Wright, 2018). In the technocratic arena, there is a tendency to believe the problem is best solved through enough expertise and detailed knowledge of a matter (Uhrwing, 2001). The discussions are characterized by "apolitical problem-solving" (Soneryd, 2007), and moral arguments are perceived as opinions and not as useful information (Palm, 2020). Part of the technocratic norm is that the public's knowledge is regarded as deficient and that citizens are involved only so they will better understand a question and accept scientific knowledge (Irwin and Michael, 2003). How the DSO frames the problems and possible solutions will be considered by analyzing interviews with the DSO and through participatory observations of meetings.

The fourth arena included here is the user arena. The choice to include the users is related to the case study, where two projects have been studied, where property owners and property developers have collaborated with the DSO to find solutions to the lack of grid capacity. In the user arena, a central part of the capacity problem concerns flexibility and opportunities for users to install ICT to control and reduce their energy consumption and costs (Lunde et al., 2016). The idea is that consumers, using various smart devices, will have choices in their energy consumption and have a stake in optimizing the system (Verbong et al., 2013). Such smart load management by end-user appliances is assumed to be more cost-effective than conventional load management (Naus et al., 2014). When responsibility is discussed in the user arena, it is done in relation to how certain users (e.g., property owners and developers) frame problems, solutions, and who is responsible for actions to be taken.

TABLE 1 | An analytical framework for studying how lack of grid capacity has been discussed in different arenas.

Arena	Actor responsible	Problem/solution
Regulations		
Media		
Technocrats		
Users		

When the four arenas are combined with the problems in focus and who is deemed responsible for them, a matrix can be developed, as shown in **Table 1**. This framework will be applied when analyzing the data.

MATERIALS AND METHODS

The present research is exploratory to gather preliminary information that will help define problems and suggest research questions. Explorative studies permit creative approaches that can contribute to new insights or raise new questions about a phenomenon (Stebbins, 2001). The empirical material comes from Sweden and will be used to illustrate how the grid capacity problem has been framed. The intention is not to conduct an in-depth study covering all actors and issues raised in the four arenas but to conduct explorative research. **Figure 1** describes the research process of this study.

According to the Swedish TSO SVK, Sweden's grid capacity problems started around 2015, with increasing demands for the grid related to urbanization, the establishment of new industries (especially data centers), and the closure of cogeneration power plants due to changed tax regulations (Svenska Kraftnät, 2020). However, in 2018, the issue first received media attention and the general public became aware of the problem (see, e.g., Magnusson, 2018). In Sweden, the regions of Stockholm, Uppsala, and Skåne have experienced grid limitations, leading to a need to prioritize between end users and industries, while electrified public transport providers have been forced to postpone or scale back expansion plans (Länsstyrelsen Skåne, 2020). Two projects dealing with how to solve the problem with the lack of grid capacity in the region of Skåne have been followed.

The first project, "The Malmö Effect," was a collaboration between the City of Malmö, E.ON, Lund University, the Research Institute of Sweden (RISE), property owners, and property developers. The aim was to map Malmö's flexibility needs and the flexibility potential of Malmö's building stock. The starting point of the project was that the transmission network around the city had reached its maximum capacity and risked being unable to deliver enough power at peak demand. This problem had become critical because the city's population was growing steadily. E.ON Energy Distribution, the DSO, applied to the Swedish TSO SVK in 2016 (application no. 2016/1412) to increase the capacity of Malmö's main network stations, Sege and Arrie, in 2016. The application was rejected because it

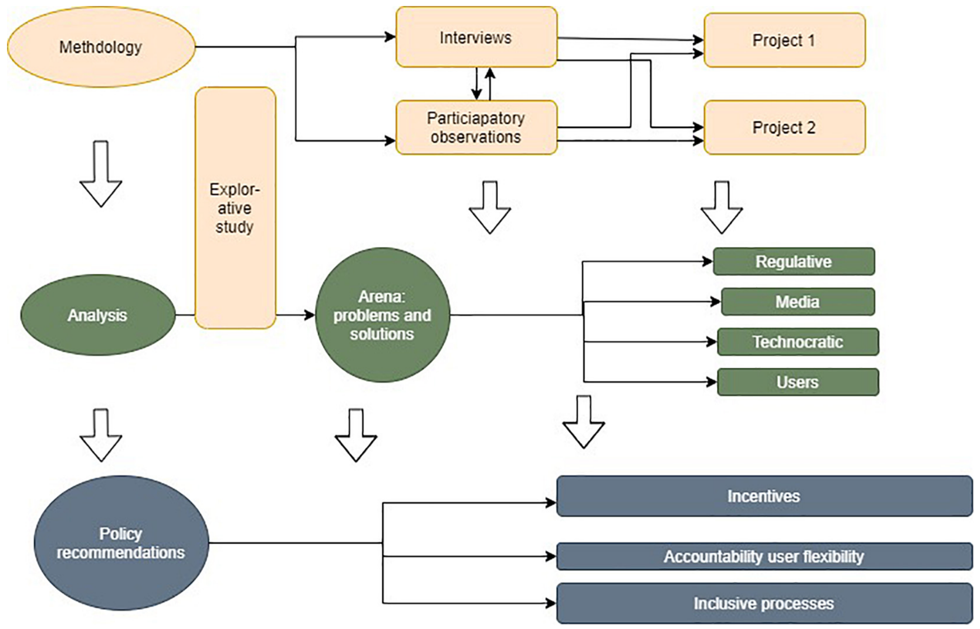

FIGURE 1 | The research process of this study.

