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Gridlocked: Sociomaterial configurations of sustainable energy transitions in Swedish solar energy communities

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ABSTRACT

Local generation of renewable energy in energy communities has long been around, but has recently experienced an upswing. This upswing is partly due to the EU Clean Energy Package (CEP), where energy communities are introduced juridically as formal actors. Within this policy package, various values are attributed to local energy communities, particularly emphasising broadened citizen participation. Also in academic contexts, energy communities are assigned an important role for a just energy transition. Considering this increasing importance and policy prevalence, it is relevant to explore what types of energy communities exist and are emerging in light of the CEP, and which values these correspond with. We do so by exploring how Swedish solar energy communities are configured and what values they foreground, through the analytical lens of problematizations. Exploring how different configurations entail particular problematizations elucidates how certain values are constructed as relevant, possibly to the detriment of other possible values, thus deepening our understanding of solar energy communities' potential contribution to a just energy transition. We discern a pattern in that particular values related to energy system optimisation are foregrounded, rather than other values such as democratisation, indicating the existence of a broader hegemony that shapes configurations of Swedish solar energy communities.

1. Introduction

Local generation of renewable energy has long been described as a central component of more sustainable futures, both in policy contexts and within academic scholarship. Energy communities have been argued to constitute an instrument for such purposes. In its most basic sense, an energy community is a gathering of individuals and/or organisations who form a cooperative endeavour to produce, manage, and/or share energy or other energy related services [1]. Although not in any way a novel phenomenon, energy communities have nevertheless gained renewed traction in energy transition debates in the EU.

Along with a heightened interest in policy circles, a diverse research literature around energy communities has emerged, where the social, economic, and environmental values of such configurations have been discussed. Proposed values have included increased production of renewable electricity, democratisation of energy systems, and decreasing and counteracting energy poverty [2–4]. In particular, the potential contribution of energy communities to shift the ownership of energy resources and empower citizens has been highlighted [5–7]. The European Regional Committee [8,9] submits that energy communities "[…] can offer leverage for involving individuals in the energy transition," echoing findings showing that such cooperatives "[…] can contribute to the decentralisation, opening up, and democratisation of energy systems." Indeed, the idea that energy communities can bring about democratisation of energy systems can be understood in the broader context of seeing community initiatives in general as essential for a just transition [10].

Agreed on in 2019, the EU Clean Energy Package (CEP) has sought to turn these sentiments into formal policymaking. Comprising eight new laws, of which the Renewable Energy Directive (EU) 2018/2001 (REDII) and the Common Rules for the Internal Market for Electricity Directive (EU) 2019/944 (IEM) are of particular relevance [11], the CEP has introduced energy communities as a new formal actor in the European energy system, proposing it as an instrument for citizens, consumers, and/or producers to take active part in the energy transition. It is here that two new types of community actors have been launched, together with a legislative framework: "renewable energy communities" (RECs) and "citizen energy communities" (CECs). Currently, these directives are

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being transposed into member states' national regulations [9].

Both the REDII and the IEM emphasise a variety of values that energy communities are imagined to be able to promote. In the preamble to the REDII [[11], p. L328/91], it is stated that "[t]he move towards decentralised energy production has many benefits, including the utilisation of local energy sources, increased local security of energy supply, shorter transport distances and reduced energy transmission losses. Such decentralisation also fosters community development and cohesion by providing income sources and creating jobs locally." Other oft-mentioned values include mitigating energy poverty, increasing citizen participation in the energy transition, increasing acceptance of renewable energy projects, and gaining access to private capital.

This underlines how significant expectations have been pinned on energy communities to contribute to a just and sustainable transition of the European energy system. Yet, the ability to express these values in practice depends on how energy communities are configured [12]. Here, the CEP plays an important role: even though the establishment of REC and CEC do not exclude additional types of energy communities defined at national levels, they can be assumed to have a strong structuring effect on what types of communities are acknowledged and provided with institutional, informational, and economic support. Considering the increasing interest in energy communities as an instrument for sustainable and just energy transitions, it is therefore pertinent to explore what types of energy communities exist and are emerging, and which values these have given expression to.

In this paper, we explore these questions by investigating four energy communities in Sweden – how these are organised and the value practices these forms of organisation afford. Our main theoretical point of departure is a sociomaterial approach, focusing on the interplay between problematisations and configurations, and how this interplay foregrounds certain values at the expense of others. The lens of problematisations entails conceptualising problems as actively produced rather than already existing "out there," shifting analytical focus towards how a particular problem is constructed and the assumptions underpinning it. Configurations as a lens highlights the mutual structuring of ideas and materialities (such as technologies), emphasising the conjoining of diverse sociomaterial elements into certain arrangements [13]. For us, problematisations and configurations conceptually underline how energy community initiatives are not pre-given but actively made through the intertwinement of diverse sociomaterial elements – in the process foregrounding and enacting particular values at the expense of others [13,14]. Drawing upon research demonstrating how values emerge as technologies are being developed, emphasising that value is always embedded in specific social contexts and defined differently by different stakeholders, we follow Barett et al. [[15], p. 706–707] in conceptualising "[…] value as performed through different sociomaterial configurations of […] strategies, platforms, and stakeholder engagement in specific times and places." Our aim is to understand which values have been foregrounded in existing and emerging energy communities in Sweden, and how these correspond (or not) to the values proposed in the CEP.

Although we restrict our focus to Swedish solar energy communities, we believe it is particularly suitable as a context for several reasons. Even if considerable energy efficiency and demand reduction measures were put in place, the political goal of making the Swedish energy system 100 % renewable until 2040 demands substantial expansion of the production of renewable electricity. Wind power expansion is often ascribed the largest potential for such purposes but has been increasingly the subject of intense conflicts – often related to an uneven distribution of costs and benefits, where local communities typically pay a high price in terms of exploited local environments and receive little to none of the economic benefits. Solar energy communities could conceivably play a significant role as an alternative, not the least in initiatives emphasising local development. In light of Sweden's highly centralised and large-scale energy system, solar energy communities could also play a significant role for democratisation, affording new modes of participation and thereby contributing to a just transition [16]. Lastly, it is not obvious that Sweden is institutionally conducive to the upscaling of energy communities [17], making it relevant from an extreme case selection rationale, as the future of energy communities in Sweden will be particularly sensitive to the kind of support that is put into policy [18,19].

