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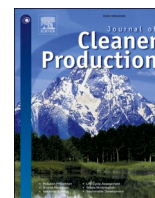
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Community energy initiatives as drivers for degrowth? An empirical investigation of their alignment with five imperatives of degrowth

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ABSTRACT

In view of the emerging social, environmental and economic crises, the degrowth movement questions the current growth paradigm. The fundamental criticism put forth by degrowth is that unlimited growth cannot be sustained within the planetary boundaries.

Citizen-owned and democratically controlled Community Energy Initiatives (CEI) engage since many years in the sustainable energy transition. This paper investigates to what extent they align with the degrowth movement. Drawing from an inventory of over 10000 European Community Energy Initiatives, we go beyond the few case studies and theoretical think-pieces. We test potential alignment by empirically investigating indicators for the following degrowth imperatives: (1) Reduce environmental impact, (2) Re-orient economic priorities, (3) Reduce inequality (4) Foster democratic decision making, and (5) Re-localize production and consumption. The results suggest a strong alignment with the environmental impact reduction, democratic decision making, and re-localized production and consumption imperatives, while the alignment with the economic re-orientation and inequality reduction imperatives varies considerably across countries and types of initiatives.

1. Introduction

Humanity faces serious climate change impacts and biodiversity loss (IPBES, 2019; Lee et al., 2023). The earth's planetary boundaries approach, developed by Steffen et al. (2015), signalled that 6 out of 9 boundaries have been crossed in 2023 (Stockholm Resilience Centre, 2023). Along Kate Raworth's (2017) donut theory, this situation, generally referred to as overshoot, requires us to review our production and consumption patterns. At the same time, the donut theory suggests the need to define a social floor: society must be able to meet its basic needs, without generating inequalities. A paradigm shift is generally put forward by advocates of degrowth, which mainly involves challenging the predominant economic growth model (Kallis and March 2015; Latouche, 2009; Schmelzer et al., 2022).

Initially degrowth built upon the criticism of the ecological destructiveness of sustained economic growth. This criticism was strongly influenced by the works of Daly (1972, 1991) on Steady-State-Economics, Georgescu-Roegen (1977) on Bio-economy,

and Meadows et al. (1974) on Limits to Growth. These authors argued that continued growth of the physical, quantitative throughput of the economy cannot be sustained in earth's closed system. Following the argument that economic growth cannot be fully decoupled from material and energy consumption, the core idea of degrowth is that an ecologically sustainable society is irreconcilable with continued economic growth (Hickel and Kallis, 2020; Parrique, 2019; Polewsky et al., 2024; Schneider et al., 2010; Vadén et al., 2020).

Over time, the degrowth concept has moved beyond its original environmental perspective, also criticising the growth paradigm as a driver for sustainability issues such as rising inequality and decline in democratic governance (Ariès, 2005; Asara et al., 2015; Cosme et al., 2017; Demaria et al., 2013; Latouche, 2009; Schneider et al., 2010). At the same time degrowth acknowledges that past economic contractions have often led to negative societal consequences such as increasing unemployment and inequality (c.f. Hickel, 2020). To avoid such negative consequences, degrowth argues for a fundamental value shift away from materialism and consumerism towards a society that associates

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quality of life with non-material well-being related to, for instance, leisure, creativity, conviviality, and cooperation (Associazione per la Descrescita, n.d.; Demaria et al., 2013; Kallis, 2018; Latouche, 2009; Research & Degrowth, 2010; Schneider et al., 2010). This value shift, so it is argued, cannot be enforced top-down, instead requiring a voluntary bottom-up process. As such, social enterprises, non-profit organisations and collective action initiatives are seen as ideal examples of degrowth in practice, as they are generally democratic, voluntary, open, and transparent structures through which average people are able to involve themselves in social and economic changes directly (Demaria et al., 2013; Petridis et al., 2015; Sekulova et al., 2013).

Community Energy Initiatives (CEI) - broadly defined as initiatives engaging in the energy transition and being democratically controlled and directly owned by citizens - are often claimed to provide a wide variety of benefits in alignment with the ideas of degrowth. Such benefits include increasing citizen participation in the energy sector, local value creation, community development, fighting energy poverty, and advancing renewable energy deployment and energy saving (Berka and Creamer, 2018; Bielig et al., 2022; Brummer, 2018; European Commission, n.d.; REScoop, n.d.). Coincidentally, CEI are often associated with increasing energy democracy (Stephens, 2019) and energy justice (Van Bommel and Höffken, 2021). These notions are also reflected in the two definitions of CEI by the European Union, stating that the 'primary purpose of which is to provide environmental, economic or social community benefits for its shareholders or members or for the local areas where it operates, rather than financial profits' (European Parliament, 2018, art. 2, 2019, art. 2).

However, even though the CEI movement has been growing significantly in the last decades, with more than 10000 initiatives existing in Europe today (Schwanitz et al., 2023b), they have mostly been investigated through case studies and systematic accounting of their impact is limited (c.f. Bielig et al., 2022). Studies that specifically address the alignment of CEI with the degrowth ideas are rare, finding conflicting results. Kunze and Becker (2015) find the highest degree of overlap between the CEI and degrowth concepts. They argue that CEI align with degrowth due to their focus on reducing energy consumption as well as ecological business models. However, the authors also point out that the investigated cases have been specifically chosen as they 'illustrate degrowth-related features particularly well' (Kunze and Becker, 2015, p. 428). Gibellato et al. (2022) investigate nine Italian CEI, coming to the conclusion that some forms of CEI adhere more closely to degrowth than others. Similarly, Rommel et al. (2018) provide a theoretical thinkpiece building on previous studies focussed on German CEI. They conclude that German initiatives are at a crossroads between a green growth path (i.e., focussing on technological advancement within the current growth paradigm) and a degrowth path (i.e., transitioning towards localised business models, energy sufficiency, and the provision of services as opposed to pursuing continued materialistic economic growth). Both Gibellato et al. (2022) and Rommel et al. (2018) point out the need to further investigate this topic, especially on the European level beyond individual countries.

This paper aims to address the lack of understanding of the alignment of CEI with the degrowth ideas on an aggregate level, beyond individual case studies of best-practice examples. The empirical investigation sources from a cross-country database recording more than 10000 of such initiatives in Germany, France, and other European countries (Wierling et al., 2023). However, while degrowth can be summarized as "a democratically planned reduction in production and consumption to restore a sustainable ecological footprint, reduce inequalities and improve quality of life" (OPCD, n.d.; Parrique, 2019), it remains a "concept in the making" (Petridis et al., 2015, p. 176) with diverse roots in various scientific disciplines and activist movements (Demaria et al., 2013; Eversberg and Schmelzer, 2018; Institute for degrowth studies, n.d.). As such, it proves difficult to empirically test the alignment of CEI with a singular unified conceptualization of degrowth. Instead, we opted for an approach to investigate the alignment of CEI with a set of

imperatives that are commonly associated with the degrowth idea. This allows for a more nuanced understanding of the synergies between CEI and the different interpretations of degrowth.

Section 2 reviews the degrowth literature with the goal to synthesize a set of five degrowth imperatives along which the following investigation of CEI and degrowth alignment will be conducted. Section 3 describes the data compilation process as well as the selection of the alignment indicators for each degrowth imperative. Section 4 presents the results of the empirical exploration of the alignment indicators. Section 5 discusses alignment of CEI with the degrowth imperatives, based on the results of the empirical exploration. Finally, Section 6 concludes the study.

2. Review of degrowth imperatives

Degrowth is not a singular concept, but an amalgamation of diverse scientific and activist ideas (Kallis, 2018; Petridis et al., 2015). The following review synthesizes the predominant perspectives on degrowth into five distinct imperatives. For this purpose, we conducted a search on Scopus for papers containing the term "Degrowth" in title, keywords or abstract. We then mapped all conceptual and review papers, that (I) discuss the meaning of the term degrowth and (II) had more than 50 citations, for their respective definitions of degrowth. In this process, two books, that were commonly cited in the reviewed papers, were also included. Furthermore, as degrowth has strong roots in activist movements (Demaria et al., 2013; Petridis et al., 2015), we also investigated definitional statements of degrowth movements that are a part of the International Degrowth Network (n.d.). Aligning topically similar statements resulted in five common degrowth imperatives (see Table A1): (I) Reduce environmental impact, (II) Re-orient economic priorities, (III) Reduce inequality, (IV) Foster democratic decision making, and (V) Re-localize production and consumption.

The first imperative, representing one of the two original core aspects of degrowth was found in every investigated definitional statement and relates to the goal of reducing humanity's environmental impact to a level that can be sustained within the planetary boundaries (Steffen et al., 2015). While degrowth recognizes the need to shift to more sustainable technologies such as renewable energy (Hickel, 2020; Kallis, 2018), it argues that an overall reduction in material and energy consumption is needed, beyond the simple substitution of one resource with another (Degrowth.info, n.d.; Degrowth Copenhagen, n.d.; OPCD, n.d.; Kallis, 2011; Latouche, 2009; Schneider et al., 2010).

The second original core imperative represents the goal of reorienting our socio-economic priorities from the economic growth paradigm to a value system focussed on non-material well-being. Degrowth argues that the aforementioned reduction in material and energy throughput is only possible through an economic contraction. For this process to find support within society, a fundamental value change needs to occur, from a society that values materialism and consumerism to one with a higher emphasis on non-material well-being related to, for instance, leisure, creativity, conviviality, and cooperation (Associazione per la Descrescita, n.d.; Degrowth Central Victoria, n.d.; Demaria et al., 2013; Degrowth.info, n.d.; Hickel, 2020; Kallis, 2018; Latouche, 2009; Research & Degrowth, 2010; Rede para o decrescimento, n.d.; Schneider et al., 2010). This process also includes the decommmodification of goods and services (Hickel, 2020; Kallis, 2018; Trainer, 2012), a shift towards informal markets based on voluntarism and neighbourhood help (Cosme et al., 2017; Demaria et al., 2013; Trainer, 2012) and a restructuring of the current financial system built on debt and excessive financial speculation (Trainer, 2012).

The increasing scarcity of resources that results from a shrinking of the economic throughput will accentuate existing wealth disparities (Trainer, 2012). Hence the third imperative argues that a degrowth transformation can only succeed if coupled with a more even distribution of wealth, both on a global level as well as within individual countries (Cosme et al., 2017; Degrowth Vienna, n.d.; Degrowth

Switzerland, n.d.; Demaria et al., 2013; Fournier, 2008; Jarvis, 2019; Latouche, 2009; OPCD, n.d.; Schneider et al., 2010).