had already been decided that the transmission lines in the Malmö region would be upgraded around 2026. This decision made it necessary to find ways to maintain a secure energy supply in Malmö.

The second project, "Sege Park," was a test bed project in Malmö to establish innovative and sustainable energy solutions in a particular development area where the city of Malmö had signed a contract with 13 property developers. Swedish municipalities do not have the authority to regulate the technical properties of buildings. To go beyond established standards and achieve more ambitious sustainability goals, the city of Malmö used property developer dialogues as a tool to negotiate various sustainable solutions. One solution investigated by the property developers was to establish a microgrid in the area to make it self-sufficient in electricity.

Qualitative methods were used to gather data. The primary methods were semi-structured interviews and participant observation workshops, seminars, and planning meetings with the actors studied. This approach affected the duration of the research, drawing attention to the broad patterns of the activity rather than episodic fragments and yielding a variety of data with which to understand different stakeholders' viewpoints (Nardi, 1996). In the first project, undertaken in 2018, two workshops were observed in which representatives of E.ON, the city of Malmö, property developers, and property owners discussed the power situation, flexible electricity use, and peak shaving.

Participatory observations were also conducted at project meetings in which E.ON, RISE, and the city of Malmö discussed solutions to be implemented in the future smart grid in Malmö. In the test bed project, Sege Park, participant observations of the dialogue meetings of the property developers organized by the city were also conducted. So far, 28 of these developer dialogues have been followed since they started in August 2017; they are still ongoing at a frequency of around one per month.

The observations have been complemented with a total of 22 interviews with property owners, the DSO, and the representatives of the city of Malmö. The interviews were conducted between autumn 2018 and autumn 2019. The interviews lasted 1–2 h and were audio recorded with interviewee consent. The interviewees were promised anonymity, so the quotations are not attributed by an interviewee name or a job title. The characterization of the participants at the two workshops, the 28 dialogue meetings, and the interviewees are described in **Table 2**. The actors are divided according to if they are private property owners (PO) or property developers (PD) with national or regional/local geographical coverage. One column is for the companies owned by the city of Malmö. E.ON has a column of its own, which also the city of Malmö has, where it is also shown which parts of the city administration are participating. The number in the brackets constitute a unique individual representing the organizations. When there are no brackets, only one person has been the representative.

The two projects used different interview guides, but both guides included the following themes:

- Background: professional background, the role in the organization, and the project studied
- The role of the organization in the project, the aim with the participation
- The energy system, what are emphasized in the organization and in the project (e.g., energy efficiency, district heating, heat pumps, individual metering, prosumer)

TABLE 2 | Actors participated during the workshops, the dialogue meetings, and the interviews, divided according to the organizations they represented.

Workshops/interviews	Property owners (PO)/developers (PD), private national coverage	Property owners (PO)/developers (PD), Private local/regional coverage	Property owners (PO), municipally owned	EON	Malmö, administration
Workshop 1, the Malmö effect	PO B (1) PD 0 PO N	PO F (1)	PO H(1)	E.ON (1) E.ON (2) E.ON (3)	PO J (1) Environmental office (1) Environmental office (2)
Workshop 2, the Malmö effect	PO P PO B (1)	PO F (1)	PO H (1)	E.ON (3)	PO J (1)
Sege park	PD A (1,2,3,4) PD B (1,2,3,4) PD E PO G (1,2) PO I (1,2,3,4) PD M (1,2,3)	PO C (1) PO D (1,2,3,4,5) PO F (2,3,4) PO K (1,2,3)	PO L (1,2,3) PO H (1,2,3,4,5)	E.ON (1,2,3,4,5,6,7,8)	PO J (2–6) Real estate office (1,2,3,4,5) Environmental office (1,2,3,4,5,6,7,8,9,10,11,12) City planning office (1,2,3,4,5,6,7,8)
Interviews	PD A (1) PD B (1,4) PD E PO G (1) PO I (2) PD M (1) PO N PD O PD P	PO C (1) PO D (1) PO F (1,4) PO K (3)	PO L (2) PH H (1,2)	E.ON (8)	PD J (6) Real Estate office (3) Environment office (4)

The number in the brackets constitute a unique individual representing an organization. When a figure is lacking the organization was represented by only one person.