2. Background

In this section, we provide an overview of the values attributed to energy communities both in contemporary energy policy – using the REDII in particular as an example – and in the research literature. It serves as an important background to our analysis since we are concerned therein with the kinds of values that have been foregrounded in our selected cases of Swedish solar energy communities, and with whether these values correspond to the visions of desirable energy future that energy communities have been expected to contribute towards realising. Because while sustainability transitions intermingle with broader, collective imaginaries of desirable futures [20], such imaginaries have also been observed to be bound to institutionalised practices and actor coalitions within nation states [21]. Transposing regulations, in other words, is a matter of translation work, intimately intertwined with already existing, place-based institutionalised practices, sociotechnical infrastructures, stakeholders' interests, and so on [21–23]. A discrepancy in values could thus point towards the need for further research about the context-specific support required for solar energy communities to deliver on their potential to contribute to an inclusive and just transition.

2.1. Values attributed to energy communities in energy policy

Increased citizen involvement in energy transition is explicitly stated as a central objective of energy communities and consequently articulated as a core value in the REDII [11]. Based on a close reading of this directive, the values expressed therein can broadly be thematised as: local development, expansion of renewable energy, improving energy system operations, improved market function, equality and equal opportunities, and democracy. In rather instrumental terms, it is proposed that increased citizen participation through energy communities will unlock private capital, thereby contributing to local development through investments in renewable energy projects, as well as increased acceptance of renewable energy through such local investments. Another instrumental value focuses on energy system optimisation, with energy communities proposed to facilitate new consumption patterns (e.g., demand flexibility) and new technology (e.g., smart distribution grids). But the REDII also includes broader, social sustainability concerns about justice, power, and freedom. In fact, energy communities are described as affording citizens and consumers the possibility to directly participate in energy production, consumption, storage, and sharing – effectively increasing the freedom of choice for consumers. Contribution towards greater equality is also described as central value. It is for instance stated that energy communities can contribute to mitigating energy poverty through decreased energy use and lower grid tariffs, while simultaneously facilitating market participation for households with limited possibility to do so (i.e., vulnerable groups). Further, it is noted in the IEM that successful energy communities have in the past produced economic, social, and ecological benefits for society that expand beyond values narrowly related to the provision of energy services.

2.2. Values attributed to energy communities in the research literature

In the research literature as well as in policy contexts, energy communities have been ascribed the potential to solve a range of problems. An oft-highlighted value is the potential of energy communities to democratise energy systems by increasing citizen participation in

transformation processes and enabling shifts towards collective ownership over renewable energy sources [1,5–7,24–26]. Such values interrelate with energy democracy agendas, often encompassing radical change towards community-owned and decentralised renewable energy systems by interlinking social movement mobilisation with solar energy community projects, renewable cooperatives, and other political struggles to rupture current regimes and reconfigure energy systems [27]. Energy democracy as a concept exists at the intersections of activism and academia, with normative underpinnings, where values such as the ones just mentioned are foregrounded in relation to energy communities.

Importantly though, some scholars have cautioned against romanticising the notion of community as it risks reifying unjust power relations and unsustainable practices – within and beyond local contexts – in the name of local empowerment [28,29]. Johnson and Hall [30] suggest that energy community initiatives that consist only of short-term interventions, and thus lack critical long-term engagement, could reproduce existing inequalities; van Veelen [31] argues that "[t]o ensure that existing differences and power relations are not simply reproduced, it is […] important to consider community governance institutions and practices"; and similarly, Radtke and Ohlhorst [32] see the need for more research that critically explores whether energy communities actually contribute to energy democracy.

Notwithstanding these reservations, there is still a general agreement that community engagement in and ownership of renewable energy projects can increase local acceptance and thus decrease the resistance to such projects, particularly when there are clear benefits for the community, such as in community-owned projects where economic profits are reinvested locally. Substantial and meaningful community engagement can also reduce resistance and create positive spill-over effects, like increased environmental awareness [33]. A literature review by Berka and Creamer [[34], p. 3412] found that "[…] there is unequivocal evidence to suggest that increased local support for renewable energy is more likely to emerge from inclusively managed projects." Indeed, some energy community projects have been observed to generate "local benefits" by facilitating identification with a particular place [35]. Such a sense of belonging, enabled through place-based attachment attained in energy community projects, is theorized to facilitate active participation among community members [36]. Berka and Creamer [34] also found that while not all such projects aim at inclusive community-building processes, this is still a general feature that distinguishes community projects from purely commercial ones. Active community building appeared in contexts where state and market support was lacking, such as in relation to the provision of basic needs like heat and power. It did so in particular where leaders explicitly interlinked their projects with local protest movements for or against a unified cause, i.e., in ideologically driven projects [34].

On a more general level, energy community initiatives have thus been postulated to be able to generate both social and economic benefits, revitalising rural areas by creating jobs, business space, and increased community investments [37,38]. In one case, Lantz & Tegen [39] found that local ownership of wind power indeed had a positive effect on local jobs and economic development, both during the construction and operation of the plant. A recent study confirmed that economic benefits to the community and lease-holding landowners were considered by many citizens as central values of solar park projects [40]. Similarly, Wiersma and Devine-Wright [36] concluded that the most common motivation across variegated cases was to alleviate local poverty, cutting electricity and heating bills by way of subsidies and grants leveraged through channels established in energy community initiatives. There are also several studies suggesting that energy communities can contribute to grid benefits, including grid stability, local energy security, and reduced transmission losses through shortening transport distances [25].