Degrowth further emphasizes the voluntary nature of the envisioned transformation process, in contrast to involuntary economic contractions such as recessions (Hickel, 2020, Jarvis, 2019). As such, degrowth proponents commonly advocate for a strengthening of more participative forms of democracy, such as direct democracies (Degrowth.info, n.d.; Demaria et al., 2013; Kallis, 2018; OPCD, n.d.; Muraca, 2013; Schneider et al., 2010; Trainer, 2012; Weiss and Cattaneo, 2017). This fourth imperative is also grounded in criticisms of current representative democratic systems that are characterised by lobbying, political elites and power struggles, and are seen as causes for economic inequalities and perceived injustices (c.f. Trainer, 2012).

The fifth imperative is characterised by a criticism of large global value chains, instead advocating for localized economies based on largely self-sufficient communities, where goods and services are produced and managed as a commons by small cooperatives or working bees (Beling et al., 2018; Degrowth.org, n.d.; Degrowth Aotearoa, n.d.; Degrowth California, n.d.; Kallis, 2018; Latouche, 2009; Rede para o decrescimento, n.d.; Schneider et al., 2010; Trainer, 2012).

3. Materials and methods

As outlined in Fig. 1, the investigation of the alignment of CEI with the degrowth imperatives was conducted along a four-step process. Following the identification of five degrowth imperatives from scientific literature and statements by degrowth movements (see section 2), a set of indicators was selected for each imperative, allowing for an investigation of the alignment of CEI with the five respective imperatives. Indicators were selected based on their ability to depict aggregate level alignment of the European CEI sector in general with the degrowth

imperatives. The data necessary for the estimation of the indicators is largely sourced from the previously compiled open-access "Energy by People - ENBP" database with over 10000 European initiatives and 16000 CEI-owned renewable energy production units (Wierling et al., 2022a, 2023). However, due to data availability limitations, most indicators are calculated for a subsample of the CEI contained in the ENBP database, with a focus on French and German CEI, as data coverage was higher for these two countries. While basic administrative data such as CEI name, founding date, and address, are available for most entries in the ENBP database, more specific data is often lacking. In some countries, extensive databases on renewable energy installations as well as detailed yearly financial reports of the CEI are available, while in other countries the only source of information are individual CEIs' websites.

Indicator results showing CEI predominantly reflecting the goals of the associated degrowth imperative were classified as 'substantial alignment', while those predominantly contradicting the associated degrowth imperative were classified as 'non-alignment'. Indicator results showing a large variability across countries or types of CEI were marked as 'partial alignment'. Final alignment of CEI with the overarching degrowth imperatives was defined based on the combined alignment of all subordinate indicators. The classification of the alignment of each individual indicator is justified in more detail in Section 5.

3.1. Data compilation

The ENBP database (Wierling et al., 2022a, 2023) of European CEI was compiled over the course of 4 years and published in 2022. The selection of CEI for the ENBP database was guided by three aspects: (I) the initiative is democratically led by citizens instead of private enterprises or public actors, (II) the initiative is striving for social or environmental benefit beyond pure economic interest, and (III) the initiative

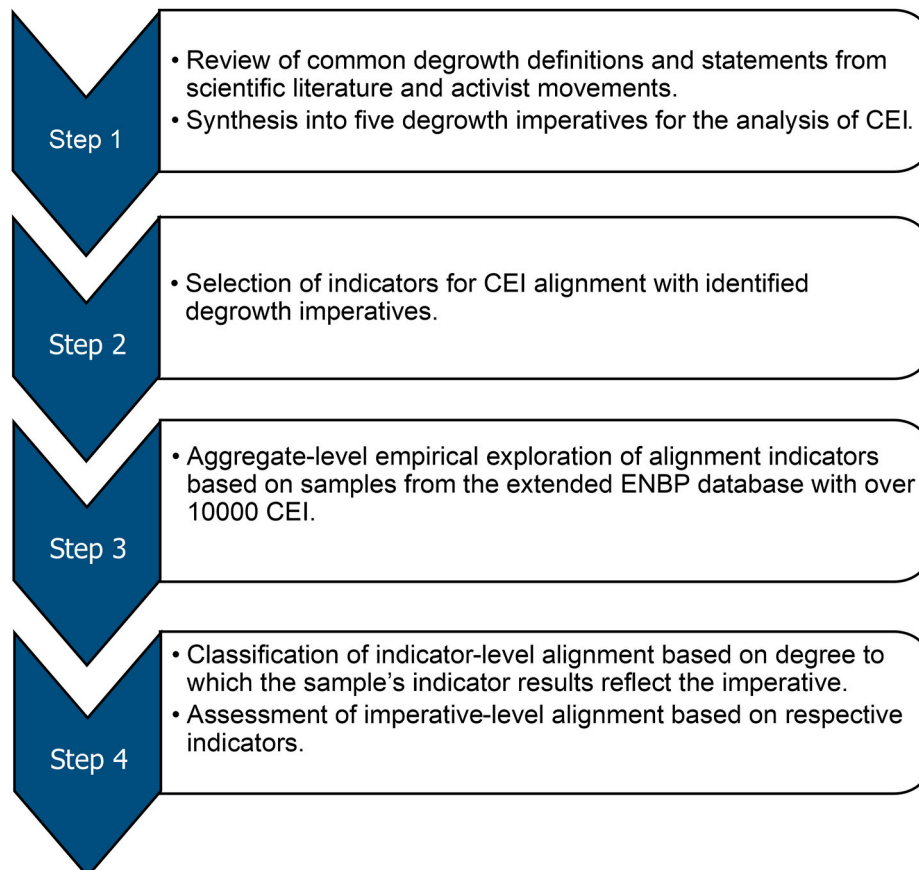


Fig. 1. Methodological process of empirical investigation of aggregate level alignment of CEI with degrowth.

engaging in activities related to the energy transition (Wierling et al., 2023). In contrast to other conceptualizations of CEI (c.f. Bauwens et al., 2022), specific criteria to evaluate the adherence to the three aspects were set to be more inclusive, with the goal to include a large variety of different forms of CEI in the database. This serves the purpose of this paper well, as it avoids selection biases as a result of choosing "best-practice examples", as for instance in Kunze and Becker (2015). Due to practical reasons related to the findability of initiatives, the database mainly includes initiatives officially registered under a legal form, such as cooperatives or associations. However, exceptions to this rule were made, if other initiatives could be identified from previous studies or based on expert knowledge. The database encompasses administrative, financial and demographic data on CEI as well as administrative and technical data on tangible assets owned by CEI (e.g. renewable energy production units). The data was collected primarily from business registers, lists of CEI maintained by CEI umbrella organisations, databases on renewable energy actors and installations, individual initiatives' websites as well as their coverage in media. Detailed information can be found in Wierling et al. (2023).

This paper extends the ENBP database by collecting additional data on the number of employees and more detailed information on the activities conducted by CEI. In a few cases, we also source from related empirical investigations of the same database (Schwanitz et al., 2023b; Wierling et al., 2020, 2021, 2022b). We further make use of data on a smaller sample of 105 CEI across Europe, available on the Energy Communities Repository, which is maintained by the European Commission (European Commission, n.d.).

3.2. Indicators for CEI and degrowth alignment

3.2.1. Imperative 1: reduce environmental impact

We investigate this imperative using two indicators. The total amount of renewable energy installed by CEI represents the aspect of a technological transition, while the share of CEI that engage in energy efficiency and sufficiency activities represents the aspect of reducing material and energy consumption. Estimates for renewable energy capacity installed by CEI are available from Schwanitz et al. (2023b), and estimates for energy consumption reduction activities are available from Schwanitz et al. (2023a) and Wierling et al. (2022b).

3.2.2. Imperative 2: Re-orient economic priorities

We first investigate the degree to which CEI purpose statements reflect the envisioned re-orientation of societal values from profit-maximisation and consumerism to subsistence and non-material well-being. Purpose statements were collected from the statutes of 374 German PV CEI, in connection with a previous study (Wierling et al., 2022b). The collected purposes were scanned for the presence of environmental or social goals beyond the economic support of their members. As additional indicator we use data from a small sample of 44 CEI contained in the Energy Communities Repository (European Commission, n.d.), stating whether profits are reinvested into community projects or distributed as dividends to members.

The aspect of decommodification of goods and services is addressed through an investigation of non-commercial services that CEI provide free of charge. Information was collected from the websites of 366 German and 127 French CEI active in the PV sector. The identified non-commercial services were classified into overarching benefit categories adopted from Bielig et al. (2022). These categories are Energy poverty reduction, Political activism, Community development, Knowledge Sharing and Other activities.

The reliance of CEI on employees was used as an indicator for the alignment with the envisioned shift from formal to volunteer-based markets. Information on employees was gathered for 540 German CEI from the yearly reports published in the national business register (Bundesanzeiger Verlag, 2024). The most recent reports ranged from 2015 to 2022. Employments were converted into full-time-equivalents

(FTE) in the following way: Part-time = 0.5 FTE, Apprentices/Dual students = 0.5 FTE, Assistants = 0.25 FTE. CEI were classified based on their number of employees using the size classes of the German Federal Employment Agency (Bundesagentur für Arbeit, 2021).

Finally, financial data of CEI serves as indicator for the alignment with the goal of abolishing the current debt-based financial sector. A previous study (Wierling et al., 2022b) investigates CEI equity ratios as well as whether CEI assets are predominantly composed of fixed tangible or financial assets. Data on equity ratios serves as indicator on CEI reliance of loans for their investments, while the share of fixed tangible and financial assets indicates the degree to which CEI engage in financial trading and speculation.

3.2.3. Imperative 3: reduce inequality

CEI may produce benefits either for their members or external stakeholders (c.f. Bauwens and Defourny, 2017), thereby potentially contributing to alleviating inequalities. We first investigate whether CEI mainly focus on providing benefits for members or external stakeholders, as well as whether CEI offer services specifically targeted towards disadvantaged groups. We then focus on who tends to benefit from being a CEI member by investigating the inclusivity of CEI members and the financial barriers for becoming a member in terms of required membership fees.

The initial investigation builds on the analysis of CEI purpose statements and non-commercial activities (see Imperative 2). Purposes were scanned for the presence of statements indicating that the CEI aims to provide wider community benefits beyond their members. Non-commercial activities were scanned for any references to the provision of special services to disadvantaged groups.

We then explore the inclusivity of the CEI member-base as well as the financial barriers for becoming a member. For the inclusivity aspects, we investigate member demographics, i.e. the share of female and vulnerable¹ members as well as those aged under 35, which is provided for 92 CEI in the Energy Communities Repository (European Commission, n.d.). The financial entry barrier is investigated through the cost of membership shares, which members are required to purchase. The ENBP database contains information on share size for 1176 CEI from Belgium, Czech Republic, France, Germany, and Switzerland. Shares have been converted from local currencies to EUR using a ten-year average, resulting in a rate of 1 EUR = 1.08 CHF for Switzerland and 1 EUR = 26 CZK for the Czech Republic.