- Demand and response issues, peak shaving, and flexibility
- Consequences of the grid capacity problems Malmö was experiencing
- Problems, solutions, and responsibilities concerning a reliable grid
- Future outlooks
- Others

The media debate from autumn 2018 to spring 2019 in the local press in Malmö was analyzed. The media material was delimited to how the discussion on the lack of grid capacity was framed in the local media of this region.

When it comes to how lack of grid capacity has been discussed in the regulative arena, two main sources were used, one describing the regulations and, another analyzing their effects on grid investments.

The material collected does not fully cover how lack of grid capacity was discussed by all the actors in all the arenas, but the material is sufficient for the present explorative aim. The data were analyzed, using the qualitative content analysis (Elo and Kyngäs, 2008). The observations and interviews were coded manually for this article, where the codes emerged from the data. The material was coded according to the actors present in the arena, the actors mentioned by the participants, and which problems and solutions were discussed. The focus was on triangulating results and identifying common patterns. Commonalities were sought in keywords and phrases and in how the subjects positioned themselves in relation to a topic.

RESULTS

The problems and responsibilities in the electricity grid in the four arenas will be discussed in relation to the two projects in Malmö. First, the regulative arena will be discussed.

The Regulative Arena

In both projects, it was common to refer to existing regulations to motivate why a suggested measure was accepted or rejected. The regulative arena consists of laws and regulations that validate some actions and restrict others. The regulative arena defines the formal roles of actors, giving them market access, depending on their competencies and qualifications (Sareen, 2020). In 1996, the Swedish electricity market was deregulated. The deregulation of the electricity market entailed separating the production and sale of electricity from its transmission, enabling competitive production and trade, both wholesale and retail. With market liberalization, legislation was changed, enabling small-scale actors to sell, or “prosume,” self-produced electricity back to the grid (Weingarten, 2012; Palm, 2018). Grid operation was not part of the liberalization but was seen as a natural monopoly and was regulated and supervised by the authorities. Given the lack of competition in electricity transmission and distribution, network operators are subject to strict regulations to promote efficiency and quality of supply and to ensure fair customer prices (Brandstätt et al., 2012). The national regulatory authority for energy, the Ei, determines a revenue cap for each DSO and the TSO for a regulatory period of 4 years.

There are around 184 DSOs and two TSOs in Sweden. One of the Swedish TSOs is SVK owned by the government. With

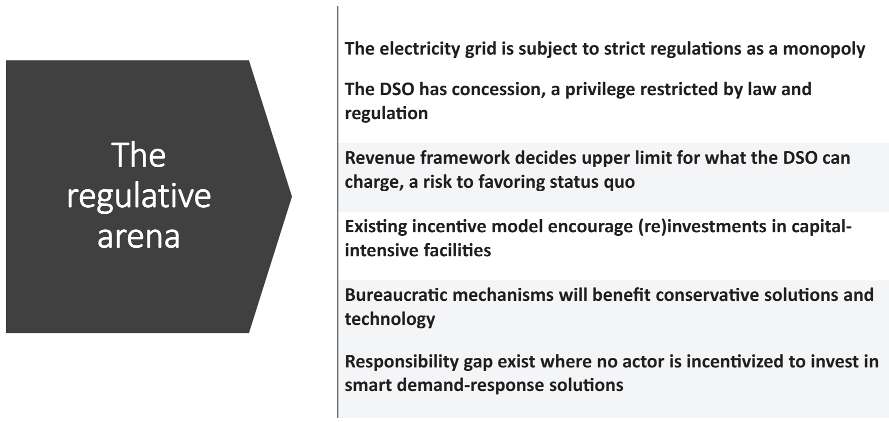

FIGURE 2 | A summary of the relevant aspects in the regulatory arena.

a few exceptions, the SVK owns and operates all parts of the transmission system. The other TSO, the Baltic Cable (BC), owns one line of transmission connecting the electricity grid between Sweden and Germany (Council of European Energy Regulators [CEER], 2020). The 184 DSOs vary in size and ownership structure, and each has a concession on the distribution of electricity, either for a defined geographical area (local DSO) or a specific line (regional DSO). The concession is a privilege restricted by law and regulation and is valid until further notice (Wallnerström et al., 2016).

The activities of the electricity grid companies are, as mentioned earlier, regulated by Ei, which decides an upper limit on how much the companies can charge customers in total fees. The purpose of the regulation is to ensure that customers pay a reasonable price for the electricity network service and to provide customers with long-term delivery reliability (Energimarknadsinspektionen, 2018). This upper limit, or revenue framework, is set in advance and applies for 4 years at a time, the current period being 2020–2023. Earlier research has identified the risk of the regulative arena, favoring the *status quo* and incumbent actors (Schot and Geels, 2008). The Swedish system has experience this problem and has been criticized for lacking innovative ideas and solutions. To promote efficient network use and, thereby, to promote the emergence of smart network solutions, Ei has introduced new incentives for electricity grid companies to reduce their network losses and smooth the load in the electricity grids. However, the existing regulatory model encourages investments in capital-intensive facilities (e.g., transformers and lines) rather than smart grid solutions (Naess-Schmidt et al., 2017). In the simple form of the model, when grid assets have reached a predetermined age, the grid companies can no longer charge the customers for them; the companies must, therefore, reinvest in aging assets if their revenues are to remain at the same level in the long run.

