Who participates in and drives collective action initiatives for a low carbon energy transition?

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Broad acceptance by and support from the society for the sustainable energy transition is indispensable. Public participation and ownership - in particular through collective action initiatives - is seen as a means to foster this support. Starting with the origin of the cooperative model, we present how it has been evolving until today. While single examples are underlining their importance for the sustainable energy transition, our statistical analysis with data from Sweden, Denmark, and Germany, questions whether they are as inclusive, just, and democratically controlled by their members as often deemed. We find that energy cooperatives are typically initiated by well-off, rural, and male sexagenarians. The participation of women and men (including in decision-making) is below parity. Concluding, in practice, the mechanism of recruiting and engaging members falls behind the theoretic ideal of socially sustainable development. Although being a promising tool to curbing sustainability, current practices rather encompass a narrow perspective of sustainable development that is geared towards technological change.

Keywords: energy transition, collective actions, energy cooperatives, public ownership, sustainability

Collective action initiatives - Joining forces to solve local problems

Definition. A cooperative is a common form of a collective action initiative (CAI). It unites people voluntarily to fulfill economic, social, and cultural needs its members have in common. This is done by a jointly-owned and democratically-controlled organization (ICA, 2018). "In general, a cooperative comprises a voluntary network of individuals who own or control a business that distributes benefits on the basis of use or ownership where ownership is largely weighted equally across individual members" (Altman, 2009). In defining cooperative organizations, three essential criteria are distinguished based on the explanation of who is a member. First is "the user-owner principle". Individuals who own and finance the cooperative are its users. Second is "the user-control principle," which means that those who shape the decision-making process are users. Third, "the user-benefits principle" implies that cooperative users are gaining from being part of the organization (Barton, 1989). A normative definition of cooperatives suggests that they should be "founded on the values of self-help, self-responsibility, democracy, equality, equity and solidarity" (Gibson et. al, 2005, 2).

The origin of the cooperative model in Europe

Throughout human history, people worked together to adapt and change their societies. There is no agreement between scientists when the phenomenon of cooperativeness developed (Nilsson, 1996). The anthropology perspective suggests that this form of organization is already present in primary organizations. For example, Margaret Mead (1935) observed among the Arapesh people

the sharing of garden plots. Examples of cooperation and collective resource management can be found in fieldwork done by Bronisław Malinowski (1922) and Alfred Radcliffe-Brown (1952).

Many studies suggest that the phenomenon of cooperatives developed during the Industrial Revolution in nineteenth-century Europe, especially in Britain, France, and Spain (Altman, 2009; Gibson et al., 2005). This form of economic organization has spread in western countries due to tensions arising from industrialization processes (Forno, 2013). They are structures created to protect the interests of social classes with limited access to the means of production or power.

The Rochdale Society of Equitable Pioneers, established in 1844 in the North of England, is regarded as the prototype of modern cooperatives (Altman, 2009; Fairbairn, 1994; Mayo, 2017). Its formal principles are known as the Seven Rochdale Principles. Founded by 28 workers of a cotton factory, this initiative was intended to improve their material situation by joining groups of consumers to buy food products at better prices. The created store was not only intended to facilitate access to products, but also to create a system of dependencies based on mutual respect, commitment, and openness. The primary mechanism was to allow customers to decide what the sales profits were to be used for, and the clients were also shareholders (Fairbairn, 1994).

The Rochdale Society's success initiated the implementation of the model in other sectors of the economy. In 1863 nearly 400 cooperative associations were operating in Britain (Seth & Randal, 1999). The universality of the model resulted in the fact that in 1895, the 1st Cooperative Congress took place. The event was already of international significance. There were delegates from Argentina, Australia, Belgium, England, Denmark, France, Germany, Holland, India, Italy, Switzerland, Serbia, and the USA. A result of the congress was the establishment of the first international organization, the International Cooperative Alliance (ICA).

The cooperative model inspired a variety of forms across Europe, which spread to different sectors and were also applied in different social orders. We refer to them in general as "collective action initiatives (CAI)". Applications range from Kibbutzim as a cooperative form of farming in Israel, consumer cooperatives and non-voluntary agro-cooperatives in socialist countries to cooperatives who are fighting for minority group rights. A basic division of cooperatives can be made along the scope of activity in different markets: (1) marketing/producer, (2) consumer/retail, (3) worker/employment, (4) housing, (5) services, and (6) finance (Gibson et al., 2005). However, pivotal to classifying cooperatives is the participants' motivation.