3.2.4. Imperative 4: foster democratic decision making

We explore this imperative by analysing the degree to which CEI adhere to the one member - one vote principle as indication for democratic decision making. We further investigate to what degree members actively participate in CEI decision making. The share of CEI adhering to the one member - one vote (OMOV) principle serves as a proxy for formal decision-making power, because specific legal forms allow, or dictate, shades of decision-making. Karakas (2019) and Wierling et al. (2023) list the adherence of different legal forms to the OMOV principle. Data about the legal forms are available for 9078 CEI. This paper adds a more detailed investigation of governance principles for 294 French CEI, based on their individual statutes. We also use data from the Energy Communities Repository (European Commission, n.d.) on the share of members that participated in the last general assembly as well as the total number of members to test a previous claim that member participation declines with increasing size of CEI (Rommel et al., 2018).

3.2.5. Imperative 5: Re-localize production and consumption

The fifth imperative advocates for increased self-sufficiency and

¹ Note that the European Energy Communities Repository, from which this data is sourced, does not provide a precise definition of the term 'vulnerable member'.

local production and consumption. CEI are seen as preferable to commercial renewable energy actors in this regard, as the generated benefits (e.g. produced energy, financial profit) tend to remain within the local community (Walker and Devine-Wright, 2008).

We first address the aspect of self-sufficiency in terms of the CEIs' ability to supply their members with energy. Schwanitz et al. (2023b) have investigated this aspect for the CEI contained in the ENBP database. We then investigate whether renewable electricity produced in CEI-owned facilities is consumed locally or fed into the general grid. For 3445 German CEI-owned PV installations, the ENBP database contains information taken from the German Core Energy Market Data Register (Bundesnetzagentur, n.d.), which specifies whether produced electricity is fully or partially fed into the public grid.

For those installations where the produced energy is not consumed directly on-site, the question arises if the CEI members (who benefit from the generated profits) are in fact located in proximity of the production unit. A geographic mismatch of CEI members and energy production units would indicate that the local community at the site of the installation does not significantly benefit from the profits generated by the energy production and feed-in. As such, we compare the geographical spread of CEI members and CEI-owned renewable energy installations. We employ information from Wierling et al. (2022b, 2020) regarding the geographic spread of CEI members as well as the degree to which CEI implement geographic restriction as a prerequisite for becoming a member. Next, the geodesic distance of each renewable energy production unit to the CEI owning the unit is analysed. Prerequisite is the existence of geolocation data for both the unit and the CEI in the ENBP database. This resulted in distance information for 12724 CEI-unit pairs.

Finally, we investigate whether CEI mainly rely on local resources represented by their use of different PV panel brands. The ENBP database contains information on the manufacturers of PV panels used in 1018 German and 366 French CEI-owned PV installations. For each manufacturer the location of its registered headquarter was identified via internet search.

4. Results

4.1. Imperative 1: reduce environmental impact

The main contribution of CEI to this imperative lies in the installation of renewable energy capacities, which Schwanitz et al. (2023b) estimate at 7–10 GW for the European CEI contained in the ENBP database. Solar photovoltaics makes up the largest share thereof. In terms of reducing total material and energy consumption, CEI contribution lies mainly in their engagement in energy efficiency and sufficiency projects. An analysis of the lines of business stated in the statutes of 562 German PV CEI finds references for energy efficiency consulting (12 %), energy saving consulting (10 %), energy efficiency services (14 %), and energy saving services (5 %) (see Wierling et al., 2022b). Furthermore, out of 10546 CEI, 759 have started energy efficiency or energy saving projects, such as information campaigns and renovation and retrofitting projects (see Schwanitz et al., 2023a). Note that CEI may not systematically report energy savings related activities, hence the above values should be interpreted as a potential minimum.

4.2. Imperative 2: re-orient economic priorities

Purpose statements of German PV CEI, representing their intended goals, show that only 50 out of 374 investigated CEI use customised statements referencing goals such as supporting social projects, local community development and sustainability transition initiatives. The remaining 324 adopt a general phrase based on the German cooperative law (GenG, §1), focussing on supporting their members. Thereof, 297 exclusively state the economic support for members, while the remaining 27 extend their focus also to members' social and cultural needs.

While the standardised statement based on the cooperative law is often chosen for its legal security and flexibility, the existence of a small number of CEI with customised purpose statements that go beyond economic support for members indicates that some CEI put more emphasis on such non-economic goals than others.

As an indicator for the aspect of decommodifying goods and services, we investigate the share of CEI that offer services to the wider community free of charge. The data show that a considerable number of CEI in our sample do not provide such non-commercial services, however significant variability exists among European countries. For Germany, we find that out of the 366 investigated cases, only 22 mention the provision of such services, related to knowledge sharing in the form of awareness raising campaigns as well as collaborations with schools and running consulting workshops (11 cases), community development such as helping social initiatives and churches and maintaining public infrastructure (8 cases), and international development assistance through supporting renewable energy and social initiatives in developing countries (3 cases). In France, 58 out of 127 initiatives provide free of charge services. Thereof, 36 focus on energy poverty reduction (e.g., helping low-income households with applications to receive subsidies for energy efficiency upgrades). 25 cases are counted that relate to knowledge sharing services. 6 initiatives engage in community development, such as hosting social and cultural events. Note that CEI may engage in more than one activity, hence the sum is not equal to its parts.

In terms of CEI reliance on volunteers or employees, we find that, in a sample of 540 German CEI, the majority relies exclusively on volunteers. Less than 16 % report on regular employees and less than 3 % have more than 10 full-time-equivalent (FTE) positions. Only 3 cases with more than 100 FTE are found. The majority of CEI having employees engage in electricity distribution and the operation of small local grids, which require specialised skills and continuous attention.

Furthermore, a previous publication (Wierling et al., 2022b) has found that CEI often have high equity ratios, with a quarter of the investigated sample having an equity ratio of over 90 %. This indicates a comparably low reliance on loans to finance CEI activities. However, cases with significantly lower equity ratios could also be identified. This study also showed that assets owned by the vast majority of investigated CEI are tangible fixed assets instead of financial assets, hinting towards a low engagement in financial trading activities.

Finally, data from the Energy Community Repository shows that more than half of the 44 CEI in the sample report that profit is exclusively distributed to members, while the remaining report that profits are reinvested in community benefit projects.

4.3. Imperative 3: reduce inequality

The investigation of the purposes of German PV CEI (see Section 4.2) shows that those CEI with customised statements (as opposed to those using the generic purpose statement) commonly mention a goal to support the development and value creation of the local community. While this can be seen as a means to decrease inequality, if targeted towards low-income communities, our previous studies suggest that CEI tend to be more active in regions with higher-than-average incomes (Wierling et al., 2020, 2021). Furthermore, beyond intended goals stated in the purposes, few investigated CEI report concrete activities targeted at addressing inequality. Some examples include "Energiegenossenschaft Starkenburg" (Energiegenossenschaft Starkenburg, n.d.) and "fairPla.net" (fairPla.net, n.d.), who foster international development assistance for countries in the Global South, or the cooperative "Qvinnovindar" (Qvinnovindar, n.d.) that promotes female engagement in the energy sector. We find, however, significant differences in the focus on equality related issues across countries. For instance, out of a sample of 127 French CEI, 36 provide free-of-charge energy consulting services to low-income households, while similar evidence could not be found among German CEI.

Beyond such CEI specifically targeting equality related aspects, the

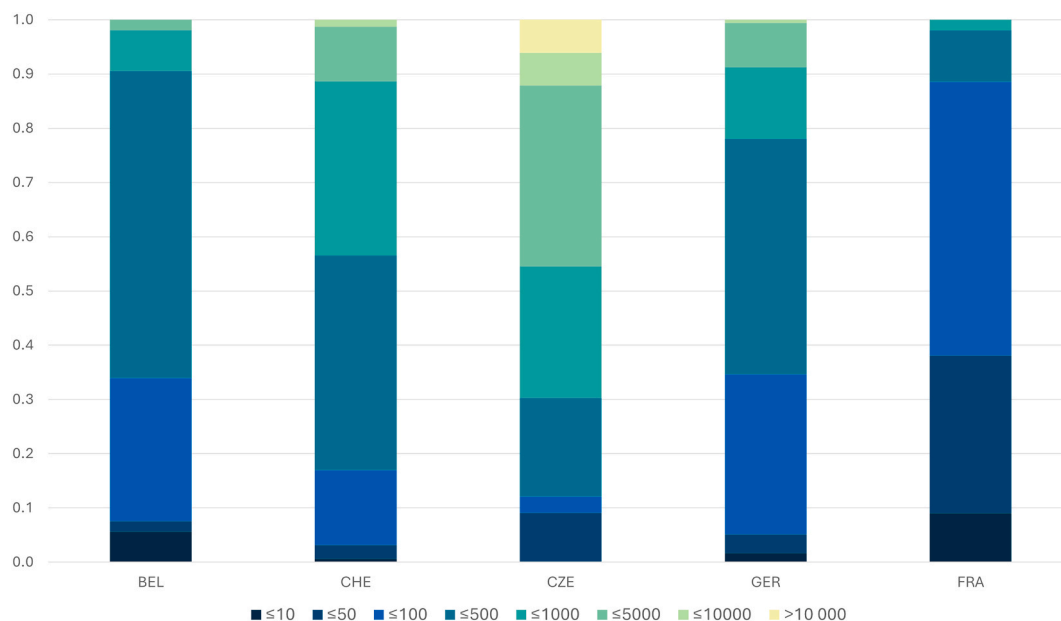


Fig. 2. Distribution of Share sizes in EUR for 53 Belgian, 159 Swiss, 33 Czech, 721 German, and 210 French CEI.

previous investigations of CEI purposes and use of profits, indicate that a significant share is mainly focused on providing (financial) benefits for members. This begs the question of the inclusivity of such CEI and who consequently benefits of being a member therein. We investigate the size of membership shares of CEI as representation for the financial barrier for becoming a member. CEI members are required to purchase at least 1 share. Fig. 2 shows the distribution of member share sizes for CEI of 5 selected countries. As can be seen, significant variability in the share size distribution can be found across countries, with the median class ranging from 50 to 100 EUR in France to 500 to 1000 EUR in the Czech Republic. The reason for the high share sizes in the Czech Republic is likely the result of a majority of Czech CEI being larger agricultural cooperatives that also engage in energy related activities such as biomass or biogas.

The financial entry barriers to CEI membership may then be linked to the lack of inclusivity of the member base. Data from the European Energy Communities Repository shows that about half of the included CEI report a share of female members below 25 %, while ~95 % report a share of vulnerable members below 25 % and ~90 % report that less than 25 % of their members are aged below 35. Other studies have confirmed that CEI members lack in diversity, with CEI members often being "well-off, rural, male sexagenarians" (Wierling et al., 2020, p. 249; see also: Radtke and Ohlhorst, 2021; Sebi and Vernay, 2020).