However, with a growing understanding of the importance of local support when developing energy infrastructure, "[…] developers of all sorts have been quick to recognize the value to be gained by framing even the largest grid-connected projects as 'community based.'" [[41], p. 7568]. Apart from being morally questionable, such a "citizen washing" risks leading to backlashes with increased distrust in and resistance to energy projects of all sorts. If anything, this calls for careful analyses of the context-specific particularities of energy communities, and the way in which the material configurations contribute to discursively framing – and thereby articulating – their normative potential. Energy communities come in many different guises from small-scale, citizen-led, and locally anchored communities engaged in energy-related activities to virtual communities with the sole purpose of managing energy efficiently [42,43]. Hence, it is safe to say that the way an energy community is sociomaterially configured has consequences for the kind of values that are put into practice [33,44]. Still, much of the research literature addresses values in a general way, as a backdrop to why energy communities are relevant to study or support. While there are lots of studies on drivers, barriers, and prerequisites for energy communities to become successful [9,45,46], there are considerably fewer studies in which values, and the manner in which they are put into practice across different configurations, have been analysed empirically [see [47,48] for comprehensive overviews]. Despite a seemingly prevalent normative undercurrent related to energy communities in the research literature [49] as well as in policy contexts, there has been a surprising lack of empirical studies – especially longitudinal ones – investigating the actual practices through which different values attributed to energy communities come to expression.

3. Conceptual framework

Considering the wide range of expectations upon energy communities to contribute to sustainable and just energy transitions, it is relevant to scrutinise which problems energy community initiatives themselves have sought to address, and how they have been configured in practice to address these problems. Therefore, our conceptual framework is tailored to investigate problematisations and configurations across cases of energy community initiatives, focusing on the values that have been foregrounded as a result. For this analytical purpose, we take a sociomaterial point of departure, implying that we see the discursive and material aspects of energy systems as interwoven and mutually structuring. Further, we understand policymaking as a constructive process, actively shaping how problems and opportunities are made sense of and addressed [50]. Seeing policymaking as a constructive process means understanding problems not as existing "out there" but as actively constructed, i.e., how "[…] specific policy proposals 'imagine' 'problems' in particular ways that have real and meaningful effects." [[51], p. 111]. Thus, it is more appropriate to speak of "problematisations" [14]. Such a conceptualisation allows us to shift our analytical gaze from problems and how they are dealt with to problematisations and how these are actively constructed and represented [52].

To address the interplay between problematisations and configurations, we proceed from a framework inspired by institutional theory and the policy analysis approach "What's the problem represented to be?" (WPR) [53]. From institutional theory, we bring the understanding that organisations are constructed by formal and informal institutions, technologies, and actors – and that these are mutually structuring [54–57]. Formal institutions include laws, rules, and regulations. Informal institutions include logics, norms, and praxes. Technologies include hardware, software, infrastructure, and other materials that are essential to the organisation, and actors include people and their resources and ways of interacting. As a framework, WPR [53] provides support in analysing how problematisations are made, asking what the problem is represented to be, and what assumptions can be seen to underlie the representations.

Our conceptual framework addresses the aforementioned lack in the literature on energy communities, where scholars have called for closer scrutiny of the values that are enacted in practice through particular,

sociomaterial arrangements. Based on poststructuralist theory, science and technology studies (STS), and organisation studies, we mobilise the concepts of problematisations and configurations to take seriously the mutually shaping effects of discursive and material elements, and to explore how particular values are enacted through the sociomaterial practices of energy communities. Other strands of literature have highlighted how grassroots initiatives – like energy communities – often encounter resistance from actors with vested interests in dominant sociotechnical regimes, such as incumbent energy utilities [58,59]. While important, our analytical approach attempts to go beyond such explanations. Rather, we are interested in the values that are enacted by the particular, sociomaterial arrangements in energy community initiatives [60,61]. This requires mobilising concepts that encompass discursive and material elements. For us, problematisations capture how energy community actors themselves construct problems based on certain assumptions, thereby positioning their sociomaterial practices as solutions to these problems [14]. Configurations enshrine how the energy communities are materially set up, in tandem with such problematisations. This does not entail claims of causal links, where discursive problematising results in material configurations. Rather, we attempt to trace how sociomaterial elements are arranged in mutually shaping processes, where material elements (configurations) may equally influence social elements (problematisations), e.g., as existing grid infrastructure influences the practices of energy community actors [12,62].

Against a backdrop of understanding value as a pluralistic social construct that takes place across different institutionalised practices of valuation [63], we recognize that energy communities are not fixed, stand-alone, or mediating platforms, but fluid enactments of strategic initiatives, technologies, and stakeholder interactions that entail different possibilities for action [64–66]. Although the concept of value practices remains quite slippery, it is useful in that it highlights how assessments of goods, services, and interactions are differentially reproduced in association with sociomaterial arrangements. Given this purpose, we align ourselves broadly with research in economic sociology and the anthropology of valuation that has focused on how value emerges from substantial interactions between people [67]. Our conceptual framework emphasises the intersubjective dimension of valuation, as processes that must be analysed in their site-specific contexts. Note that this is to oppose an understanding of the nature of values as something personal and preferential, as if residing in the human subject as a motivation for action. Rather, value results from an action of valuation, and this action is ultimately political in the sense that it involves "[…] relations, assumptions, and contests pertaining to power." [[67], p. 57]. When we refer to the value practices of energy communities, we mean the collective arbitrages between socially conditioned variables such as beliefs, desires, convictions, preferences, priorities, and ambitions, as well as the material techniques and technologies through which these variables become aggregated and gain discursive traction [60,61]. Such material enactment is constitutive of, and thus crucial to understanding, the valuations that are produced in practice.

3.1. Methods and material

By attending to the co-construction of problematisations and configurations, we examine which values are being enacted by various energy community initiatives. As mentioned, energy communities can be sociomaterially configured in different ways, foregrounding certain values at the expense of others. This is pressing given how energy communities are assigned a great deal of normative potential in both scholarly and policy communities. Comparing several initiatives thus enables us to further explore whether there are commonalities and differences between them.

Our analysis is based on an interpretative qualitative approach, combining several methods for data generation. Local solar energy communities were identified through: 1) targeted searches via search engines such as Google, in which we used Swedish equivalents of terms like "energy community," "energy cooperative," and "solar community"; 2) a review of research literature addressing local (solar) energy communities in Sweden, identified through Web of Science; 3) a short survey sent to all regional energy offices in Sweden; and 4) snowballing. The identified solar energy communities were analysed in-depth through a combination of interviews, observation, and participant observation in workshops, seminars, conferences, and similar events, as well as compiling publicly available information about the initiatives from websites and documents.