The spreading of the cooperative model to the energy sector

With the electrification at the turn of the 19th to the 20th century, the cooperative model also expanded towards the energy sector. A compelling case of an electricity cooperative from 1920 is the Samerberg Cooperative in rural Bavaria, which was initiated by a priest (see picture below). Its hydropower plant with 40 km of electricity grid, 70 motors, and 2500 lamps served about ten communities with more than 1000 inhabitants. The local newspaper "Rosenheimer Anzeiger" reports[1]: "The far-sighted of the Samerberg can look back with pride on what has been accomplished. The importance of community-benefits and the cooperative, mutual support is very apparent at the Samerberger plant. In no other way could the unified supply of the remote

[1] From www.e-werk-samerberg.de/historie/12-rueckblick-auf-75-jahre-eg-samerberg.html (24.11.2019).

villages and scattered individual farms of the local area have been carried out. Here, everyone had to stand for one and one for all."

Figure 1: *Electricity cooperative from 1920, started by a priest. Source: OVB-online, 2019.*

During the second half of the 20th century, awareness about environmental problems, resource limitations, energy security, and environmental pollution was growing, strongly fueled by the percussions of the oil crisis in the 1970s as well as the nuclear arms race during the cold war. Cooperatives were seen as a means to tackle these sustainable development problems and - last but not least - to make local voices heard and seen through providing testbeds for societal change. A prime example is the transitioning of Denmark away from fossil fuels to renewable energy, which was strongly driven by local wind energy cooperatives. In the 1980s, the first cooperatives started, snowballing to about 600 by 1990 and about 1000 cooperatives by the year 2000 (and declining afterward, see Wierling et al. 2018 for an exploration).

Figure 2: *Electric mobility for rural areas - the "Dörps Mobil". Source: doerpsmobil-sh.de.*

Today, examples of CAIs engaged in the sustainable energy transition can be found all over Europe, and the fields of activity and forms are investigated in the next section. A very recent example is the cooperative "E-Dörpsmobil" in rural Northern Germany. The name underlines the strong local ties, since Dörp is low-german for village (Dorf). The cooperative addresses two problems at the same time. The first concerns the lack of grid capacity for selling excess wind power, and the second is the improvement of rural mobility through shared electric cars. As of today, the model has been spreading in Schleswig-Holstein, involving 22 other communities under the motto "Dörps-mobil - we move the village. Northern lights drive e-green".

The cooperative "Qvinnovindar" is an example from Sweden, which approaches the sustainable energy transition in a particular holistic way. In 2007, rural activist Wanja Wallemyr started a woman's only collective to promote sustainable energy, and to shift the gender power balance in the energy sector by economically empowering women. The most significant barrier for them to get engaged is lack of access to financial resources, due to banks' inexperience and, thus, reluctance in providing entrepreneurial loans to females. The collective began with nine members

who pooled their funding together in order to afford a share in a local wind park. The collective has since grown to over 80 members. The cooperative spun off a second similar female energy-based cooperative, Q2, and has also attracted interest from other countries.

In research on CAIs, indeed, the opinion prevails that energy cooperatives are engaging in the energy transition not only to foster the deployment of renewables and the provision of sustainable energy services but also to promote just and inclusive participation as well as broader political ambition. In the next section, we elaborate on this in more detail. This review and analysis is followed by investigating empirical evidence on "Who participates and who drives the collective model to engage in the energy transition?". The focus countries for the statistical analysis are Sweden, Denmark, and Germany.

The cooperative approach to solving local problems

Fields of activities. The historical and recent examples of CAIs presented in the previous section indicate that various forms have been and are being tested to address local problems in a cooperative approach. Figure 3 illustrates the variety of responses to local circumstances found by creative citizens exploring the cooperative approach. In short, each period led to the evolution of its specific modes of organizing; and the same holds for different countries across Europe since societal characteristics, legislation (at national and/or regional level), and, last but not least, the local problems at stake are strongly influencing the preferred model for collective action.