4.4. Imperative 4: foster democratic decision making

A core aspect of the democratic nature of CEI is the decision-making process based on the One Member - One Vote (OMOV) principle which is independent of a member's share, in contrast to a voting system dependent on a shareholder's share, that is common in private shareholding companies. Our data show that 40 % of CEI are registered under the legal form of cooperative, which generally adheres to the OMOV principle (c.f. Karakas, 2019). While other legal forms adopted by CEI are more flexible in terms of governance, the OMOV principle remains a common choice. A detailed investigation of French CEI, which generally prefer other legal forms such as the joint-stock-company (SAS), confirms this point. Over 90 % of the French CEI still adhere to the One Member - One Vote principle voluntarily.

While this principle sets the legal framework for a more egalitarian governance system compared to other companies, it is also interesting to investigate whether it truly translates to a highly participative decision-

making within CEI. Rommel et al. (2018) point out a trend where member participation in general assemblies tends to decline with increasing size of the CEI. The yearly general assembly is the main tool through which the entire member-base is able to participate in major decisions (e.g. payout of dividends, electing steering committee, deciding on new projects). Based on the data from the European Energy Communities Repository, we can confirm this trend. As Table 1 shows, the participation rate in the most recent general assembly almost continuously declines with increasing median membership numbers. Data on membership numbers of CEI included in the ENBP database show that close to half of the CEI have above 100 members. Assuming that the trend shown in Table 1 holds true, would indicate that a significant share of CEI have comparably low member participation in decision-making. Similar trends of low participation rates were also identified in other studies (Van Veelen, 2018; Wierling et al., 2020).

4.5. Imperative 5: re-localize production and consumption

In terms of self-sufficiency, CEI theoretically produce sufficient energy to cover the energy needs of all their members (Schwanitz et al., 2023b). The question arises, however, whether this energy is truly used for local self-consumption or simply fed into the national grid. Fig. 3 shows the evolution of the ratio between full and partial feed-in over the last 20 years for a sample of German CEI-owned PV units. A clear trend from almost exclusively full feed-in to increasing partial feed-in installations can be observed. This trend coincides with the gradual reduction of feed-in tariffs over the past two decades (Wirth, 2024). The decreasing profitability of the feed-in tariff business model therefore

Table 1

Comparison of membership participation in last general assembly with median membership number for all CEI with participation rate in given range. Intervals for assembly participation were adopted from the European Energy Communities Repository.

Assembly participation rate (%)	Median membership number
<25	334
26-44	129
45-55	68
56-75	47
76-90	16
>90	27

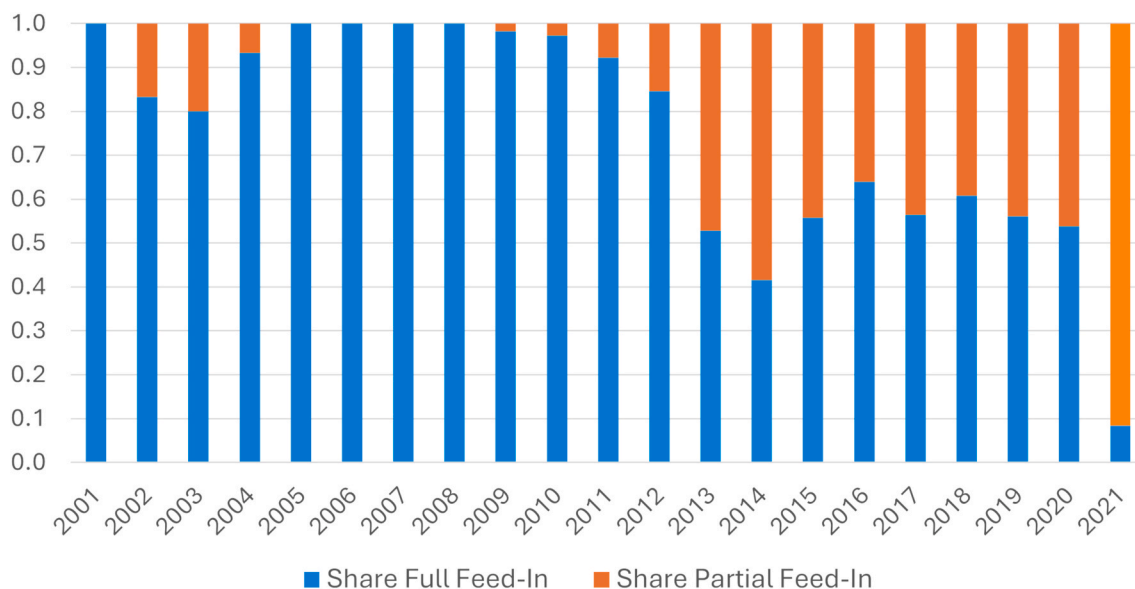


Fig. 3. Share of 3811 newly installed German PV units owned by CEI that fully feed electricity into the national grid or partially use electricity for local self-consumption.

pushed CEI to experiment with new business models, such as local self-consumption (Wierling et al., 2022b).

In such cases where produced energy is fed into the grid, the local (financial) benefits only arise if CEI members are located in close proximity to the production facilities. In terms of the geographic spread of CEI members, Wierling et al. (2020, 2022b) find evidence indicating that CEI members are commonly located closely to the CEI and that some CEI even enforce geographic restrictions on membership.

Next, we investigate the geographical spread of CEI activities. Fig. 4 shows the share of production units located within a certain radius of the CEI for the sample of 12724 CEI across Europe. About a quarter of installations are located directly at the CEI headquarter (<1 km distance). In total, almost two thirds of installations lie within a 10 km radius. However, we do also find occasions where production units are located several hundred or even more than thousand kilometres from the CEI, occasionally even being located in foreign countries. A more detailed breakdown along technology types and countries can be found in appendix Fig. A1. The exception being Swiss and Spanish installations. However, for these two countries, our sample only comprises installations from 2 CEI each, therefore not being representative. Regarding the two most common technologies, wind installations are generally located at greater distance than solar PV installations. Noteworthy is also the low spatial spread of biomass/biogas and heating technologies.² These constitute a large share of the samples for Finland and Denmark. The low spatial spread of these technologies is a result of being used in local district heating systems operated by the CEI. The same is true for hydropower installations in Germany, a significant share of which have been installed in the first half of the 20th century by rural electrification cooperatives, with the aim of providing electricity to rural areas de-prioritized by market and state actors. Those that remain active today tend to still operate local electricity distribution grids. These results confirm a previous study on a smaller sample, exclusively investigating CEI owned PV installations in Germany and Italy (Wierling et al., 2021). Interestingly, Rommel et al. (2018) point out that, especially for wind installations, there is a chance that recent changes in

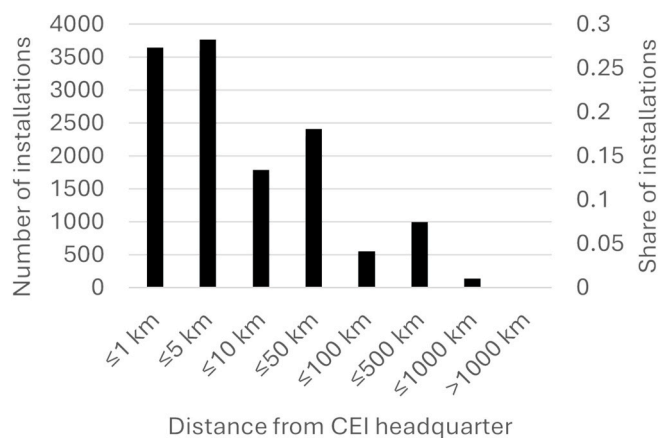


Fig. 4. Share of 12724 CEI production facilities located within specified distance from headquarters for total sample of CEI across Europe.

legislation in Germany as well as technological development may lead to increasingly larger turbines located at greater distances. Our data does not substantiate this claim, neither for Germany nor the EU in total. While turbines have increased in capacity, there is no significant correlation between year of installation and distance from CEI headquarter. The same is also true for other technologies than wind.

These results indicate that both members and energy production facilities are mostly located in close proximity to the CEI headquarter. This suggests that the financial benefits generated from feeding produced electricity into the grid and distributing the revenues as member dividends remain within close proximity to the CEI.

Finally, we investigate the PV panel brands used by German and French CEI as representation of CEIs' use of local resources. Fig. 5 shows the world regions in which the registered headquarter of the PV panel producer is located. German CEI continuously rely strongly on PV panels from East Asian manufacturers, mainly Chinese. The remaining panels are sourced mostly from European and North American manufacturers. French CEI, on the other hand, rely predominantly on European manufacturers (mostly German and French), only showing a significant share of East Asian brands in the years 2017–2020. In 2020, a large percentage of panels were also sourced from North American brands. It is important to note that this is not a perfect representation, as today the

² Overlap between the two technologies may exist: Biomass/biogas technologies may be used for either heat or electricity production (or both). The category Heat therefore includes all heating technologies not further specified, or fossil fuel-based heating systems.