The interviews were semi-structured and lasted between thirty minutes to an hour. Due to the COVID-19 pandemic all interviews and observations took place via video conferencing systems such as Zoom and Microsoft Teams. To the extent that this has had any impact on our empirical material, we believe this to be mainly positive in terms of accessibility. Interviewees were first invited to a digital meet-and-greet, and later to one or more formal interviews. Interviews were recorded and transcribed. Our interviews as well as our fieldwork were informed by the empirical questions summarized in Fig. 1 below. The empirical material was subsequently coded and thematically analysed using the software Atlas.ti.

We view themes as reflecting a pattern of shared meaning, organised around a central organising concept. In this conceptualisation, themes capture the essence and spread of meaning, uniting data that might otherwise appear disparate, or meaning that occurs in multiple and varied contexts. Built from smaller meaning units (codes), themes serve to explain large portions of a dataset, sometimes with reference to patterns beneath the surface of the data, but sometimes also by describing and categorising what is explicit and concretely expressed. On a more practical level, texts and transcripts were inserted into the Atlas software to assist qualitative analysis, and the material was coded both inductively and by analytical question themes (Fig. 1), applying techniques inspired by qualitative content analysis, such as keyword searches, identification of repetitions, as well omissions and unexpected statements. The documents, field notes, and interview transcripts were analysed in parallel. This allowed for a reflexive approach, where our thematic analysis of written material served to inform and iteratively shape our interview guide, as well as letting our observations in the field and our interviews illuminate our interpretation and coding of documents and website information. The themes identified were then contrasted with expectations on energy communities figuring in energy policy and with previous research (Background section) to inform our conclusions.

As we gained insight into the Swedish energy community field and established contacts with various actors, we singled out four cases to base this study upon – one solar energy community in the town of Vimmerby in Småland county; one in the small, rural village of Näversjön in Jämtland county; one on the countryside of Östergarn on the island of Gotland; and one in the newly developed city district of Hammarby Sjöstad in the capital of Stockholm. As we shall see in the next section, the selection has intentionally been made to portray a diversity of existing configurations. It has also sought to reflect a variety of geographical areas, particularly in relation to how densely developed the territories are, with a case selection of solar energy communities located both in predominantly urban regions, intermediate regions, as well as predominantly rural regions.

4. Analysis

In this section, we present a selection of four solar energy communities in Sweden, with an emphasis on the sociomaterial configuration of each case and their associated value practices. Here we look across the presented cases to unpack the problematisations underpinning the configurations. It allows us to explore how different configurations are entangled with specific ways of framing the problem (which these energy communities are then made to address), as well as the assumptions animating them. Our analysis thereby seeks to disentangle how

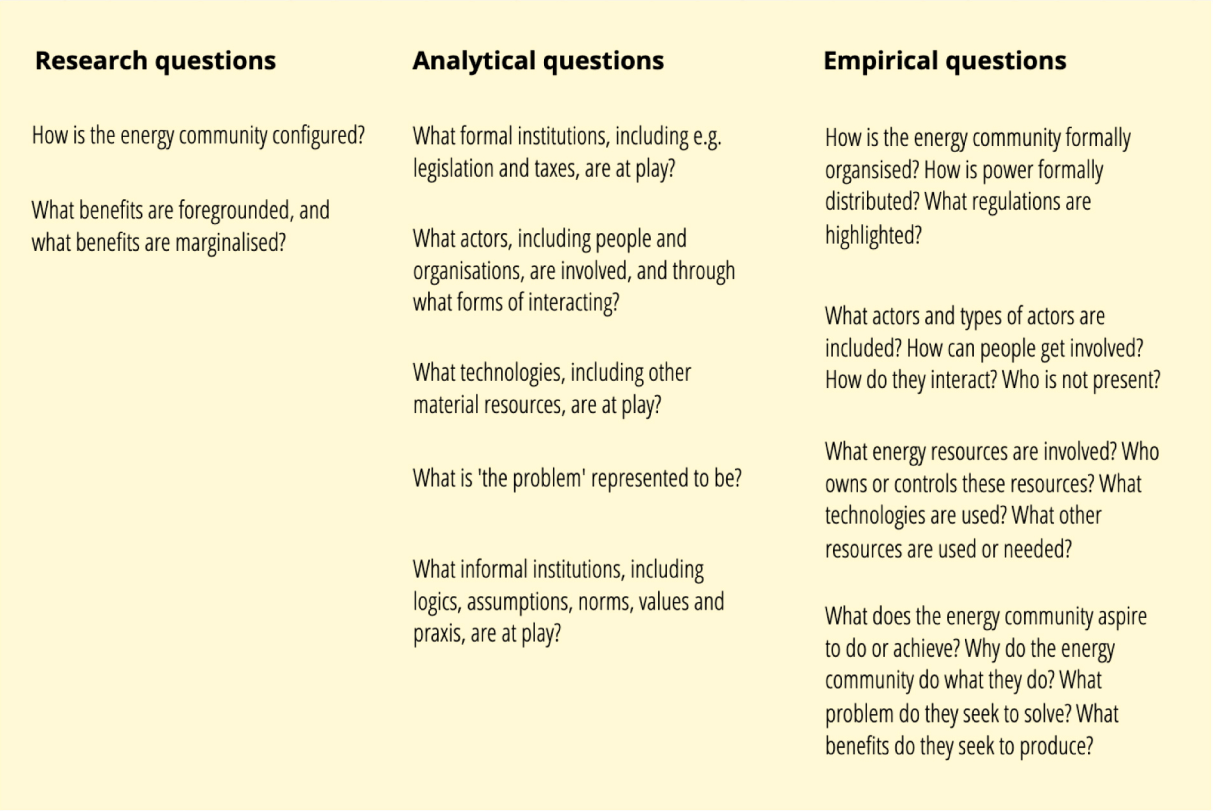

Fig. 1. Research questions and how they are translated into analytical and empirical questions, respectively.

particular values attributed to solar energy communities are made to "make sense" within different sociomaterial configurations, through their construction as solutions to particular problems. Rather than presenting a case-by-case comparison, we single out some overarching themes to illuminate how these problematisations and the sociomaterial configurations presented above are entangled, exemplifying how different values are foregrounded in practice [14].

4.1. Optimising the grid or seizing the means of electricity production?

Central to how solar energy communities have been discursively framed in the Swedish context is a strong, recurrent emphasis on benefits related to grid optimisation and expansion of renewable power production. However, comparing two superficially similar configurations – Solenergi i Vimmerby (eng. "Solar energy in Vimmerby") and Solel i Näversjön (eng. "Solar electricity in Näversjön") – reveals both a set of corresponding values as well as some important differences in terms of problematisation.