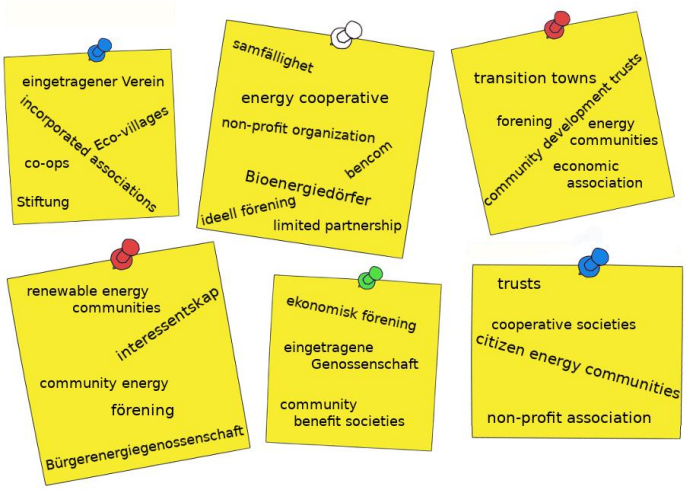

Figure 3: *Variety of collective action initiatives across Europe. Source: own figure.*

Independent of their adopted model, CAIs generally foster and strive for economic, environmental, social, political, and infrastructural goals. In the view of the energy sector these include aspirations to reduce home energy bills, generating income for the communities, reducing energy poverty, promoting local economic development, skills development, job creation, reducing carbon emissions, improving the local environment, health and wellbeing, supporting education, social cohesion, social inclusion, volunteerism, community empowerment, influencing energy policy, gaining community leadership, energy independence, and building refurbishment. Out of these goals, the top three found to be most significant in energy communities were reducing household energy bills, reducing emissions, and energy independence (Seyfang et al.,

2013). In summary, the different fields of activity of CAIs in the sustainable energy transition can be categorized as follows:

- Community owned generation assets[2]* The idea is to produce and sell energy to a supplier. The income from the operation is shared among the CAI members or reinvested in one or another way.
- Virtual sharing over the grid*. The CAI owns and manages assets, shares the profits and the energy produced among their members. This can be organized through a common supplier that is in charge of matching supply and demand.
- Sharing of local production through community grids*. Energy is physically shared, deploying a community grid. Micro-grids and district heating are typical examples.
- Distribution and operation of electricity. Electricity is collectively purchased at the market and redistributed to members or other customers. The idea is to realize economic savings or to guarantee the origin of electricity. Lately, activities are extending towards the broad-band services utilizing the same infrastructure.
- Light contracting. The provision of street lighting in the community is organized. A motivation is to use locally generated electricity. Often the switch to light contracting comes together with the retro-fritting of existing infrastructure (e.g., LED technology).
- Energy consulting. The idea is to provide information services to the local society on a variety of topics, ranging from the planning of renewable installations, training of operations, and energy efficiency measures to energy businesses models.
- Financial support to improve the energy efficiency of households. The idea is to enable funding schemes for low income households to improve energy efficiency. This appears to be a popular field of activity for Irish energy cooperatives.

The various forms. A number of frameworks (both from the legislative bodies and scientific literature) attempt to define CAIs for the energy transition. Some focus on their specific forms, such as energy cooperatives, adopting the general definition for cooperatives provided by the International Cooperative Alliance (ICA, 2018), or local energy communities, as in the Communication of the European Commission (COM, 2016). Others zoom in on community energy (Hicks & Ison, 2018; IRENA Coalition 2018). A more commonly used definition for collective renewable energy projects in general is proposed by Walker and Devine-Wright (2018). The definition proposes to use two dimensions, the process and the outcome dimension, as a way to classify collective action initiatives. The process dimension refers to the organizational structure of the initiative (i.e., Who decides and who is involved?); whereas the outcome dimension refers to the purpose of the initiative (i.e., What are the type of community benefits generated and for whom are they intended?).

Closely linked to the concept by Walker and Devine-Wright (2018) is the definition used in the European legislation (COM, 2018). In the Clean Energy Package of the European Union, the concept of local energy communities is defined in Article 2(6), being an "… association, a cooperative … or other legal entity which is effectively controlled by legal shareholders or members and is generally value rather than profit driven; although it performs its activities at the local level this may extend across borders …" Two forms are being differentiated, which are

[2] * The first three fields of activities are referred to by CEER (2019), which we take over here.

"Citizen Energy Communities (CEC)" and "Renewable Energy Communities (REC)". They differ in their spatial and technological focus. REC are stricter regarding locality as all members need to be "located in the close proximity of the renewable energy project" (COM, 2018). Additionally, while CEC are technology-neutral but limited to the electricity sector, REC foster the promotion of renewable energy technologies in the entire energy sector (CEER, 2019).