There is a risk that bureaucratic mechanisms will benefit conservative solutions and technology (Asmelash, 2015; Sareen, 2020). When Copenhagen Economics (Naess-Schmidt et al., 2017) surveyed Swedish grid companies about their investments, the companies reported on investments in ICT solutions contributing, for example, to flexibility. However, these investments represented a very small part of all the investments made and planned by the grid companies. Most electricity grid companies saw these ICT investments as complementing "traditional" investments, such as upgrading wiring and replacing transformers. A corresponding problem is the existence of an institutionalized "responsibility gap" in which the TSOs and DSOs have financial incentives to invest in new lines and transformers, but no incentives to invest in other grid solutions, such as demand-response technology and services (Morstyn et al., 2018).

In Copenhagen Economics' survey, the companies that had invested in smart grid solutions stated that the main driver of those investments was increased customer benefits rather than more efficient network use. Copenhagen Economics also stated that neither the indicators of effective network use nor the revenue framework regulation had any impact on the investment decisions of the grid companies. The companies lack interest and relevant incentives, and standards have not kept pace with the emergence of the techno–economic opportunities that smart grid regulations could unlock (Vallés et al., 2016; Naess-Schmidt et al., 2017).

Figure 2 summarizes the most relevant regulatory aspects in relation to the projects in Malmö.

The Media Arena

In the media arena, one can identify various ways to perceive a subject. Articles advocate certain perspectives and help establish what are perceived as relevant problems and opportunities in the electricity grid (Tidwell and Tidwell, 2018). Several regions in Sweden have experienced an increasingly urgent problem with the electricity grid capacity. This has long been a topic of discussion in the energy sector but has not been a matter of public debate. This situation changed in 2018, when the media started to report on the lack of grid capacity.

The situation in Skåne, also described in the introduction, was that, when the nuclear power reactor Barsebäck closed in 2005, the region had become heavily dependent on electricity generated outside the region. The TSO SVK was lagging with increasing the north-south capacity, and Malmö was facing growing capacity problems. In November 2018, the biggest newspaper in southern

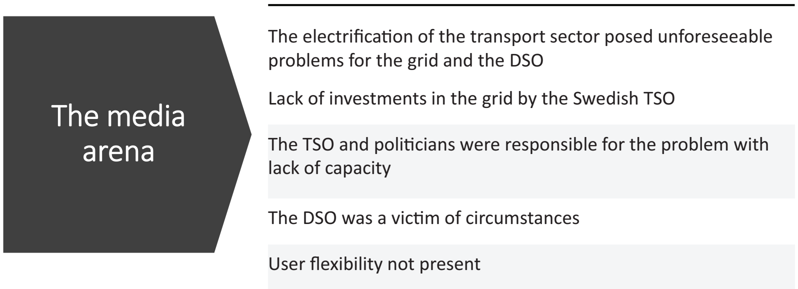

FIGURE 3 | A summary of the main findings in the media arena.

Sweden, *Sydsvenskan*, reported on a meeting E.ON had organized in which the power balance in the region was discussed. The title of the article was "Electricity Shortage in Skåne," and the introduction was:

"SKÅNE: When the railway is being expanded, the electricity supply has a problem. With an increasing number of electric buses and electric cars to be introduced on the market, E.ON is warning of electricity shortages in Skåne".

According to the article, part of the problem was that the Swedish TSO's project to upgrade electricity transmission from central to southern Sweden had been delayed. The delay was aggravated by and jeopardized the expansion of the railway and various industries (Magnusson, 2018).

This story appeared in several media, and its main message was that, as the number of electric buses and cars increases, there would be insufficient power in Skåne. The focus of the problem was described as a combination of lack of investments in the grid, and that problems and solutions were located to others than the DSO, such as the TSO and politicians (e.g., Magnusson, 2019). The government and politicians were seen as part of the problem: they had not done enough and had not taken responsibility for the situation. All the media were reporting on the same meeting that E.ON had organized, portraying E.ON as a victim of the upcoming situation and calling for action from politicians and authorities. The message what that public transport was to be electrified, depending on how it suited the grid capacity, not how it suited the transition of the transport sector.