Solenergi i Vimmerby is an economic association started in 2017.[1] The association provides share owned solar power, and both natural and juridical persons are welcome as members. According to their statutes, the aim of the association is to "[…] promote the members' interest in producing electricity in an environmentally friendly way through promoting solar in Sweden in a long-term manner, and by selling solar energy to enable the expansion of more solar facilities, as well as to enable members to receive returns in the form of dividends." The association currently owns one solar park called "Vennebjörke," mounted on the rooftop of a large sheep shed. Total capacity amounts to 94.4 kW, with an annual production of around 80 MWh [68]. The solar park is connected to the local grid through a cable built and paid for by the local energy company. Ownership of the park is split into 319 shares, each of which has been acquired for the cost of approximately 500 EUR [69]. Daily business is managed by a board, currently consisting of five people, and which is elected at an annual general meeting (AGM) by present members of the association. As for all economic associations, at the AGM each member has one vote, no matter how many shares the person owns.

Solenergi i Vimmerby represents a sociomaterial configuration that is quite common in a Swedish context: share owned solar power, formally organised as an economic association, and with development and management of the facility carried out by a board and by professionals. It is easy to understand why this configuration has become popular: for most people, being a member simply requires paying for one share and occasionally taking part in general meetings. Technical skills or knowledge is not required, nor is knowledge about incentive systems or juridical systems. This low level of engagement however means that there are limited possibilities for empowerment through gaining new skills and experiences. The entry cost of 5000 SEK also makes the solar energy community unavailable for low-income households.

Like Solenergi i Vimmerby, the economic association Solel i Näversjön operates with a share owned model, but here members buy shares in accordance with their estimated electricity use. Founded in 2013 with the aim of constructing and managing a solar park, it currently has a total of 96 shares, and each share provides roughly 1000 kWh per year. Construction of the solar park was handled by members of the association. According to the statutes, the main aim of the association is to promote members' economic interests through several measures, including the production of sustainable electricity, long-term promotion of solar electricity production in Sweden, and enabling

[1] Economic association is a particular organisational form in Swedish law. These are mandated to promote their members' economic interests, which is not the same as generating economic profit. Economic associations differ from stock-companies in this regard. Whereas stock-companies are mandated by law to generate profit for investors, economic associations are mandated to promote members' interests in a broader sense (often including local social benefits as well as ecological benefits).

revenue for members either through self-consumption of electricity or financial revenue by selling electricity in the market. Another aim is to ensure further construction of solar power generation in Sweden through the sales of electricity. This measure is predicated upon a contractual arrangement with an electricity trading company.

There are three main actors in the sociomaterial configuration in Näversjön: the Solel i Näversjön economic association, the regional utility (DSO) Jämtkraft, and the electricity trading company ETC El. Interviewees described how the solar energy cooperative and ETC struck a contractual agreement, whereby the cooperative sells electricity very cheaply to ETC El and then buys it back for the same price. This arrangement effectively entails rounding complicated electricity market regulations, allowing members of the cooperative to produce, share, and use the generated electricity locally. The arrangement is enabled by the DSO from whom the cooperative leases a local transmission cable connecting the solar park to a local substation, meaning that the cooperative is obliged to pay grid fees. Related to participation afforded by this configuration, it is stated in the statutes that members participate as suppliers and users of the services provided by the economic association and by informing non-members about solar electricity. Anyone can apply to become a member as long as they are deemed able by the board to follow the statutes and contribute to the association's goals. Membership is predicated on owning at least one share.[2] In practice, participation has been very limited after construction was completed in 2015, consisting mainly of adjusting the PV frames and some maintenance, otherwise simply "reaping the benefits."

While both the Solenergi i Vimmerby and the Solel i Näversjön initiatives are offsprings of study circles, in Näversjön the study circle was arranged in collaboration with an organisation tied to the labour movement. The "why" of the latter solar energy community is intertwined with this origin, as the main driver is to own, or seize, the means of electricity production. This also connects to the arrangement with the electricity trading company ETC El. ETC started as a leftist newspaper in the 1970s but has expanded into different branches, including solar electricity production and solar electricity sales.

The problem in Näversjön is thus foremost represented as one of sedimented capitalist power relations in a centralised, large-scale electricity system, whereby the proposed solution entails citizens "taking matters into their own hands" by DIY-constructing small-scale solar energy cooperatives to seize the means of electricity production. The problem is represented as one of centralised ownership of energy resources, with the proposed solution of altering such power relations through shifting ownership of said resources. Underlying this representation of the problem are assumptions sprung from the intellectual history of the labour movement as well as the rural context – local development is assumed to have to be carried out by citizens, taking matters into their own hands, whereas energy system power struggles are analogous to power relations between classes. Comparing Vimmerby and Näversjön – two fairly similar configurations – elucidates how configurations are entangled with particular problematisations, and through such problematisations, the associated values can come to be interpreted and expressed in different ways: the "why" of the Vimmerby solar energy community entails expanding renewable electricity production, whereas in Näversjön there is an explicit ambition to shift power relations by reconfigured ownership relations.

The problematisation formed in Näversjön, then, possibly entails an antagonistic edge that is not present in Vimmerby, where the central "why" pertains to expanding renewable electricity production within contemporary energy system infrastructure. Although it could be argued that both initiatives are firmly rooted within the same structures – organizationally, technically, actor-wise – the problematisation and underlying assumptions differ. The Näversjön configuration comes across as rather marginalised however, in that it is peripherally located and not well-known across the Swedish energy landscape. It could be argued further that the actor constellation and afforded participation for citizens is not necessarily set up to challenge power relations in the energy system; there is possibly a mismatch between challenging big capital and the actual configuration, which is dependent upon the DSO and does not necessarily create openings for challenging such power relations through broadened participation. Conversely, one could claim that Näversjön is an attempt at influencing slow, long-term infrastructural change processes, and thus the solution is apt in relation to the aim: seizing the means of electricity production.