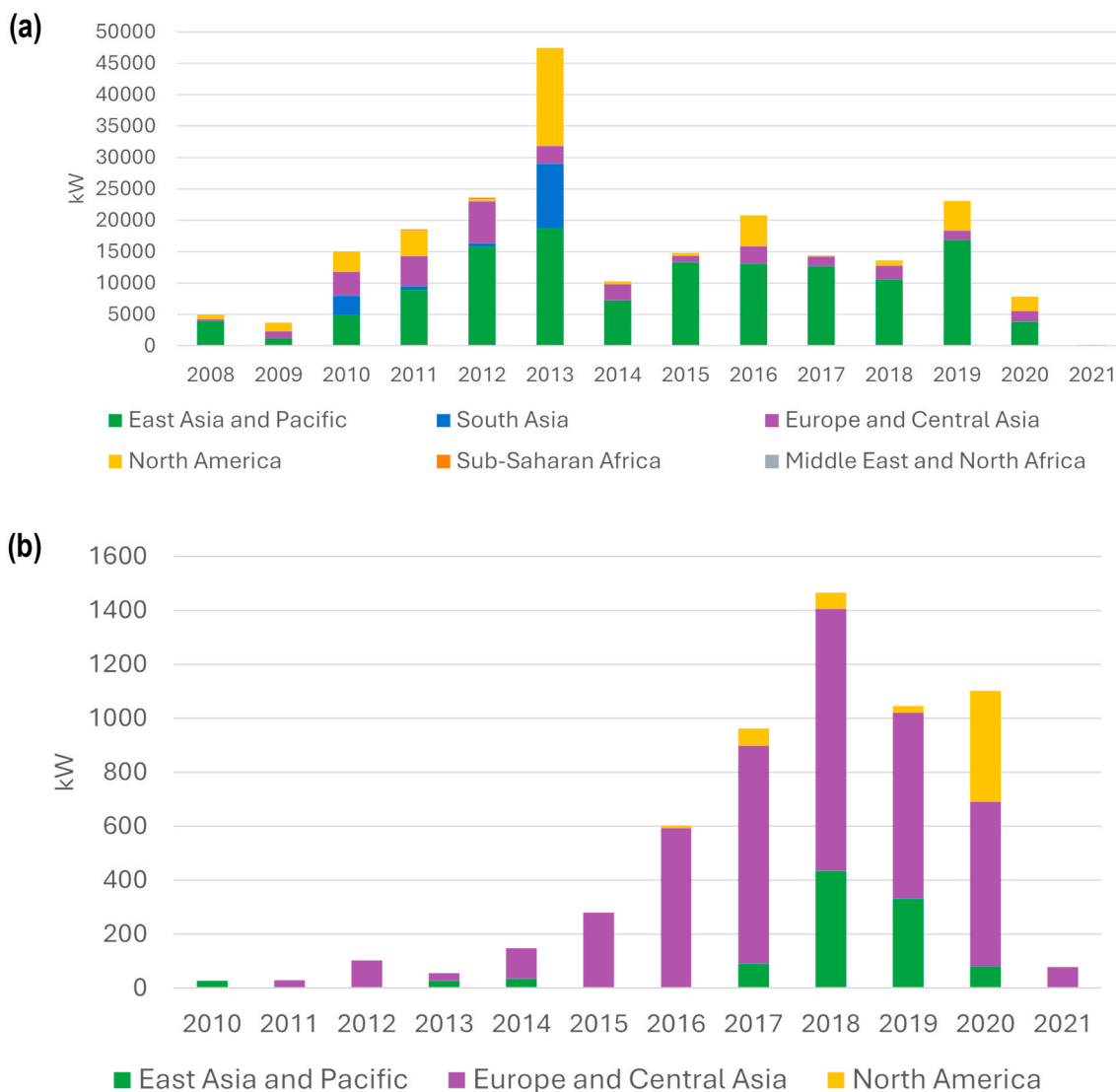


Fig. 5. a and b: Location of registered headquarter of PV panel manufacturer of 1018 German (top) and 366 French (bottom) CEI-owned PV installations, based on share of total newly installed capacity per year in kW. Classified into World regions based on the World Bank.

vast majority of PV panel assembly occurs in China, even for non-Chinese manufacturers (IEA, 2022). However, the considerably greater use of European panel brands among French CEI compared to German ones still hints towards a greater awareness on local sourcing of materials among French CEI. Furthermore, international companies tend to pay taxes in the country of their registered headquarters, and as such the choice of panel brand contributes to the respective country's economy.

5. Discussion

Fig. 6 summarises our findings regarding the alignment of CEI with the five degrowth imperatives. Our investigation indicates that CEI across Europe align strongly with the environmental impact reduction imperative, mainly through their engagement in deploying renewable energy technologies. However, some controversy can be found in the degrowth movement around the use of technology (c.f. Kerschner et al., 2018). While some see technological advancement as necessary for a sustainable transition, others specifically criticise the narrative that technological advancement is the sole solution to current environmental challenges, instead emphasising the need to lower material and energy consumption rather than simply substituting one resource with another. In fact, degrowth specifically criticises other development narratives

such as green growth for their assumption that environmental impact can be fully decoupled from material and energy consumption through technological advancement (Hickel and Kallis, 2020; Polewsky et al., 2024; Schneider et al., 2010; Vadén et al., 2020). Only a small share of CEI report activities related to energy consumption reduction, indicating a weaker alignment with this aspect. However, it is likely that not all CEI report such activities hence the true share is expected to be higher. In summary, we interpret the ability of CEI to fulfil the energy needs of their estimated 2 million members across Europe (Schwanitz et al., 2023b), as well as contributions to energy savings, as indication for a strong alignment with the first degrowth imperative.

Regarding the economic re-orientation imperative, our results show large variability within and across countries. On the one hand, CEI reliance on volunteers, and avoidance of loans and financial trading activities indicates a strong alignment with this degrowth imperative. On the other hand, we find that CEI often state primarily economic goals in their purposes and often distribute profits to members. Finally, we see that French CEI report considerably more non-commercial activities compared to German ones. The variability in terms of purposes, profit distribution and non-commercial activities hints towards an only partial alignment of the CEI sector as a whole with the second degrowth imperative. The aspect of voluntarism is also subject to some

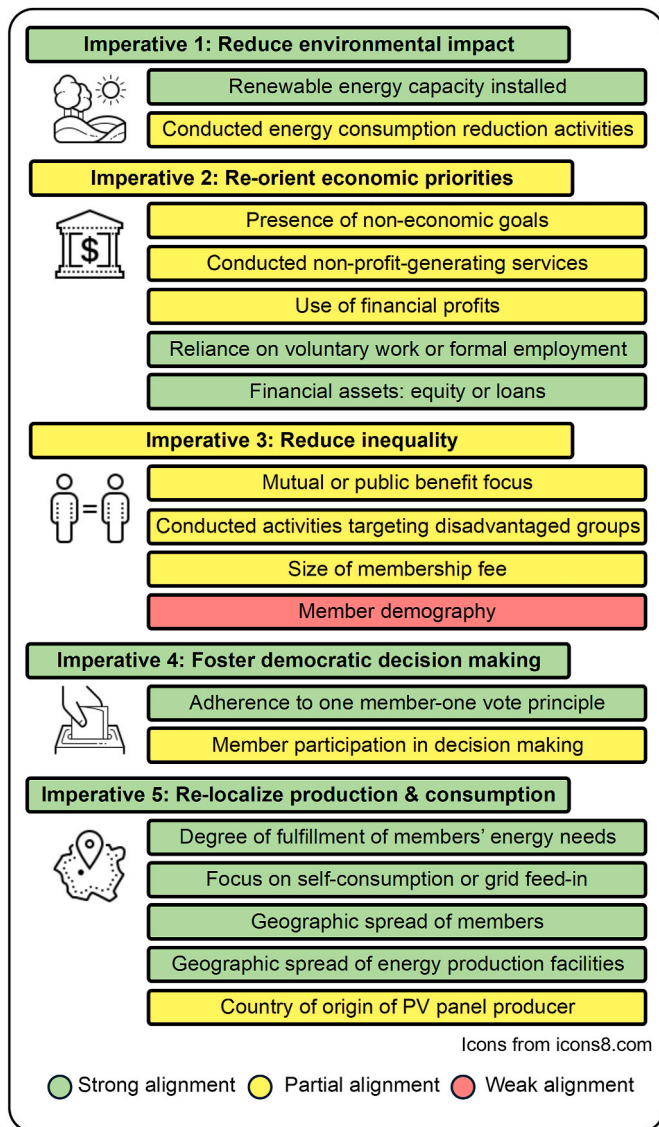


Fig. 6. Summary of degrowth imperatives, associated indicators and CEI alignment with respective degrowth imperative. Icons from [icons8.com](https://www.icons8.com/).

controversy within the literature. While some emphasise the need to move towards a more informal economy based on voluntarism and neighbourhood help (Cosme et al., 2017; Demaria et al., 2013; Trainer, 2012), others argue instead for mechanisms such as a job guarantee (e.g. Hickel, 2020). Depending on the stance taken on this issue, our results on reliance on employees or volunteers can be interpreted differently. Overall, our findings are in line with other studies such as Dilger et al. (2017) that situate CEI on a spectrum ranging from "investor-type" to "prosumer-type" initiatives. The former mainly focus on providing financial returns to members, while the latter emphasise a direct value proposition towards their members' or external stakeholders' needs.

Similar variability can also be found in terms of the alignment of CEI with the equality imperative. Relating our investigation of CEI membership share sizes to a study from 2020, which compiled microdata on household savings from the European Central Bank (Demertzis et al., 2020), indicates that low-income households likely struggle to afford the purchase of such shares. According to this data, the first quartile of French, German and Belgian household savings lie between ca. 1200 and 2200 EUR. This suggests that median membership share sizes of up to 500 EUR in Germany and Belgium represent a significant proportion of the total savings of the poorest 25 % of the population. Note also that CEI

occasionally require the purchase of several shares, thereby further exacerbating this issue. The exception being France with only just over 10 % of CEI having a share size above 100 EUR. Demertzis et al. (2020) do not provide data on household savings for the Czech Republic and Switzerland. However, it can be expected that the pattern in the Czech Republic is similar to that of Belgium and Germany, potentially even more pronounced given the far higher membership fees. In Switzerland, the higher membership fees are likely counter-balanced by generally higher household incomes and wealth. CEI members also often lack diversity in terms of female, vulnerable and young members. We furthermore find evidence suggesting that CEI are often focussed on supporting members and only occasionally offer services specifically targeted towards disadvantaged groups. The focus on providing member benefits combined with the lack of inclusivity of the member base indicates a weak alignment of CEI with the core idea of the equality imperative, being a more equal distribution of wealth and resources. On the other hand, the French case indicates a far greater alignment with the imperative, with share sizes being significantly lower compared to other countries as well as a stronger focus on providing services to disadvantaged groups.

In terms of the governance imperative, we find that CEI across Europe adhere to the One Member - One Vote principle, indicating a highly democratic decision-making structure, thereby aligning with this imperative. However, degrowth also argues for a move to more direct democratic decision-making structures instead of representative democracies (Research & Degrowth, 2010; Schneider et al., 2010; Trainer, 2012). The majority of CEI tend to elect a steering committee that runs the day-to-day operations, and only major decisions are made in the yearly general assembly. Especially among larger CEI, member participation in general assemblies seems to decline, leaving the decisions in the hands of a small group of representatives. However, even though this indicates that CEI members do not regularly make use of their right to participate in the decision-making, the formal governance structure of CEI still guarantees every member the possibility to equally influence the decision-making if they so wish. As such, we argue that CEI nonetheless align strongly with the fourth imperative. Especially small CEI seem to closely represent the ideals of this degrowth imperative.

Finally, we find a strong alignment of CEI with the local sufficiency imperative. Based on a large cross-national sample, we find that CEI predominantly install renewable energy facilities within close proximity of their headquarters. Evidence from a smaller German sample also indicated a re-focussing on local self-consumption. The only variation that could be observed relates to the brand of used PV panels, where we find that French CEI have a stronger focus on using European panels, compared to German CEI. This imperative is, however, also the most controversial one. Mocca (2020) points out that a somewhat idyllic depiction of local communities dominates within the degrowth community, not grounded in robust scientific findings. Trainer (2012) and Bauhardt (2014), for example, envisage a degrowth society based on local, self-sufficient and frugal neighbourhoods, that are increasingly also in charge of public services currently provided by the state, such as retirement, health and education services. Other authors point out the need to expand public services which small local communities will not be able to provide (Hickel, 2020; Kallis, 2018). Depending on the perspective on this issue, our results can be interpreted differently.