This distinction is accounting for alternative technology preferences across Europe. For example, while solar energy is currently the dominant technology for energy cooperatives in Germany, wind power is more popular in Denmark and The Netherlands (Oteman et al., 2014). Furthermore, it recognizes historical developments, since the local problems addressed by CAIs are changing alongside with the society and the prevailing energy paradigm. For example, Transition Towns in the United Kingdom do not advocate for specific technologies. Instead, they emphasize the need to transition away from fossil fuel sources (Seyfang & Haxeltine, 2012). Likewise, the energy transition in Germany was influenced by elements within the civil society that opposed nuclear power after the 2011 Fukushima disaster (Moss et al., 2015).

On a national level, the process dimension of Walker and Devine-Wright (2018) is most commonly represented by the chosen legal form. As of today, cooperatives are the most common legal form used in the European community energy sector (Huybrechts & Mertens, 2014; Yildiz et al., 2015) and are generally deemed to provide the best institutional framework for locally owned and participatory approaches to renewable energy projects. They encompass both the social and economic dimension in their scope and are characterized by a "one member – one vote" decision making process, thus providing high levels of co-determination (ILO, 2013; Viardot, 2013; Huybrechts & Mertens, 2014; Yildiz et al., 2015). Out of the 28 EU member states, plus Norway and Switzerland, 17 countries have national laws that strictly require the "one member – one vote" principle for cooperatives. Three countries (Sweden, Germany and Finland) additionally allow a proportional voting system, while Slovakian law only allows proportional votes based on membership shares. Luxembourg and Portugal generally adhere to the "one member – one vote" concept, however it is possible for some members to obtain several votes and Poland only requires it for cooperatives with solely natural persons as members. Lastly, six countries - Belgium, Bulgaria, Hungary, Ireland, Malta and the Netherlands - do not require specific governance structures for cooperatives (Cocolina, 2016; Karakas, 2019).

Depending on the national legal framework, other relevant legal forms are associations, (limited) partnerships, foundations, and trusts. In several countries, such as Denmark and Sweden, associations and cooperatives are combined into the same legal form (forening/förening). In other cases, these are separate legal entities, for instance the German "eingetragene Genossenschaft" (cooperative) and "eingetragener Verein" (association). In Denmark, partnerships are among the common legal forms for CAIs, especially in the wind energy sector (Wierling et al., 2018). A partnership (Interessentskap) in Denmark can be set up by a minimum of two legal or natural persons. Equal voting rights are allowed, but not required. CAIs in the form of trusts can be found in the United Kingdom, as so called "community development trusts" (Seyfang et al., 2013). This collective legal form commonly has similar structures as a limited shareholding company. However instead of share owners, it has members. The members generally have the right to vote, but it is possible to restrict the right to a specific group of members (Wilcox, 2019).

Legal forms can furthermore provide information on the purpose of the initiatives (i.e., the outcome dimension, see above), which is connected to a requirement on how the planned societal benefits of the initiative are being generated and distributed. Swedish law, for example, differentiates between "ekonomisk förening" (economic association) and "ideell förening" (non-profit association). Whereas the former is required to promote its members' financial interests, the latter does not allow for member profits. Instead, the initiative has to strive for non-monetary societal benefits (Bolagsverket, 2019a, 2019b). A similar classification can also be found in the United Kingdom, where "cooperative societies (co-ops)" and "community benefit societies (bencoms)" are distinguished. Coops are the ones who focus on the members' financial interests, while bencoms - as the name suggests - target community benefits (BIS, 2011).

Investigating the claim of inclusive, just, and democratic control

As shown above, CAIs in the energy transition can take various forms regarding technological focus, organizational structure, legal forms, and approaches to distribute the benefits generated to their members and the wider community. Yet, one main theme can be found in all of them - the key element of inclusive, just, and democratic control that members of the initiatives are possessing (e.g. Hicks & Ison, 2018; IRENA, 2018; ICA, 2018; Walker & Devine-Wright, 2018). For this reason, CAIs are often seen as a way to enable "energy democracy" (e.g Klagge & Meister, 2018, Stephens, 2019), a concept, which most commonly refers to the transformation of the currently centralized and monopolized energy markets into economically and socially just, inclusive markets (Burke & Stephens, 2017; Van Veelen & Van der Horst, 2018; Szulecki, 2018)

This vision is, however, recently being challenged by questioning whether CAIs in the energy transition are indeed as inclusive as deemed. Van Veelen criticises that the current literature on energy democracy and community energy "often assumes rather than demonstrates that the forms of governance it promotes are more democratic than the status quo" (Van Veelen, 2018, 1). A further issue relates to the aspect of how "community" is being defined in related community energy projects. Simcock (2014) argues that decision processes should include all who are affected by the decisions. Yet, CAIs largely only enable democratic control for their members and the wider community - still affected by the decisions taken - is left out. An example provided by Simcock (2014) is the decision on where to place new wind turbines.