4.2. Between business interests and bottom-up ambitions

Another key aspect to how solar energy communities have been framed in the Swedish context is to present them as bottom-up citizens initiatives. Again, however, comparing two cases with the same emphasis on the importance of grassroot participating – Austerland Energi (Eng.: Austerland Energy) and Hammarby Sjöstad – reveals significant discursive discrepancies in how the associated values are construed.

Austerland Energi is an energy community under development, located in the countryside on the island of Gotland in the Baltic Sea. The currently envisioned configuration consists of several components. Electricity will be produced by floating solar panels placed on an irrigation pond by a local sewage plant and a farm, as well as an additional ground mounted solar PV installation. The ambition is to connect around 200 households scattered across the countryside with the production units, a battery storage, an EV carpool with charging stations, the farm, software for 'smart' steering of energy resources, eventually a hydrogen storage and production component acting as an interface for electricity production and storage, a local sewage treatment plant, and the regional power grid. Initially, it was discussed whether this would be best achieved through a local DC grid or via the existing low-voltage grid, but over time the coalition has gravitated towards establishing a virtual energy community, likely aided by technology companies.

The primary actors involved are Nygarn Utveckling AB (a local development company) and Skags Gård AB (a local farm). Several other actors are also tied to the coalition, including an energy consultancy firm specialised on solar power called Solisten; Energenious AG, a Berlin-based software developer working with optimisation-modelling of decentralised energy systems; Foyen, a law firm specialised on electricity market regulations; Ferroamp, a technology company developing smart energy solutions; and Energicentrum Gotland, a pilot-character regional energy office on the island. The project group, i.e., the persons primarily responsible for the initiative, consists of people tied to the local community on eastern Gotland.

While the formal organisational setup is unclear, it appears as though some form of share owned model will be used, allowing for different modes of participation. Based on observations and interviews, forms of participation discussed include increasing the PV capacity of the energy community by household installations, switching to EV and contributing to the EV carpool, and possibly engagement in the daily operations, maintenance, and development of the energy community. It could also conceivably entail simply owning a share and allowing the potential local system operator (LSO) or the DSO to manage indoor heating or water boilers for aggregation to balance the grid. LSO is yet to be formalized as a type of actor in the energy system but could potentially constitute an interface as an energy system operator in local low-voltage settings in some capacity. It is therefore increasingly discussed in relation to energy communities and microgrid configurations [70]. However, the extent of the engagement is currently explored together with some household residents and will likely remain unclear until formal organisational setup is decided upon. As of now, there are openings to suggest that different forms of engagement could possibly be afforded by the configuration, perhaps allowing participants a degree of flexibility in terms of preferred involvement and financial investment.

[2] Personal correspondence with member of the association.

The rationale of the initiative entails several "whys." One is to enable low-carbon self-consumption of electricity among the households and the farm. But broader sustainability concerns also underpin the initiative, and in interviews, project material, and during observations, it has been recurrently described as a "local manifestation of the Paris climate agreement." Furthering local development and owing up to international environmental commitments are regularly expressed as "whys," as is decarbonizing transportation, both private cars and farming vehicles, and shifting to collective modes of transportation through carpooling. Such recurrent descriptions are enlightening of the problem representation. An interviewee working with the project group stated that the ecological footprint of Swedes is "neither just nor sustainable," and that Austerland is about "our relation to the rest of the ecosystem and other parts of the world; it is about justice." The interviewee also expressed hope that the initiative would impact broader transition debates. Another interviewee expected the initiative to open up conversations about broader unsustainable patterns of everyday life, such as how we travel, and instead contribute to carpooling increasingly becoming a norm. These examples highlight how broader sustainability concerns with energy use at their core animate the attempt at establishing a solar energy community on Gotland.

The twin ambitions of local development and empowerment are often emphasised as a necessary pair. In an interview with a member of the project group, it was explicitly stated that it was not primarily financial gain or economic incentives that had sparked interest from the start, but rather "what's best for the local community." Such ambitions are rooted in the local context, with the local development company Nygarn Utveckling AB initiating preceding community-oriented projects. An interviewed project member stated that "we cannot count on others for support, we must deal with this ourselves," and further explained that the closing of the local school had sparked intense engagement in local development in the area.

The involvement of the regional energy office Energicentrum Gotland also illuminates an underlying "why." Gotland has a weak connection to the mainland grid and thus a strained capacity situation on the island, preventing widespread expansion of renewable electricity production, which necessitates solutions to decrease dependence on the increasingly unstable regional grid. Simultaneously, Gotland has been designated a pilot region for energy transition, with the aim of achieving a 100 % renewable energy system and other environmental policy goals before the rest of Sweden. There are thus also ambitions for Austerland to manage energy loads by becoming an aggregator to the regional grid operator, contributing with balance to the island's regional grid. Energicentrum Gotland was established as a pilot-character regional entity to facilitate and drive processes conducive to these goals, making sure the transition is locally anchored and meaningful among the island's population. Energicentrum's engagement in Austerland makes sense from such a perspective: the sociomaterial configuration envisioned could potentially produce values related to empowerment and participation, locally embedding transition processes, as well as contributing with system services such as balancing the grid on the island during strained capacity situations and decreasing dependency on the mainland transmission grid.

In sum, the problem is represented by Austerland Energi as one of unsustainable and unjust political-economic relations – globally and regionally – mediated through sedimented power relations in the energy system, with the solution of shifting such relations in favour of citizens and local communities. The problematisation is underpinned by a pragmatic and experimental approach to sociomaterial change, of transforming power relations from within said system, potentially harbouring a radical potential.

In contrast to Austerland, Hammarby Sjöstad is a high-profile urban sustainable development project in Stockholm. Discontent among residents, including some influential figures, led to the formation of a local citizens initiative in 2012: Hammarby Sjöstad 2.0. Today, this initiative mainly consists of an economic association called ElectriCity, established in 2014 with the aim of improving upon the initial attempt at creating a sustainable urban district by making Hammarby Sjöstad climate-neutral by 2030. Researchers employed by the research institute RISE explained in an informal conversation how ElectriCity had managed over time to build up trust and relationships with individual housing and residents associations, as well as other organisations in the city district, generating engagement in energy issues among such organisations. A vast number of organisations are members in ElectriCity, stretching from the local non-profit association for housing and residents' associations, Sjöstadsföreningen, to large companies such as Skanska (construction) and Stockholm Exergi (heat and electricity production, owned by Fortum) as well as the City of Stockholm.