The media implicitly also ascribed users a key role in managing the upcoming situation. Investment in the grid would be delayed until 2026, and the system had to find a way to balance demand and supply in the interim. Although the articles had a supply focus, flexibility was indirectly discussed from the perspective of how the grid owners could benefit from increased user flexibility, but flexibility was usually seen as an insufficient measure, mainly as a complementing tool (e.g., Editorial, 2019). The other perspective on user flexibility and demand response, in which flexibility is seen as a way for users to exert control over their electricity consumption through various ICT solutions, was essentially lacking from the debate (see, e.g., Nyborg and Røpke, 2013; Strengers, 2013; Verbong et al., 2013; Hansen and Hauge, 2017). From a user perspective, new technology has increased the opportunities for electricity users to shape and control their electricity costs, for example, by remote, time, and price control of heating, ventilation, and white goods use. This discourse also treats new technology as enabling companies to sell new services to electricity customers, such as control and energy efficiency (compare, e.g., Nyborg and Røpke, 2013; Goldbach and Gölz, 2015), though this framing was not evident in the media debate.

Figure 3 summarizes the main findings in the media arena.

The Technocratic Arena: The DSO

In the technocratic arena, legitimation is gained *via* a set of practices, including systematic checks and approval of actions that require technical experts (Sareen, 2020). In this arena, certain methods and actions have credibility and were approved as suitable. Regarding the grid capacity problem, the E.ON representatives had quite consistent framing and message. Society was facing increased energy demand due to the growing population and more sectors becoming electrified. The way to meet this energy demand, in the long run, was through investments in transmission and distribution lines. This was not feasible in the short run; however, and given unchanged grid capacity, the solution was to use the available energy and infrastructure more efficiently, which, according to E.ON, imposed demands on individual users. The representatives called for shared responsibility, saying, "Power imbalance is not only a problem for E.ON and the TSO but a problem for all of us" (Observation, February 14, 2019). Individual users had to contribute through different forms of energy storage and through optimizing energy flows. Another way the property developers could contribute was by choosing district heating instead of heat pumps for their properties (Observation, February 14, 2019).

In the Sege Park test bed project, a goal for the area was to install rooftop photovoltaic panels and to use all self-produced electricity locally. An idea that emerged early in the process among the property owners was to combine photovoltaics, heat pumps, and a microgrid, and to balance supply and demand internally among the buildings in the area. During the interviews, many property developers expressed their desire for a shared solution in the area:

"We have looked into what we as property developers can have: A grid that property owners themselves own, so that we can keep the energy within Sege Park. Those solar panels that are planned will be connected to the existing grid, but then we must sell it (the electricity) back to the main grid. With a microgrid, we could keep the energy within the district" [PD A(1)].

The technocratic arena

The DSO	Property owners
Avoid heat pumps, district heating was preferred from a capacity perspective	Choice of district heating not related to capacity problems, E.ON just wants to sell more services
Shared responsibility for maintaining sustainable electricity supply and a reliable grid	The DSO is responsible for the grid, the property owners for the energy system in their buildings
E.ON acts in the interest of the common	E.ON acts in the interest of the company, not in the interest of the property owners
Microgrids and cooperative ownership are too expensive and lacks regulatory support	Other values than financial at stake, such as self-control over the system
E.ON speaks with one voice	Mixed opinions among the property owners

FIGURE 4 | A summary of the main arguments by the DSO and the property owners.

The property developers hired two different consultants to investigate the preconditions for energy investments in general and a microgrid more specifically (ÅF, 2019; Knowit, 2020). Both consultants explained that establishing a microgrid was impossible for the moment because it did not aligned with Swedish regulations. The market is a monopoly market, and, according to the law, it was illegal to distribute electricity between different property owners. The DSO had the concession and had to own the grid. The consultant reports were discussed at two different meetings. At one of the meetings, the consultant and E.ON stated that heat pumps should be avoided and that district heating was preferred, one reason being that district heating did not add any additional load to the electricity grid (Meeting observations, February 14, 2019). When interviewing the property owners, it was clear that the property owners did not see the recommendation to choose district heating in light of capacity problems but as a way for E.ON as a corporate group to sell more services to the property owners. E.ON Energy Distribution owns the electricity grid in the area, and E.ON Heat owns the district heating system. Another problem was that energy issues were discussed technically at the meetings, and it was difficult for the property owners to rate the advantages and disadvantages of different solutions because they lacked a background to energy engineering.

During the meetings, E.ON tried to develop a collaborative atmosphere with a feeling of shared responsibility for maintaining a sustainable electricity supply and a reliable grid. Several times, E.ON returned to the fact that it was acting in the interest of the Commons (i.e., to secure access to electricity) and not only in its interest, but not all property owners were convinced.