6. Conclusion

Rommel et al. (2018, p. 1751) see CEI "at a crossroads" between a green growth or degrowth pathway. Our empirical compilation drawing from a large cross-country sample shows that CEI align strongly with the environmental, governance and local sufficiency imperatives of degrowth. At the same time our results indicate that the alignment with the economic re-orientation and equality imperatives varies across countries and indicators. In the literature (see Table A1 in appendix), the governance and local sufficiency imperatives are mentioned less

frequently compared to the other three imperatives. Thus, we find a closer alignment with the less frequently mentioned imperatives. Further research will be necessary to better understand the reasons for the observed variability in some of the imperatives. For instance, the fact that French CEI show a greater alignment with the economic re-orientation and equality imperatives may be a result of the strong roots of the degrowth movement in France. In fact, the degrowth movement ("*Decroissance*" in French) is often stated to have originated in France (Demaria et al., 2013; Petridis et al., 2015).

Finally, it is important to note that the controversies discussed in Section 5 show that degrowth remains a 'concept in the making' (Petridis et al., 2015, p. 176; see also: Demaria et al., 2013; Eversberg and Schmelzer, 2018; Sekulova et al., 2013). Its value therefore lies not necessarily in its scientific robustness, but in its potential to offer a counter-narrative to the dominant growth narrative, aiming to inspire various new ideas and rally social movements that envisage more sustainable ways of living (Augustyn, 2024; Kallis, 2018; Petridis et al., 2015). As such, our findings should therefore be interpreted as indication of the alignment of CEI with the currently dominant narrative of degrowth. Whether the alignment of CEI with the different imperatives of degrowth truly has the potential to advance a transformation to a sustainable society will require further research on the scientific robustness and feasibility of the different degrowth strategies in general.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jclepro.2025.145612>.

Appendix 1. Overview over degrowth imperatives mentioned in scientific literature and activist movements

Tab. A1

Degrowth imperatives used in commonly cited journal articles and books, as well as on websites of known degrowth activist initiatives.

Reference	Scopus/ Google Scholar Citations	Journal	Journal Impact Factor	Reduce environmental impact	Re-orient economic priorities	Reduce inequality	Foster democratic decision making	Re-localize production & consumption
Peer-Reviewed Publications								
Hickel (2020)	178	Globalizations	2.5	x	x	x		
Trainer (2012)	97	Futures	3	x	x	x	x	x
Cosme et al. (2017)	179	Journal of Cleaner Production	11.1	x	x	x		
Schneider et al. (2010)	703	Journal of Cleaner Production	11.1	x	x	x	x	x
Research and Degrowth (2010)	78	Journal of Cleaner Production	11.1	x	x	x	x	
Demaria et al. (2013)	506	Environmental Values	2.2	x	x	x	x	
Kallis (2011)	671	Ecological Economics	6.6	x	x	x		
Asara et al. (2015)	219	Sustainability Science	6.8	x	x	x	x	
Fournier (2008)	218	International Journal of Sociology and Social Policy	1.9	x	x	x	x	
Weiss and Cattaneo, 2017	169	Ecological Economics	6.6	x	x	x	x	x
Beling et al. (2018)	80	Ecological Economics	6.6	x	x	x		x
Muraca (2013)	78	Environmental Values	2.2	x	x		x	
Jarvis, 2019	73	Progress in Human Geography	6.3	x	x	x	x	x
Books & commentaries								
Hickel et al. (2022)	128	Nature Comments	n/a	x	x	x		
Latouche (2009)	1577	Mille et une nuits/ Polity Press	n/a	x	x	x		x
Kallis (2018)	526	Agenda Publishing	n/a	x	x	x	x	x
Activist Movements								
degrowth.info, n.d.	n/a	n/a	n/a	x	x	x	x	x
degrowth.org, n.d.	n/a	n/a	n/a	x	x	x	x	x

(continued on next page)

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CRediT authorship contribution statement

Jan Pedro Zeiss: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Valeria Jana Schwanitz:** Writing – review & editing, Data curation, Conceptualization. **August Wierling:** Writing – review & editing, Data curation, Conceptualization. **Timothy Peter Marcroft:** Writing – review & editing, Data curation. **Constantin von Beck:** Writing – review & editing, Data curation. **Arnaud Diemer:** Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Tab. A1 (continued)

Reference	Scopus/ Google Scholar Citations	Journal	Journal Impact Factor	Reduce environmental impact	Re-orient economic priorities	Reduce inequality	Foster democratic decision making	Re-localize production & consumption
Associazione per la Descrescita, n.d.	n/a	n/a	n/a	x	x	x		
OPCD, n.d.	n/a	n/a	n/a	x	x	x	x	
Degrowth aotearoa, n.d.	n/a	n/a	n/a	x	x	x	x	x
Degrowth California, n.d.	n/a	n/a	n/a	x	x	x		x
Degrowth Central Victoria, n.d.	n/a	n/a	n/a	x	x			
Degrowth Copenhagen, n.d.	n/a	n/a	n/a	x	x	x		
Degrowth Switzerland, n.d.	n/a	n/a	n/a	x	x	x	x	
Degrowth Vienna, n.d.	n/a	n/a	n/a	x	x	x		
Institute for degrowth studies, n.d.	n/a	n/a	n/a	x	x	x		
Rede para o decrecimento, n. d.	n/a	n/a	n/a	x	x	x	x	

Appendix 2. Indicators for testing alignment of CEI with degrowth imperative

Tab. A2

Summary of indicators, data samples and data sources for each investigated degrowth imperative.

Indicator	Sample size	Data source
Imperative 1 – Reduce environmental impact		
Total renewable energy capacity installed by CEI	Total sample of 10546 European CEI	Schwanitz et al. (2023b)
Share of CEI conducting energy consumption reduction activities	10546 European CEI; 562 German PV CEI	Schwanitz et al. (2023a) , Wierling et al. (2022b)
Imperative 2 – Re-orient economic priorities		
Presence of non-economic goals in CEI purpose	374 German PV CEI	Wierling et al. (2022b)
Share of CEI offering non-profit generating, public benefit services	366 German PV CEI 127 French PV CEI	CEI Websites
Use of financial profits	44 CEI across Europe	Energy Communities Repository (European Commission, n.d.)
Reliance of CEI on voluntary work or formal employment	540 German CEI	CEI yearly reports (Bundesanzeiger Verlag, 2024)
CEI financial assets – equity or loans	Two samples of 265 and 191 German PV CEI.	Wierling et al. (2022b)
Imperative 3 – Reduce inequality		
Stated purpose of CEI – mutual or public benefit focus	374 German PV CEI	Wierling et al. (2022b)
Conducted activities specifically targeted towards disadvantaged groups	366 German PV CEI 127 French PV CEI	CEI Websites
Size of membership fee of CEI	1176 CEI, Thereof: BEL: 53, CHE: 159, CZE: 33, GER: 721, FRA: 210	ENBP Database
Member demography - inclusivity of CEI	92 CEI across Europe	Energy Communities Repository (European Commission, n.d.)
Imperative 4 – Foster democratic decision making		
Formal governance principles of CEI - adherence to one member - one vote principle	Analysis of general adherence based on chosen legal form for 9078 CEI; Detailed analysis based in individual statutes for 294 French CEI	ENBP Database
Member participation in decision-making processes	85 CEI across Europe	Energy Communities Repository (European Commission, n.d.)
Imperative 5 – Re-localize production and consumption		
Energy self-sufficiency – Degree of fulfilment of members' energy needs	Total sample of 10546 European CEI	Schwanitz et al. (2023b)
Focus on self-consumption or feed-in of electricity into national grid	3811 German CEI-owned PV installations	ENBP Database
Geographic distribution of members	46 Danish CEI & 286 German PV CEI	Wierling et al. (2020, 2022b)
Geographic spread of energy production facilities	12724 CEI-Unit pairs Thereof: AUT: 1, BEL: 98, CHE: 39, CZE: 37, DNK: 395, ESP: 11, EST: 132, FIN: 26, FRA: 876, GER: 10108, GRC: 49, HRV: 5, NLD: 707, POL: 43, SWE: 197	ENBP Database
Use of local resources – Country of origin of PV panel producer	366 French CEI-owned PV units 1018 German CEI-owned PV units	ENBP Database

Appendix 3. Breakdown of distances between CEI and owned renewable energy generation facilities

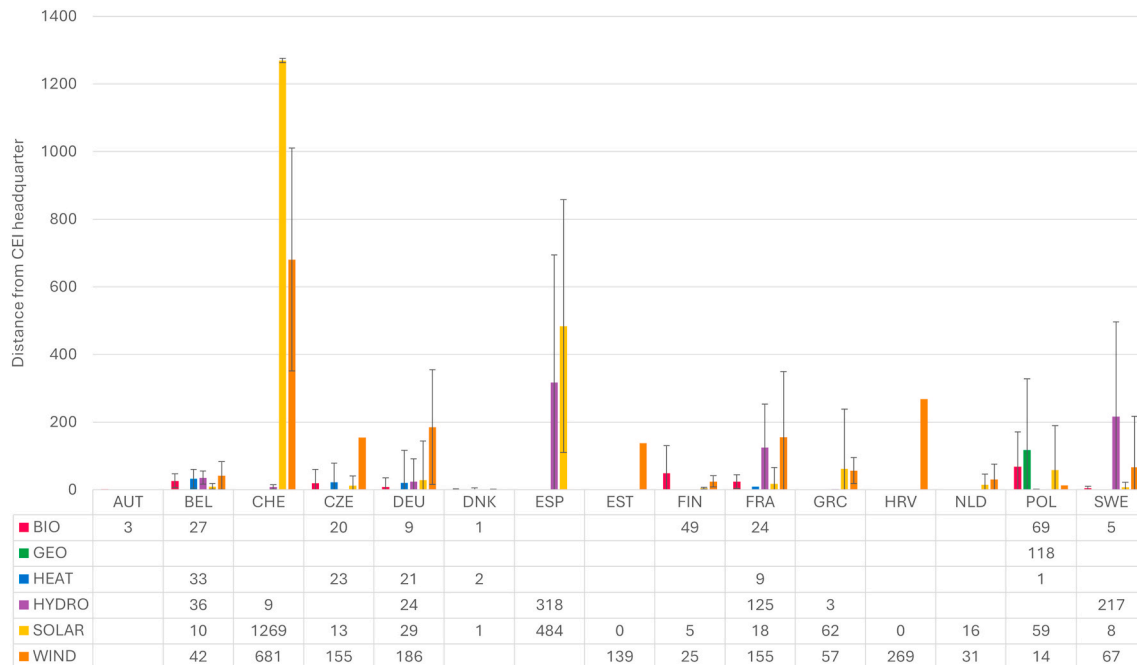


Fig. A1. Breakdown of average distances between CEI and owned renewable energy generation facilities. Separated by technology type and country. Error bars show 1 standard deviation.

Data availability

This study largely uses data contained in the open access ENBP database on European CEI, which is available on dataverse.no (2022a). Additional information on compilation and usage of the ENBP database can be found in Wierling et al. (2023). This data was extended by additional datapoints which are attached as supplementary file to this study. Further data was collected from the European Energy Communities Repository (European Commission, n.d.).