In 2021, a consortium including ElectriCity was granted funding by the Swedish Energy Agency for a large project to develop local energy communities in Hammarby Sjöstad and a new city district under construction in Örebro called Tamarinden. On several occasions, project members from ElectriCity have presented the initiative as a bottom-up energy community. The project is described as an energy community testbed, emphasising testing technologies and business models for how microgrids can be developed to produce, store, and share renewable electricity in Hammarby Sjöstad. Besides testing technologies, the project also includes a legal component to review rules and regulations relevant for energy communities and develop knowledge to change these in favour of maximising the potential of grassroots energy initiatives.

The planned technical setup includes rooftop solar electricity production, charging stations for EVs, battery storage, and a biogas-based generator for reserve power. With the DSO Ellevio as a partner in the project, the plan is to use the existing low-voltage grid, under the local substation, to share electricity between participating households and commercial properties. However, there are also plans to establish an LSO in partnership with the DSO to act as an aggregator to pool the energy resources, and through the establishment of a flexibility market alleviate a strained grid capacity situation in the Stockholm region. This is envisioned to require a smart management system, for which there are favourable preconditions since many of the tenant-owned housing associations have previously upgraded their systems for heating and electricity. The main energy resources, then, are the already existing low-voltage grid, a flexibility market to be developed, solar PV, EVs and EV charging, battery storage, and a generator for backup power.

The formal organisational setup is not entirely clear regarding the establishment of an LSO – how such an entity would look like, who its principal owner would be, and how this would relate to electricity market regulations. Legally, it would likely require either the DSO to be in control of it or a bilateral contract between the DSO and prospective LSO. How the energy community will be formally organised is also unclear – whether a new economic association will be established to operate the energy community or if a share owned model tied to the existing ElectriCity association will be used. Affordances to participate in the energy community for individual citizens and households mainly appear to be through existing avenues provided by the professionalised organisational setup. The clearest example is by virtue of being a member in tenant-owned housing associations, with a system of one vote per member during AGMs (where many issues besides energy are discussed). The planned sociomaterial configuration thus implies a distance between the management of the energy system and individual households. The onus on developing a flexibility market and smart management system further implies that a technical system for aggregating load in a more automated fashion is a preferred solution.

In a presentation about Hammarby Sjöstad, a project member from ElectriCity expanded on several overarching purposes with the initiative, which can elucidate the problematisation that the solar energy community configuration is entangled with. First, to construct a real estate "power reserve," benefitting the local and regional power grid in Stockholm in terms of available power and grid capacity. Second, to promote renewable electricity production instead of constructing

centralised power production such as combined heat and power plants. Third, creating a mutually profitable business model for a flexibility market. Finally, to contribute to energy transition as well as "helping the entire grid" and other city districts.

The broader context of high-profile sustainable urban development districts in Stockholm can further elucidate the "whys." An interviewee who was from the outset engaged in the application to the Energy Agency for the joint project between Hammarby Sjöstad and Tamarinden detailed strong institutional connections between ElectriCity's board and the research institute RISE, and how this connection sparked a "business interest" underlying the application. In line with this, RISE states that the goal of the project is to make Sweden an international leader for innovative energy services, while enabling energy transitions in new and already existing built environments. This ambition elucidates how the energy community project in Hammarby Sjöstad is aligned with broader ambitions in the wider Stockholm urban area, as part of a longer lineage of new city districts for innovation and technology development for sustainable urban development. In contemporary urban politics, such ambitions gather under the umbrella of Stockholm Green Innovation Districts, of which ElectriCity is a member. The problem in Hammarby Sjöstad is thus represented as an "innovation deficit," with the solution of using city districts as testbeds with the aim of stimulating innovation to develop new green technology that can contribute to national export ambitions and economic growth, while alleviating a strained regional grid capacity [71]. During observations this was regularly articulated as a primary rationale of the solar energy community project.

While both Austerland Energi and Hammarby Sjöstad are described as bottom-up energy communities, their respective problematisations elucidate how "bottom-up" in practice can look very different. Hammarby Sjöstad is geared towards the greentech export ambitions in Stockholm, whereas Austerland Energi is rather centred on local development. Affordances for participation are unclear in both cases, but through their problematisations and configurations some significant differences reveal themselves. In Hammarby Sjöstad, individual households primarily participate as tenant-owned housing associations, likely through Sjöstaden – one among a substantial body of members in ElectriCity, itself a large and professionalised organisation. In Austerland Energi, project members work directly with households and come across as genuinely interested in the households' perspectives and wishes, e.g., setting up a local reference group for household members and using these as entry points to further explore possible configurations. Further, in Hammarby Sjöstad the configuration largely seems to revolve around the idea of establishing a flexibility market based on aggregation of loads, utilising the existing grid and energy market, and such ambitions appear to be more important than citizens' engagement. Although both configurations are still under development, this nevertheless comes across as a considerable difference between the two.

4.3. Social sustainability beyond grid benefits

Looking across the four aforementioned configurations, there is a striking emphasis on the grid benefits – optimisation, increasing grid capacity through load shifting, and increasing renewable power supply – of energy communities. Hammarby Sjöstad is the clearest example, where the configuration has been arranged to produce benefits related to grid optimisation and developing profitable business models. This is closely entangled with how the problem is represented in this case, as the energy community project is aligned with a lineage of sustainable urban development projects in the form of "green innovation districts" to realise long-standing Swedish ecomodern dreams of green technology exports [72]. Such ecomodern ambitions permeate the envisioned configuration, as can be seen in the primary goals articulated for the initiative as well as the professionalised and complex network of organisations involved in ElectriCity. The main difference to previous green innovation districts is the substantial emphasis on citizen involvement in descriptions of the project as bottom-up. Seemingly, citizens are mainly afforded participation by virtue of being members of tenant-owned housing associations, represented by Sjöstadsföreningen as one of a considerable number of major players involved in ElectriCity, and thus citizens seem to be positioned at a distance from energy resources in practice. Proposed values related to democratising the energy system seems largely excluded by the problematisation and sociomaterial configuration in Hammarby Sjöstad. With the strong actor coalition involved, working within highly professionalised and institutionalised structures, it is reasonable to think that the initiative could work to normalise energy communities as an actor in the energy system. Further, it is easy for citizens to become involved – simply being a member of a tenant-owned housing association is enough. On the other hand, this constitutes a barrier: since there are primarily upper-middle-class citizens living in such apartments in the city district, access to participation is heavily conditioned by financial circumstances.