The property owners did not feel that E.ON or the proposed energy solutions of the consultant were in their best interest, despite several workshops and a report on the subject [e.g., interviews PO C(1), PO G(1), PO H(1), and PO I(2)]. Some of the property owners also had an idea to establish an energy community in Sege Park. In connection with Knowit's presentation of its investigation results concerning the potential for a microgrid, a general discussion of establishing an energy community arose. It was discussed that energy communities were important at the EU level as part of the Clean Energy Package (CEP). When a microgrid was seen as an energy community also other values rather than just the economic ones needed to be considered. One of the property developers meant that an investment in a microgrid, or any other cooperatively owned energy system, should not be motivated by financial reasons alone but be based on other values. This property developer meant that a decision should be related to the possibility of controlling the system in the future, including controlling electricity consumption, distribution, and production. There were, however, also critical voices raised among the property developers to both establishing a microgrid and an energy community. One property developer said, for example: "I can pay for an improved environment, but I do not want to pay for anything that does not have any environmental value. I do not think the environmental benefits of an energy community are big enough." (Observation, January 30, 2020). The meeting ended with mixed feelings. When asked at the next meeting, it seemed as if they would drop the idea with a microgrid due to the existing regulations in Sweden.

Figure 4 summarizes the main arguments by the DSO and the property owners.

The User Arena: The Property Owners and Developers

In the user arena, the electricity grid was mainly discussed in relation to ICT or smart technologies that allow the real-time monitoring and management of energy flows. Households are not yet the imagined energy co-managers expected to engage with

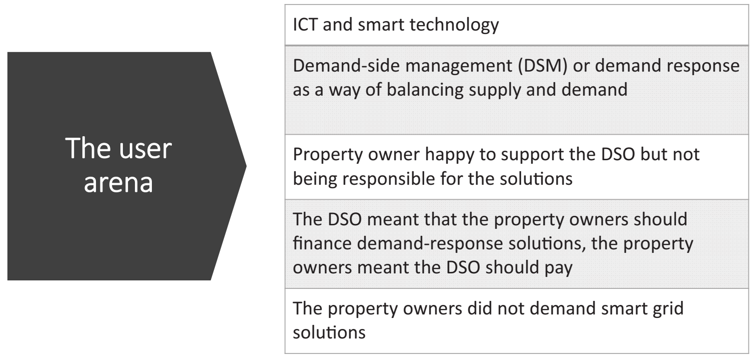

FIGURE 5 | A summary of the main findings in the user arena.

these technologies (Smale et al., 2017), but there is a home energy management system in which both the system and installers function as intermediaries between the grid and households (Smale et al., 2019). While households have been studied in earlier research, property owners as an important smart technology user group have attracted less attention.

As discussed earlier, establishing an energy community was discussed in the Sege Park project. The Malmö Effect project took another approach and examined the effects of and conditions for power optimization through smart control and optimized production, distribution, and consumption of both electricity and heating. Part of the project was to initiate collaborative dialogues, particularly with property owners and developers, about various solutions and opportunities to address future challenges in the grid.

The property owners were participating in this project because of an explicit desire to help balance demand and supply in the electricity system. Demand-side management (DSM) or demand response as a way of balancing supply and demand was a key issue. DSM is intended to shift electricity demand to better match generation, and consumer flexibility is an important part of doing this (Powells et al., 2014). By applying demand response, this flexibility can be used to shift the load to address certain objectives (Albadi and El-Saadany, 2008). The property owners and E.ON had a common interest in finding solutions in which office buildings, residential buildings, and commercial premises collaborated to support and balance the grid. One respondent explained his interest in the project as follows:

"If we have energy demand right now and someone else has a surplus, then we can discuss how to deal with that, and we can apply a system perspective. Usually, we control this individually, but, here, we can be part of something bigger" [Interview PO D(1)].

The property owners had problems seeing why they needed to have any deeper engagement in the issue, as they had many other issues they felt were more pressing. They were happy to support E.ON, but not to take the lead in the issue. The property owners did not see why they should engage in E.ON's core business and "E.ON's problem of lack of capacity." A common question from them was: What is in it for us? (Observation, September 13, 2018). In Sweden, there are few financial incentives for customers to be more flexible in their energy consumption (Palm et al., 2018), and Sweden, notably, has low and flat electricity prices. Making consumers more active requires a market in which the consumers have incentives and are given opportunities to be flexible (Ellabban and Abu-Rub, 2016). This was not the case in Malmö, and the property owners had little to gain from investment in, for example, ICT. At one workshop, the property owners stated that investments in smart grid technology must be made by E.ON (Observations, September 13, 2018). One property developer said, "The model should be that E.ON assumes the cost, and that it will be a large-scale control system surveilling the buildings" (Observations, September 13, 2018). From the perspective of the property owners, E.ON should pay because it is E.ON that has something to gain from controlling energy system of a building.

Another general observation was that the property owners did not demand any smart grid technologies. When E.ON raised the issue, the property owners responded, but they did not express any great interest in adopting systems to manage their electricity consumption (the same has also been noted outside Sweden; see, e.g., Luthra et al., 2014).

Figure 5 summarizes the main findings in the user arena.

DISCUSSION

The lack of grid capacity has no quick fix, and addressing it requires collaboration among various actors (Verbong et al., 2013). Issues concerning problem definition, legitimacy, and responsibility could become barriers to further development of the grid and to potential solutions (Wolsink, 2020). Therefore, it is also important to identify different views and perceptions among a variety of actors in different contexts and not only focus on the professional actors. This has been the main ambition of this study.