The following section therefore investigates data from Sweden, Denmark, and Germany. The objective is to provide quantitative insights on who engages in and who takes decisions in the initiatives. We investigate membership structures of renewable energy CAIs in regards to income levels, age, gender distribution, location, and the composition of board members.

Collective action initiatives - Who participates and who decides?

A statistical snapshot from Sweden, Denmark, and Germany

Denmark. For the statistical analysis, we query the Danish Business Register (datacvr.virk.dk). We deploy a sub-sample of partnerships (Interessentskap) engaging in wind energy (vindmøllelaug, møllelaug). In order to separate collective actions from enterprises run by

individuals (prosumers), we select those where owners cannot be identified, as otherwise, it is a matter of private and not collective ownership. Excluding also initiatives with fewer than five members, the sample for Denmarks contains 46 entries. For all of them, places of residence of all members are obtained. Analyzing postal codes, we derive a locality measure. In the first step, the surface centroid is determined. Then the 90% quantile for the distances of the individual places of residence is calculated.

Figure 4, l.h.s., is an example of the statistical analysis undertaken for each of the 46 CAIs. Numbers equal the number of CAI members living in the same postal district. In the example shown, the CAI has 87 members altogether. The majority clusters around Northern Jutland. On the r.h.s. of Figure 4, the histogram for the full sample is shown. The majority of CAI members are located within a 50-km range.

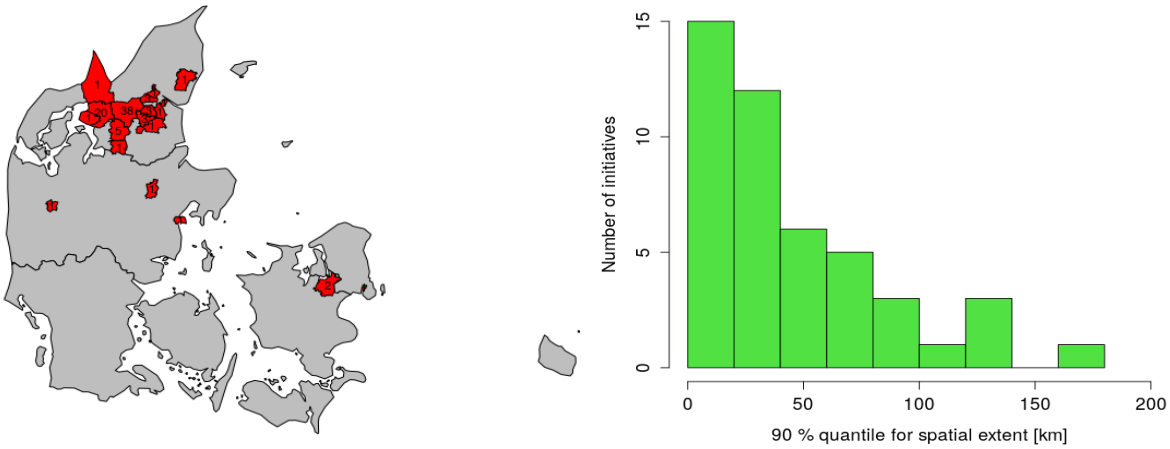

Figure 4: *The locality of collective wind partnerships in Denmark: Number of members in the same postal district (l.h.s.) for one exemplary CAI. Distribution of CAIs with members located within a specific range (r.h.s.). Own figure, for sources of data, refer to the text.*

Sweden. In the statistical analysis, we consider incorporated associations (ekonomisk förening), non-profit associations (samfällighet), and non-profit organizations (ideell förening). Swedish data are sourced from allabolag.se and vindstat.com; the former is an information service provider for Swedish companies and the latter a website providing wind statistics. Additionally, self-reporting of the initiatives on websites was used, and yearly reports were analyzed to collect information on membership data. The Swedish inventory comprises 182 entries.