References

Ariès, P., 2005. La décroissance, un mot-obus. *La Décroissance* 26.

Asara, V., Otero, I., Demaria, F., Corbera, E., 2015. Socially sustainable degrowth as a social-ecological transformation: repoliticizing sustainability. *Sustain. Sci.* 10, 375–384. <https://doi.org/10.1007/s11625-015-0321-9>.

Associazione per la Decrescita, n.d. Decrescita. URL: <https://www.decrescita.it/decrescita/> (accessed 4.22.24).

Augustyn, P., 2024. Can the ‘Master Narrative’ of Growth be Replaced by New Stories of Shrinking and Degrowth? A Biosemiotic Perspective on the ‘Stories we live by.’. *Biosemiotics* 17, 93–110. <https://doi.org/10.1007/s12304-023-09538-7>.

Bauhardt, C., 2014. Solutions to the crisis? The Green new deal, degrowth, and the solidarity economy: alternatives to the capitalist growth economy from an ecofeminist economics perspective. *Ecol. Econ.* 102, 60–68. <https://doi.org/10.1016/j.ecolecon.2014.03.015>.

Bauwens, T., Defourny, J., 2017. Social capital and mutual versus public benefit: the case of renewable energy cooperatives. *Ann. Publ. Cooper. Econ.* 88, 203–232. <https://doi.org/10.1111/apce.12166>.

Bauwens, T., Schraven, D., Drawing, E., Radtke, J., Holstenkamp, L., Gotchev, B., Yildiz, Ö., 2022. Conceptualizing community in energy systems: a systematic review of 183 definitions. *Renew. Sustain. Energy Rev.* 156, 111999. <https://doi.org/10.1016/j.rser.2021.111999>.

Beling, A.E., Vanhulst, J., Demaria, F., Rabi, V., Carballo, A.E., Pelenc, J., 2018. Discursive synergies for a ‘Great Transformation’ towards sustainability: pragmatic contributions to a necessary dialogue between human development, degrowth, and buen vivir. *Ecol. Econ.* 144, 304–313. <https://doi.org/10.1016/j.ecolecon.2017.08.025>.

Berka, A.L., Creamer, E., 2018. Taking stock of the local impacts of community owned renewable energy: a review and research agenda. *Renew. Sustain. Energy Rev.* 82, 3400–3419. <https://doi.org/10.1016/j.rser.2017.10.050>.

Bielig, M., Kacperski, C., Kutzner, F., Klingert, S., 2022. Evidence behind the narrative: critically reviewing the social impact of energy communities in Europe. *Energy Res. Soc. Sci.* 94, 102859. <https://doi.org/10.1016/j.erss.2022.102859>.

Brummer, V., 2018. Community energy – benefits and barriers: a comparative literature review of community energy in the UK, Germany and the USA, the benefits it provides for society and the barriers it faces. *Renew. Sustain. Energy Rev.* 94, 187–196. <https://doi.org/10.1016/j.rser.2018.06.013>.

Bundesanzeiger Verlag, 2024. Unternehmensregister. URL: <https://www.unternehmenregister.de/ureg/> (accessed 4.22.24).

Bundesnetzagentur, n.d. Marktstammdatenregister. URL: <https://www.marktstammdatenregister.de/MaStR> (accessed 4.22.24).

Bundesagentur für Arbeit, 2021. Betriebsgrößen auf Basis von Beschäftigungsverhältnissen. URL: <https://statistik.arbeitsagentur.de/DE/Navigation/Grundlagen/Methodik-Qualitaet/Methodenberichte/Beschaeftigungsstatistik/Methodenberichte-Beschaeftigungsstatistik-Nav.html>.

Cosme, I., Santos, R., O’Neill, D.W., 2017. Assessing the degrowth discourse: a review and analysis of academic degrowth policy proposals. *J. Clean. Prod.* 149, 321–334. <https://doi.org/10.1016/j.jclepro.2017.02.016>.

Daly, H.E., 1991. *Steady-State Economics, second ed., with new essays*. Island Press, Washington, D.C, ISBN 1559630728.

Daly, H.E., 1972. In defense of a steady-state economy. *Am. J. Agric. Econ.* 54, 945–954. <https://doi.org/10.2307/1239248>.

Degrowth Aotearoa, n.d. What is degrowth? URL: <https://www.degrowth.nz/what-is-degrowth/> (accessed 02.24.25).

Degrowth California, n.d. More about degrowth. URL: <https://www.degrowthcalifornia.org> (accessed 02.24.25).

Degrowth Central Victoria, n.d. Home. URL: <https://degrowthcentralvic.org> (accessed 02.24.25).

Degrowth Copenhagen, n.d. Our manifesto. URL: <https://manifestodegrowthcph.tiiny.site> (accessed 02.24.25).

Degrowth Switzerland, n.d. About degrowth. URL: <https://www.degrowth-switzerland.ch/about-degrowth/> (accessed 02.24.25).

Degrowth Vienna, n.d. What is degrowth? URL: <https://www.degrowthvienna.org/en/degrowth-2> (accessed 02.24.25).

Degrowth.info, n.d. What is degrowth? URL: <https://degrowth.info/en/degrowth> (accessed 4.16.24).

Degrowth.org, n.d. Degrowth. Research and degrowth. URL: <https://degrowth.org/definition/> (accessed 4.22.24).

Demaria, F., Schneider, F., Sekulova, F., Martinez-Alier, J., 2013. What is degrowth? From an activist slogan to a social movement. *Environ. Values* 22, 191–215. <https://doi.org/10.3197/096327113X13581561725194>.

Demertzis, M., Domínguez-Jiménez, M., Lusardi, A., 2020. The financial fragility of European households in the time of COVID-19, policy contributions 2020/15. Bruegel. URL: https://www.bruegel.org/system/files/wp_attachments/PC-15-2020-final.pdf.