A key arena for the electricity grid is the regulatory arena, where it is important to create incentives for cost-effective and innovative solutions benefiting society (Agrell et al., 2013; Crispim et al., 2014). The existing regulation incentivizes investments in the existing infrastructure, such as lines and transformers. There is, however, a lack of incentives in ICT facilitating user flexibility. In the regulative arena, no actor is responsible for supporting demand side and user flexibility.

Earlier research has highlighted that existing market actors are slow in adopting, e.g., ICT solutions (Güngör et al., 2011; Good et al., 2017), which increases the need for regulations that incentives such investments. Many issues related to the users, such as demand-side flexibility and investments in ICT in buildings, are not addressed in the regulative arena, and it remains unclear who should promote such solutions. As a result, suitable ICT investments have not been made, and it is unclear who can be held responsible. In Malmö, no actor was promoting ICT solutions, and ICT was seldom an issue raised. When no actor is assigned to deal with the demand side, there is no obvious agency to complain to regarding, for example, lack of investments in ICT. A responsibility gap occurs which needs to be dealt with in future regulations.

In Sege Park, the property owners wanted to develop a microgrid organized as an energy community in line with the ideas in the EU directive (EU, 2018). Energy community is, by the EU, seen as beneficial in many ways, as they increase local energy production, bolster energy supply security, and reduce transmission losses. Decentralized ownership has also been put forward as an enabler of the transition toward a more renewable energy system (Haney and Pollitt, 2013; Johnstone et al., 2020). The DSO in Malmö and the involved consultants did not consider ownership a central issue. For them, it was instead a non-issue; it was taken for granted that Sege Park should have a centralized system owned by the DSO. This is a reasonable standpoint, considering how Sweden seems to implement the EU directive. The Ei has suggested to the Swedish government that energy communities should not be allowed to own electricity grids (Energimarknadsinspektionen, 2020). The Ei emphasized in their recommendation to the government the development of the national grid, where all parts interact to optimize benefits of the entire system. Ei also mean that the many regulations connected to a grid makes it complicated to own and maintain. This violates the idea in the CEP that an energy community should be easy to run and not be surrounded by an administrative burden. An energy community can still share electricity between its member. Sharing of electricity can take place through e.g., blockchain technology or Virtual power plants (Energimarknadsinspektionen, 2020). How Sweden will implement the CEP is, however, still to be seen. In this process, it is, however, important that values other than just economic and technical are considered and where solutions are developed where energy communities profit from own produced electricity. When energy communities are not allowed to own a grid this will mean that sharing of electricity will take place on the market and grid fees and energy taxes must be paid. Therefore, it is important to find innovative solutions where profit can stay in the local community. This is partly lacking in the Ei's report to the government. The electricity grid has for long been dominated by a few professional actors, and this has led to convergence of perspective, narrowing options, and a few influential actors. Creative solutions and innovations are benefited from the participation of many actors and interests (see, e.g., Palm and Thoresson, 2014; Lazoroska and Palm, 2019), and the inclusion of many perspectives is something that could be improved in relation to the electricity grid.

CONCLUSION AND POLICY IMPLICATIONS

Traditionally, the electricity grid has been treated as a purely technical system, whereas issues concerning public participation, responsibility, and what considerations are included in and excluded from the agenda have been less researched. Few have studied how different key actors perceive their own roles and roles of others in sustaining a well-functioning grid. This has been the focus of this study, and a challenge has been to capture the perspectives of a variety of societal actors. The chosen approach has been to analyze how the lack of grid capacity has been framed in terms of the responsible actors, problems, and solutions in the regulative, media, technocratic, and user arenas. **Figure 6** summarizes the results.

The regulative arena consists of laws and regulations, many of which concern the electricity grid because it is a monopoly and lacks competition in electricity transmission and distribution. The network operators are subject to strict regulations to promote efficiency and quality of supply and to ensure fair customer prices. Central actors in the regulative arena are the DSOs and TSO. The existing regulatory model encourages investments in capital-intensive facilities (e.g., transformers and lines) and discussed problems and solutions related to this rather than demand-side solutions and user flexibility.

The media arena was here represented by the media debate in Skåne in autumn 2018 and spring 2019. The problem described was that the expansion of electricity transmission from central to southern Sweden had been delayed, this being aggravated by the expansion of the railway and various industries. The focus of the problem was gradually shifted to the electrification of the transportation sector, and the responsible actors were mainly seen as the politicians and the TSO. The solutions were to invest more in the transmission lines and to utilize user flexibility to comply with the needs of the grid.