Austerland Energi and Solel i Näversjön stand out slightly as they do not exclusively foreground grid benefits as described above. While it is not yet clear which affordances for participation that the configuration in Austerland enables, the project members engage closely with households, exploring possible configurations together with them. Based on an explorative approach of making residents into co-producers in the configuration, it seems clear that Austerland Energi harbours potential for democratising the energy system. The approach is rooted in their problematisation, elucidated by the insistence on how empowerment by shifting ownership and operation of energy resources can instigate climate action – providing a local manifestation of the Paris climate agreement, as it were. The configuration might bring energy closer to citizens, and citizens closer to energy. This has the potential to correspond with values proposed in the CEP that stretches beyond optimising current grid infrastructure.

Clearly, Austerland Energi and Solel i Näversjön also correspond with benefits related to grid optimization – Austerland harbours the ambition to become an aggregator for the regional grid operator – and benefits related to expanding renewable power production. However, the environmental and empowerment ambitions in Austerland are more radical than in Hammarby Sjöstad and Solenergi i Vimmerby, as elucidated by their hopes of shifting cultural norms related to transportation and ownership (car sharing, energy sharing, etc.) through broader community engagement. With the configuration under development, it must be stressed that these values might not come to expression in practice. Still, compared with Hammarby Sjöstad, we can see how there is greater correspondence with values related to citizen empowerment, reducing inequalities, and deep socioecological transformations. In Hammarby Sjöstad, the problem is represented primarily as one of an "innovation deficit," gearing the configuration towards export potential. While citizen engagement is emphasised in material produced by this actor constellation, the envisioned configurations emerging with such problematisations appear less set up to address values related to democratising the energy system.

Even in cases with configurations more closely resembling cooperative form, values related to democratising the energy system does not seem central in practice. In the case of Solel i Näversjön, the problematisation revolves around shifting power relations from corporations to empowering local people, although the configuration does not necessarily afford much active participation. In certain respects, ownership of energy resources is shifted to members of the economic association who buy one or more shares, but the configuration is still dependent upon the contract with the regional grid owner, while grid optimisation and stabilisation of the grid is articulated as central values of the energy community. As an interviewee phrased it: "Once construction is finished, there is not much activity or participation related to the solar park other than reaping the benefits over time." There is thus a risk that ambitions of shifting power relations remain an ideal rather than a practice, without stronger affordances for democratisation of the energy system.

5. Conclusion

Through our analysis we can see that most problematisations produce configurations that correspond with proposed values of energy communities related to grid benefits, primarily grid stability and expansion of renewable electricity production. In our cases, we find considerably less correspondence with other values proposed in academic and policy contexts, most notably related to democratisation of energy systems and to energy poverty. Indeed, there is a risk that there are initiatives that flew under our radar, but our broad empirical search makes it unlikely that this would do more than alter this picture slightly. The prevailing focus on technoeconomic values is in line with previous research on Swedish energy politics, which show the dominance and inertia of industrial-modern ideals embodied in centralised, large-scale energy system structures [73,74].

While it might be unsurprising to find that the broader energy landscape is dominated by such technoeconomic value practices, it is still noteworthy that this hegemony has managed to migrate also into solar energy communities with a strong bottom-up citizen empowerment framing – particularly considering the varied values afforded to energy communities in REDII, related to citizen empowerment and just transitions. The recurrent emphasis on values related to the operations of the current grid infrastructure, even in cases such as Austerland Energi, where primarily other values more commonly associated with energy communities (such as empowerment and climate justice) are emphasised, indicates how energy community actors frame the problem in line with this hegemony. This dominance of grid benefits, seemingly at the cost of democratisation and energy poverty, indicates an entrenched discourse.

Consequently, our analysis goes beyond explanations centering on dominant regime resistance owing to vested interests. Despite the manifold values ascribed to energy communities in scholarly literature and contemporary policy, we see a tendency among those who are themselves engaged in doing energy communities (including initiatives pre-dating CEP as well as initiatives launched after CEP) to foreground grid benefits. Studying different actors in different places and settings across the country, our interpretation is nevertheless that Sweden appears to harbor a strongly formative, sociomaterial context that shapes both the imaginations and material set-ups among them.

The focus on grid benefits and increased production of renewable energy is very similar to the process through which smart grids has been conceptualised in Sweden. Smart grids initially promised consumer empowerment, prosumer proliferation, and decentralisation of energy systems among other values. But these arguments have increasingly turned into technoeconomic problematisations with system optimization as primary values, epitomised in a contemporary tendency to emphasise how aggregation of many households' energy resources through service companies can benefit the energy system infrastructure [74]. It resonates with some of our findings in this article: even explicitly grassroots-oriented solar energy communities appear to be largely professionalised, intertwined with intricate company structures, and often run by various expert organisations who take care of practical matters for citizens.

This point is further underlined by the fact that several of the configurations explored – and in particular those receiving most attention nationally – seem not to fulfil the requirements by REDII to be classified as a Renewable Energy Community. In the case of Hammarby Sjöstad, with so many large corporate actors involved in ElectriCity, it is unlikely that the envisioned configuration could be considered a REC, since the REDII definition of a REC restricts membership to physical persons, SMEs, and authorities.

In conclusion, we can distinguish significant differences between the various problematisations and configurations, and only Austerland Energi and Solel i Näversjön appear to potentially correspond with proposed values related to democratisation of the energy system, if we define democratisation in terms of broadening affordances for citizen participation in the energy system along with ownership and control of energy resources [1,10]. The peculiar pattern of foregrounding grid benefits at the expense of values related to democratisation across cases underlines the importance of closely attending to concrete initiatives and governance institutions [31,32,35]. Further, it prompts additional analysis of a broader hegemony whose contours we have only begun to vaguely discern. Such explorations can shed further light on the potentials and pitfalls of solar energy communities to contribute to a just, sustainable energy transformation in a “green frontrunner country.”

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Data availability

Data will be made available on request.

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