- Dilger, M.G., Konter, M., Voigt, K.-I., 2017. Introducing a co-operative-specific business model: the Poles of profit and community and their impact on organizational models of energy co-operatives. *J. Co-oper. Organ. Manage.* 5, 28–38. <https://doi.org/10.1016/j.jcom.2017.03.002>.
- Energiegenossenschaft Starkenburg, n.d. AfrikaStark. URL: https://www.energiestark.de/projekt_art/afrikastark/ (accessed 4.5.24).
- European Commission, n.d. Energy communities repository. URL: https://energy.ec.europa.eu/topics/markets-and-consumers/energy-consumers-and-prosumers/energy-communities/energy-communities-repository-products_en (accessed 12.17.24).
- European Parliament, 2018. Directive (EU) 2018/2001 of the European Parliament and of the Council of December 2018 on the Promotion of the Use of Energy from Renewable Sources. <http://data.europa.eu/eli/dir/2018/2001/oj>.
- European Parliament, 2019. Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on Common Rules for the Internal Market for Electricity and Amending Directive 2012/27/EU. <http://data.europa.eu/eli/dir/2019/944/oj>.
- Eversberg, D., Schmelzer, M., 2018. The degrowth spectrum: convergence and divergence within a diverse and conflictual alliance. *Environ. Values* 27, 245–267. <https://doi.org/10.3197/096327118X15217309300822>.
- fairPla.net, n.d. That's how it works. URL: <https://www.fairpla.net/en/the-idea/thats-how-it-works/> (accessed 4.5.24).
- Fournier, V., 2008. Escaping from the economy: the politics of degrowth. *Int. J. Sociol. Soc. Pol.* 28, 528–545. <https://doi.org/10.1108/01443330810915233>.
- Georgescu-Roegen, N., 1977. The steady state and ecological salvation: a thermodynamic analysis. *Bioscience* 27, 266–270. <https://doi.org/10.2307/1297702>.
- Gibellato, S., Iaia, L., Fiano, F., Usai, A., 2022. Renewable energy communities and degrowth: participative governance for energy management. In: 2022 IEEE International Conference on Technology Management, Operations and Decisions (ICTMOD). Presented at the 2022 IEEE International Conference on Technology Management, Operations and Decisions (ICTMOD). IEEE, Marrakech, Morocco, pp. 1–8. <https://doi.org/10.1109/ICTMOD55867.2022.10041824>.
- Hickel, J., 2020. What does degrowth mean? A few points of clarification. *Globalizations* 18, 1105–1111. <https://doi.org/10.1080/14747731.2020.1812222>.
- Hickel, J., Kallis, G., 2020. Is green growth possible? *New Polit. Econ.* 25, 469–486. <https://doi.org/10.1080/13563467.2019.1598964>.
- Hickel, J., Kallis, G., Jackson, T., O'Neill, D.W., Schor, J.B., Steinberger, J.K., Victor, P. A., Ürge-Vorsatz, D., 2022. Degrowth can work — here's how science can help. *Nature Commentaries*. URL: <https://www.nature.com/articles/d41586-022-04412-x>.
- Institute for degrowth studies, n.d. What is degrowth? URL: <https://degrowth.se/whatis-is-degrowth-1> (accessed 02.24.25).
- International Degrowth Network, n.d. IDN member groups and organisations, URL: <https://degrowth.net/members> (accessed 02.24.25).
- IEA, 2022. Special Report on Solar PV Global Supply Chains. International Energy Agency, Paris. <https://www.iea.org/reports/solar-pv-global-supply-chains>.
- IPBES, 2019. Global assessment report on biodiversity and ecosystem services of the Intergovernmental science-policy platform on biodiversity and ecosystem services. URL: <https://doi.org/10.5281/ZENODO.3831673>.
- Jarvis, H., 2019. Sharing, togetherness and intentional degrowth. *Prog. Hum. Geogr.* 43, 256–275. <https://doi.org/10.1177/0309132517746519>.
- Kallis, G., 2018. *Degrowth*. Agenda Publishing, Newcastle upon Tyne, ISBN 9781911116806.
- Kallis, G., March, H., 2015. Imaginaries of hope: the utopianism of degrowth. *Ann. Assoc. Am. Geogr.* 105, 360–368. <https://doi.org/10.1080/00045608.2014.973803>.
- Kallis, G., 2011. In defence of degrowth. *Ecological Economics* 70, 873–880. <https://doi.org/10.1016/j.ecolecon.2010.12.007>.
- Karakas, C., 2019. Cooperatives: characteristics, activities, status, challenges. URL: [https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI\(2019\)635541](https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI(2019)635541).
- Kerschner, C., Wächter, P., Nierling, L., Ehlers, M.-H., 2018. Degrowth and technology: towards feasible, viable, appropriate and convivial imaginaries. *J. Clean. Prod.* 197, 1619–1636. <https://doi.org/10.1016/j.jclepro.2018.07.147>.
- Kunze, C., Becker, S., 2015. Collective ownership in renewable energy and opportunities for sustainable degrowth. *Sustain. Sci.* 10, 425–437. <https://doi.org/10.1007/s11625-015-0301-0>.
- Latouche, S., 2009. *Farewell to Growth*. Polity Press, Cambridge, ISBN 9780745646169.
- Lee, H., Calvin, K., Dasgupta, D., Krinner, G., Mukherji, A., Thorne, P.W., Trisos, C., Romero, J., Aldunce, P., Barrett, K., Blanco, G., Cheung, W.W.L., Connors, S., Denton, F., Diongue-Niang, A., Dodman, D., Garschagen, M., Geden, O., Hayward, B., Jones, C., Jotzo, F., Krug, T., Lasco, R., Lee, Y.-Y., Masson-Delmotte, V., Meinshausen, M., Mintenbeck, K., Mokssit, A., Otto, F.E.L., Pathak, M., Pirani, A., Poloczanska, E., Pörtner, H.-O., Revi, A., Roberts, D.C., Roy, J., Ruane, A.C., Skea, J., Shukla, P.R., Slade, R., Slangen, A., Sokona, Y., Sörensson, A.A., Tignor, M., Van Vuuren, D., Wei, Y.-M., Winkler, H., Zhai, P., Zommers, Z., 2023. Summary for policymakers. In: Lee, H., Romero, J. (Eds.), *Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Intergovernmental Panel on Climate Change (IPCC), Geneva, pp. 1–34. <https://doi.org/10.59327/IPCC/AR6-9789291691647>.
- Meadows, D.H., Meadows, D.L., Jørgen, R., Behrens III, W.W., 1974. *The Limits to Growth: a report for the club of rome's project on the predicament of mankind*, 2. A Potomac Associates Book. Universe Books, New York, ISBN 0876631650.
- Mocca, E., 2020. The local dimension in the degrowth literature. A critical discussion. *J. Political Ideol.* 25, 78–93. <https://doi.org/10.1080/13569317.2019.1696926>.
- Muraca, B., 2013. Décroissance: a project for a radical transformation of society. *Environ. Values* 22, 147–169. <https://doi.org/10.3197/096327113X13581561725112>.
- OPCD, n.d. Charte. URL: <https://www.opcd.co/observatoire/charte/> (accessed 7.14.24).
- Parrique, T., 2019. *The political economy of degrowth* (Doctoral Thesis). Université Clermont Auvergne, Stockholms Universitet. URL: <https://theses.hal.science/tel-02499463v1>.
- Petridis, P., Muraca, B., Kallis, G., 2015. Degrowth: between a scientific concept and a slogan for a social movement. In: Martinez-Alier, J., Muradian, R. (Eds.), *Handbook of Ecological Economics*. Edward Elgar Publishing, Cheltenham, UK & Northampton, MA, USA. <https://doi.org/10.4337/9781783471416.00012>.
- Polevsky, M., Hankammer, S., Kleer, R., Antons, D., 2024. Degrowth vs. green growth. A computational review and interdisciplinary research agenda. *Ecol. Econ.* 217, 108067. <https://doi.org/10.1016/j.ecolecon.2023.108067>.
- Qvinnovindar, n.d. Qvinnovindar. URL: <https://qvinnovindar.se/> (accessed 7.22.24).
- Radtke, J., Ohlhorst, D., 2021. Community energy in Germany – bowling alone in elite clubs? *Util. Policy* 72, 101269. <https://doi.org/10.1016/j.jup.2021.101269>.
- Raworth, K., 2017. *A Doughnut for the Anthropocene: humanity's compass in the 21st century*. *Lancet Planet. Health* 1, e48–e49.
- Rede para o decrescimento, n.d. Decrescimento? URL: <https://www.decrescimento.pt> (accessed 02.24.25).
- Research & Degrowth, 2010. Degrowth declaration of the Paris 2008 conference. *J. Clean. Prod.* 18, 523–524. <https://doi.org/10.1016/j.jclepro.2010.01.012>.
- Rommel, J., Radtke, J., Von Jorck, G., Mey, F., Yildiz, Ö., 2018. Community renewable energy at a crossroads: a think piece on degrowth, technology, and the democratization of the German energy system. *J. Clean. Prod.* 197, 1746–1753. <https://doi.org/10.1016/j.jclepro.2016.11.114>.
- Schmelzer, M., Vetter, A., Vansintjan, A., 2022. *The Future is Degrowth: a Guide to a World Beyond Capitalism*. Verso, London, New York, ISBN 9781839765841.
- Schneider, F., Kallis, G., Martinez-Alier, J., 2010. Crisis or opportunity? Economic degrowth for social equity and ecological sustainability. Introduction to this special issue. *J. Clean. Prod.* 18, 511–518. <https://doi.org/10.1016/j.jclepro.2010.01.014>.
- Schwanitz, V.J., Paudler, H.A., Wierling, A., 2023a. The contribution of European citizen-led energy initiatives to sustainable development goals. *Sustain. Develop.* 28, 2844. <https://doi.org/10.1002/sd.2844>.
- Schwanitz, V.J., Wierling, A., Paudler, H.A., von Beck, C., Dufner, S., Koren, I.K., Kraudzun, T., Marcroft, T., Mueller, L., Zeiss, J.P., 2023b. Statistical evidence for the contribution of citizen-led initiatives and projects to the energy transition in Europe. *Sci. Rep.* 13, 1342. <https://doi.org/10.1038/s41598-023-28504-4>.
- Sebi, C., Vernay, A.-L., 2020. Community renewable energy in France: the state of development and the way forward. *Energy Policy* 147, 111874. <https://doi.org/10.1016/j.enpol.2020.111874>.
- Sekulova, F., Kallis, G., Rodríguez-Labajos, B., Schneider, F., 2013. Degrowth: from theory to practice. *J. Clean. Prod.* 38, 1–6. <https://doi.org/10.1016/j.jclepro.2012.06.022>.
- Steffen, W., Richardson, K., Rockström, J., Cornell, S.E., Fetzer, I., Bennett, E.M., Biggs, R., Carpenter, S.R., De Vries, W., De Wit, C.A., Folke, C., Gerten, D., Heinke, J., Mace, G.M., Persson, L.M., Ramanathan, V., Rayers, B., Sörlin, S., 2015. Planetary boundaries: guiding human development on a changing planet. *Science* 347, 1259855. <https://doi.org/10.1126/science.1259855>.
- Stephens, J.C., 2019. Energy democracy: redistributing power to the people through renewable transformation. *Environment* 61, 4–13. <https://doi.org/10.1080/00139157.2019.1564212>.
- REScoop, n.d. The REScoop model. URL: <https://www.rescoop.eu/the-rescoop-model> (accessed 4.9.24).
- Stockholm Resilience Centre, 2023. Planetary boundaries. URL: <https://www.stockholmresilience.org/research/planetary-boundaries.html> (accessed 7.17.24).
- Trainer, T., 2012. De-growth: do you realise what it means? *Futures* 44, 590–599. <https://doi.org/10.1016/j.futures.2012.03.020>.
- Vadén, T., Lähde, V., Majava, A., Järvensivu, P., Toivanen, T., Hakala, E., Eronen, J.T., 2020. Decoupling for ecological sustainability: a categorisation and review of research literature. *Environ. Sci. Pol.* 112, 236–244. <https://doi.org/10.1016/j.envsci.2020.06.016>.
- Van Bommel, N., Höffken, J.I., 2021. Energy justice within, between and beyond European community energy initiatives: a review. *Energy Res. Soc. Sci.* 79, 102157. <https://doi.org/10.1016/j.erss.2021.102157>.
- Van Veelen, B., 2018. Negotiating energy democracy in practice: governance processes in community energy projects. *Environ. Polit.* 27, 644–665. <https://doi.org/10.1080/09644016.2018.1427824>.
- Walker, G., Devine-Wright, P., 2008. Community renewable energy: what should it mean? *Energy Policy* 36, 497–500. <https://doi.org/10.1016/j.enpol.2007.10.019>.
- Weiss, M., Cattaneo, C., 2017. Degrowth – taking stock and reviewing an emerging academic paradigm. *Ecol. Econ.* 137, 220–230. <https://doi.org/10.1016/j.ecolecon.2017.01.014>.
- Wierling, A., Schwanitz, V.J., Zeiss, J.P., Von Beck, C., Arghandeh Paudler, H., Knutsdotter Koren, I., Kraudzun, T., Marcroft, T., Müller, L., Andreadakis, Z., Candelise, C., Dufner, S., Getabecha, M., Glaase, G., Hubert, W., Lupi, V., Majidi, S., Mohammadi, S., Safara Nosar, N., Robio Du Pont, Y., Roots, P., Rudek, T.J., Sciallo, A., Sehdev, G., Ziaabadi, M., Zoubin, N., 2022a. ENBP inventory “Energy by people” - first Europe-wide inventory on energy communities. <https://doi.org/10.18710/2CPQHQ>.
- Wierling, A., Schwanitz, V.J., Zeiss, J.P., von Beck, C., Paudler, H.A., Koren, I.K., Kraudzun, T., Marcroft, T., Müller, L., Andreadakis, Z., Candelise, C., Dufner, S., Getabecha, M., Glaase, G., Hubert, W., Lupi, V., Majidi, S., Mohammadi, S., Nosar, N. S., du Pont, Y.R., Roots, P., Rudek, T.J., Sciallo, A., Sehdev, G., Ziaabadi, M., Zoubin, N., 2023. A Europe-wide inventory of citizen-led energy action with data from 29 countries and over 10000 initiatives. *Sci. Data* 10, 9. <https://doi.org/10.1038/s41597-022-01902-5>.
- Wierling, A., Zeiss, J.P., Candelise, C., Gregg, S., Hubert, W., Schwanitz, V.J., 2020. Who participates in and drives collective action initiatives for a low carbon energy

- transition? In: Diemer, A., Nedelciu, E., Schellens, M., Morales, M., Oostdijk, M. (Eds.), *Paradigms, Models, Scenarios and Practices for Strong Sustainability*. Editions Oeconomia, Clermont-Ferrand, ISBN 979-10-92495-13-3, p. 15.
- Wierling, A., Zeiss, J.P., Lupi, V., Candelise, C., Sciuolo, A., Schwanitz, V.J., 2021. The contribution of energy communities to the upscaling of photovoltaics in Germany and Italy. *Energies* 14, 2258. <https://doi.org/10.3390/en14082258>.
- Wierling, A., Zeiss, J.P., Von Beck, C., Schwanitz, V.J., 2022b. Business models of energy cooperatives active in the PV sector—A statistical analysis for Germany. *PLOS Sustain. Transform.* 1, e0000029. <https://doi.org/10.1371/journal.pstr.0000029>.
- Wirth, H., 2024. Aktuelle Fakten zur Photovoltaik in Deutschland. Fraunhofer - Institut für Solare Energiesysteme, Freiburg. URL: <https://www.ise.fraunhofer.de/content/dam/ise/de/documents/publications/studies/aktuelle-fakten-zur-photovoltaik-in-deutschland.pdf>.