The technocratic arena was studied in relation to two projects in Malmö. The long-term solution to the lack of grid capacity was to invest in lines and transformer stations. In the short term, the solution was to use the available energy and infrastructure more efficiently, which, according to the DSO, imposed demands on individual users. Addressing the lack of grid capacity was a shared responsibility, and users needed to contribute with different solutions benefiting the grid. The grid was, however, discussed technically, and it was difficult for non-professionals to rate the advantages and disadvantages of different solutions. The property developers in Sege park did, however, expressed an interest in having a microgrid, which they could own together as an energy community, but this turned out to be incompatible with existing regulations.

In the user arena, represented by the property owners and developers of two projects in Malmö, the electricity grid was mainly up for discussion with ICT or smart technologies and demand-response management. However, it was not discussed how such investments support not only the grid but also energy

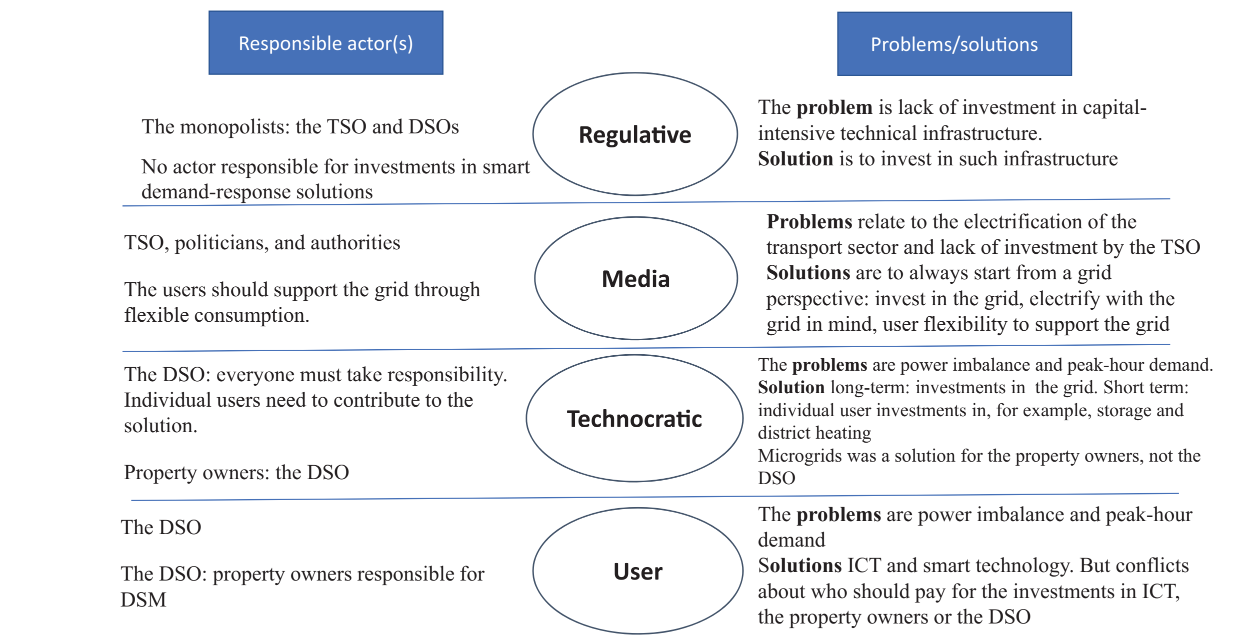

FIGURE 6 | Problem and solutions as discussed in different arenas.

use in the buildings. When these ICT investments were described as investments supporting the smart functions of the grid, the property owners meant that the DSO should pay for them. The property developers did not demand any smart grid technologies themselves but were prepared to assist E.ON by giving them access to their energy systems of the buildings.

Policy Implications and Future Research

The main policy recommendations from this study are the following:

1. It is important to start incentivizing investments in ICT, facilitating user flexibility.
2. In the regulations, it is important to make one or several actors responsible and accountable for supporting demand-side and user flexibility.
3. Include more values and interest beside economy and technology when developing the future grid.

The electricity grid has been developed within a technocratic frame, with a few professionals dominating the agenda. This has led to convergence of perspectives and narrowing options. It is important to open up processes to include a multitude of actors, interests, and perspectives.

When the EU's Clean Energy Package is to be transposed into national regulations, it is important to consider other values and interests aside from economy and technology. The idea with energy community is to acknowledge other values such as trust, self-control, engagement, and democratization.

The limitations of this work are that it includes a limited number of actors and a limited time period. As an explorative study, it contributes with insights into how different actors perceive problems, solutions, and responsible actor(s) for the lack of grid capacity. The framework developed here can, however, be amended and advanced in future research. It would be interesting to also broaden the focus to encompass more actors and geographical areas and deepen the examination of the framing of the issue.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because the interviewed persons have been promised to be kept anonymous. Transcripted interviews might reveal their identity. Requests to access the datasets should be directed to JP, jenny.palm@iiiee.lu.se.

AUTHOR CONTRIBUTIONS

JP is the single author. JP conducted the research, literature review, data compilation, writing, and tables.

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