77 of the cooperatives are active in the area of wind energy, 27 in electricity distribution and trade, 17 in hydropower, 10 in solar energy technology, 8 in biogas, 8 in energy consulting, and 35 are eco-villages. As of 2016, collective energy projects owned about 2% of the total 6468 MW installed capacity of wind power in Sweden (96 out of 3342 installations).

We focus the following analysis on the subset of Swedish wind cooperatives, obliged to report data on members and board (65 data entries for incorporated associations). They typically have several hundreds of members, but there are few with several thousand members, and some have just a few tens. The numbers did not significantly change over the years, which is also linked to the business model of the energy cooperatives in Sweden. The purchase of a wind turbine is financed by the sale of shares (typically of 1000 kWh/year). Members of cooperatives purchase several shares, which is primarily driven by their own electricity consumption. Once the total

costs for a wind turbine are realized, shares are no longer for sale. Our results are in agreement with those reported in Magnusson & Palm 2019.

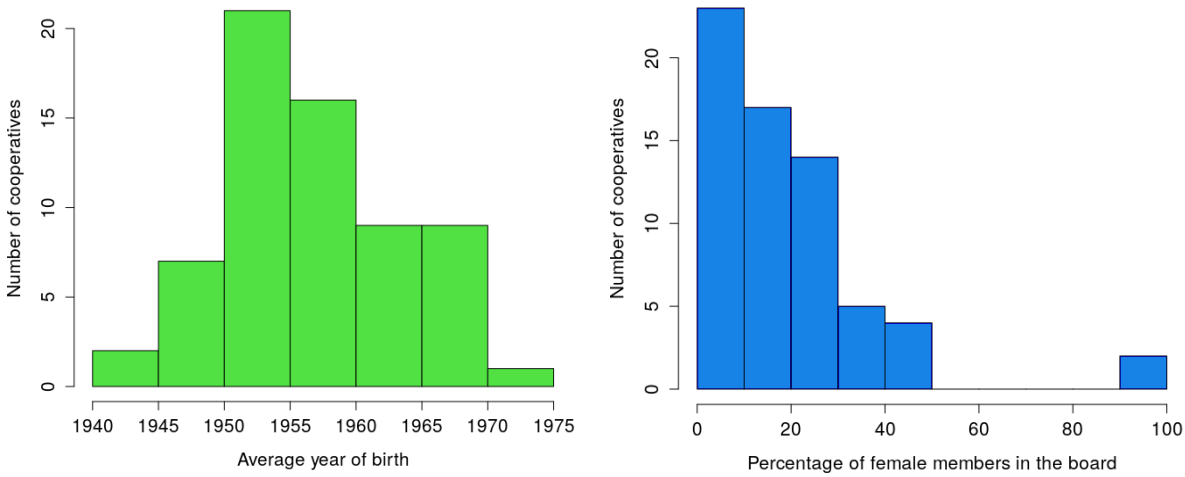

Figure 5: *Member demography and participation in decision-making in energy cooperatives from Sweden. Own figure, for sources of data, refer to the text.*

In Figure 5, we take a closer look into the demographics of wind cooperative members. As the left-hand side of the figure shows, the average age of all members is around [illegible]2 years (2019). This suggests that citizens engaged in cooperatives are comparably well off, and this can be confirmed when mapping the location of the cooperatives to the average income distribution in the respective communities (see also the case of Germany, where we show the data in Fig. 6). A similar analysis reveals that most of the cooperatives are located in rural areas. The right-hand side of Fig. 5 shows that the participation of females in the board of cooperatives is clearly below parity. The exception comes from two women cooperatives (see also the description of the examples in the previous section). Finally, we also report statistics on the participation of members in yearly meetings, which have been collected from reports of cooperatives published online (18 cases). On average, less than 15% of the members participated in the yearly meetings.

Germany. For the German sample, data are sourced from the German Business Register (www.unternehmensregister.de). We consider cooperatives active in photovoltaic installations and map their legal addresses with socio-economic data on the NUTS-3-level (Eurostat). Altogether, 407 different cooperatives with 3322 different PV installations between 1993 and 2019 were compiled. The total installed capacity is about 540 MWp.

Figure 6 shows the location of the collaborative energy projects (red dots pin their addresses at the right-hand side) vis-a-vis with the income distribution (middle) and population density (right-hand side). The cooperatives are active in rural, high-income areas.

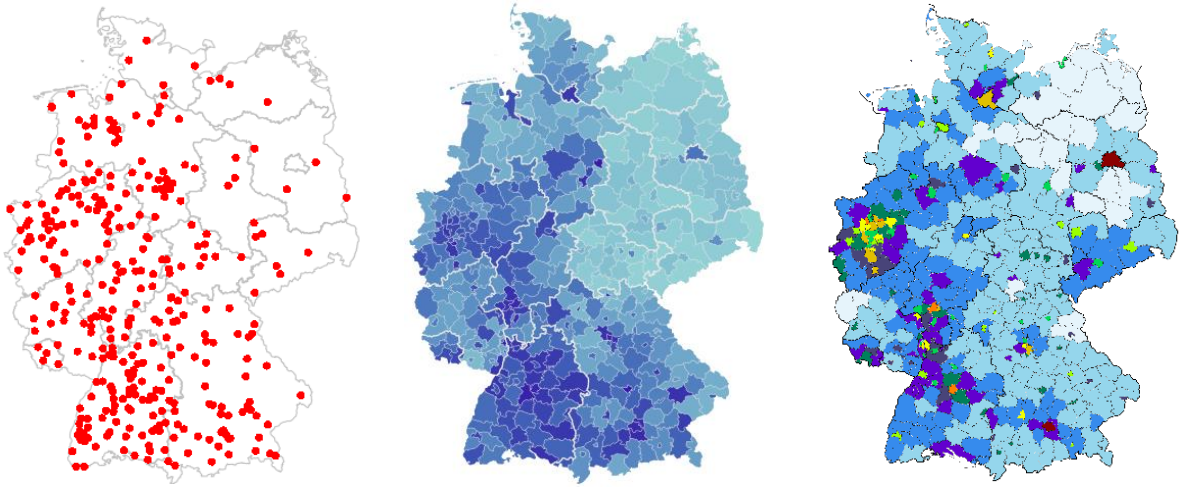

Figure 6: *Collaborative PV projects in Germany (addresses - l.h.s.) vs. gross wages in Germany (middle, light blue: low income, dark blue: high income) and population density (r.h.s.: heat map with growing density). Own figures, for sources of data, refer to the text.*

Discussion of research findings

Who participates in cooperative energy projects?

From the examples, review, and statistical analysis, we find that dedicated individual and grassroots activists focusing on unmet needs are prominent initiators of energy cooperatives. These typically surround a desire to have a stronger voice in the energy system and to promote sustainable energy technologies (c.f. fields of activities presented in the Section above). The most important enabling factors are the change of perception towards sustainability and identity creation around the CAI. This gives a cooperative sense of purpose among the members and a growing member base with increased visibility. However, insights from the statistical analysis indicate that members of CAIs are not representative of society. From the Swedish sample of energy cooperatives, we infer that the typical member is male, with an average age above 60. All our country samples hint towards rural areas as being the core regions of activity. The Danish sample further confirms that initiatives are mostly local (falling into the 50 km range). Mapping of the German sample with income distributions at the NUTS-3 level, we furthermore find that the location of cooperatives coincides with high-income regions. Summarizing, participants in cooperative energy projects seem to be well-off, rural, and male sexagenarians. Our findings of limitations of inclusiveness to the membership of CAIs are in line with a recent study commissioned by the European Parliament's Policy Department for Citizens' Rights and Constitutional Affairs. The study stresses that gender inequalities are "preventing women from the involvement in the energy transition and career advancement in this area" (EU study 2019). Similarly, are the case study results presented in Fraune (2015), Rommel (2018), and Łapniewska (2019), who observe a general under-representation of women in CAIs active in the energy sector. We can add that the same seems to hold for younger generations and, in tendency, for groups less well endowed.

Our finding has consequences for the innovative potential of CAIs, which may not be tapped to the fullest extent possible. The reason is that the most significant innovations of CAIs are laying

in the collective decision-making processes and education of local community members, both of which benefit when being representative of the community and which support the social dimension of sustainable development. In particular, technological innovation serves as an enabler but is not sufficient on its own to build a successful movement and gain traction. In this light, a successful sustainable energy transition is more dependent on social innovation - and inclusive participation.

Who drives decisions?

The statistical analysis of the Swedish sample revealed that only a sub-group actively engages since not more than 15% on average are participating of the members are participating in the yearly meetings (AGM). This coincides with findings from interviews conducted in Van Veelen (2018, 651), who notes that "... members are often content to leave staff and directors of the community organization 'to just get on with it' (CG2, general member). Groups' reports of low attendance figures at their AGMs and their difficulty in attracting new Directors appear to confirm this assertion that many members have no desire for greater involvement." Furthermore, analyzing the composition of the boards of the Swedish energy cooperatives, we find that the participation of female members is below parity.

It serves our point to quote Van Veelen (2018, 652) again: "The frequent involvement of a small number of people in community projects can also raise concerns regarding these leaders' representativeness of the wider community, not least because community leaders often were similar in age, gender and/or socio-economic background." We conclude that our quantitative results point once more to weak addressing the social dimension of sustainable development.

Limitations of the statistical analysis

The dataset compiled is not complete, since reporting duties vary across countries. The measure of locality is a work in progress, as boundary effects are not yet controlled. Hence, quantitative results should be used with care and not without context. Data only indicate trends.

Summary and outlook

We find that collective action initiatives (CAI) are an essential tool and testbed to solve local problems and to curb the sustainable energy transition in Europe. Moreover, the number of initiatives as well as their members are growing, and the fields of activities are broad. However, energy cooperatives are typically initiated by well-off, rural men of age 60+, and it is only a core group of members that drives decisions. Moreover, the participation of women and men (including decision-making) is below parity. Altogether, participation in collective energy projects is not inclusive when compared to the cross-section of society. Concluding, in practice, the mechanism of recruiting and engaging CAI members falls behind the theoretic ideal of socially sustainable development. Although being a promising tool to curbing sustainability and reaching an impact beyond their members and locality of the initiative, current practices rather encompass a narrow perspective of sustainable development that is primarily geared towards technological change, such as the switch from fossil to renewable sources.

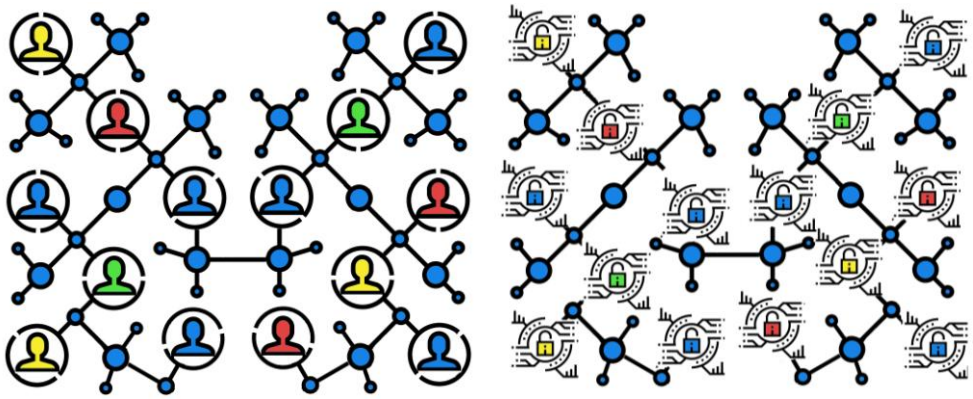

Figure 7: *Collective action vs. distributed ledger. Both share basic features - people are interacting with each other, in the latter case through, e.g., blockchain technology. Own figure.*

While case studies may provide deeper insights into selected cases, a statistical analysis offers the possibility to identify generic features. With the availability of new and comprehensive data on CAIs, it is worthwhile to investigate their role in the sustainable energy transition beyond case studies to provide aggregated evidence. In particular, the following questions arise: (1) How far-reaching is the impact of CAIs beyond the members involved (e.g., by informing and experimenting, gaining new members, and influencing policy agendas)? (2) Will the cooperative model become more wide-spread (e.g., to urban areas), and is the aggregate contribution to the energy transition comparable to those of other players in the energy market? A starting point is the statistical evidence compiled by Wierling et al. 2018, which is one of the first attempts in that direction. In favor of a spreading speaks that the cooperative model is flexible and well suited to solve current problems. Here, it is interesting to point to the similarities between cooperative networks and distributed ledgers (e.g., blockchain technology; refer also to Fig. 7). The latter translates the concept of the 19th century into the 21st century. Through peer-to-peer contracts and trading, distributed ledgers enable activity without hierarchies and intermediaries. All participants collaborate on equal ground in the jointly operated network. Finally, it is interesting to explore whether the often-heard claim that local collective actions are more democratic than transnational can be supported by statistical evidence or not (e.g., Kunze and Becker 2014).

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