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Original research article

Value dynamics in energy democracy: An exploration of community energy initiatives

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ABSTRACT

In the European Union, energy democracy (ED) is considered a socially desirable policy goal. One way to achieve ED is through empowering local communities to become agents of value change who can pursue more sustainable and equitable energy provision with community energy initiatives (CEI). However, such people-driven value change is complex in nature. CEIs are multifaceted sociotechnical systems that bring together sets of values and are composed of agents (i.e., people), technologies (e.g., solar panels), and institutions (e.g., renewable energy policies). Yet not much research is conducted into how values relate and overlap within this complex nexus of people - technology - institutions on a pathway to democratizing the energy sector through civic participation. In this paper, we spotlight value relationality to capture the diversity in the value landscape of people-driven energy transitions. We claim that each sociotechnical system has "climate" of its own, or *value dynamics*, induced by interrelating values. We propose an account that captures value dynamics, explores value sets brought together by the different sociotechnical components of CEIs and investigates various ways in which these value sets interrelate. To elucidate value dynamics in the context of CEIs, we have conducted a literature review, a content analysis of regional, national (i.e., Dutch), and EU policies, and expert interviews in two illustrative case studies. We finalize the paper with recommendations for further research on value dynamics in CEIs across various sociotechnical contexts.

1. Introduction

Over several decades, societal interest in the democratization and decentralization of energy production, generation, and distribution has grown sharply in many countries around the world (e.g., [1–5]). Increased bottom-up decentralization of the energy sector can be viewed as a reaction to existing challenges with centralized energy systems (e.g., [6,7]), which in the European Union (EU) still mostly depend on fossil fuels that cause harmful impacts on the environment and induce geopolitical conflicts [8–10]. Guided by efficiency, optimization, and profit maximization values, centralized energy systems have been locked in societies in a combination of technological, social, and economic path dependencies [11–14]. These path dependencies have accumulated in the energy sector over the last two centuries, leading to environmental degradation and social inequalities [15].

In light of alerting implications of anthropogenic climate change and recent tragic geopolitical events related to fossil fuel production, distribution, and supply [8,16], environmental movements are now more persistent than ever [16]. The motivation to transition into greener and more decentralized energy systems has been growing in response to anger and frustration with the inability of national governments to deal effectively with this issue. Subsequently, emerging institutional support and an increase in the installed capacity of renewable energy technology (like wind and solar) have enabled local communities to decide whether or not to stick with centralized energy systems [17]. The introduction of renewable technologies and their accessibility has created new forms of energy-related practices and the potential to engage in action by realizing values such as sustainability, equity, and democracy—not only for economically developed countries but also for those still in the process of development (e.g., [18]). One way to see this transition in the energy

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sector is as *a people-driven process of value change* ([19], p.383) that brings along socially (and ethically) desirable values previously overlooked by regime incumbents like recognition, diversity, empowerment, social justice, enthusiasm, democracy, autonomy—as in the case of social movements for fair energy systems and community energy initiatives (CEIs).

Such a process of change is supported by policy goals like energy democracy (ED), democratic goals supported by and for local communities aiming at more proactive participation (and the fairer) in decision-making about energy systems, while also having some form of ownership and financial participation in energy system assets [20–22]. Although ED aims to aid communities on their path to decarbonization and democratization, in the EU energy sector, people-driven value change is still rather complex in nature. As some studies have shown the process of empowering local communities can sometimes lead to injustices [1], controversies [23], and value conflicts [19,24,25], consequently followed by resistance toward specific greening projects (e.g., wind park project development) [26]. Whereas academic scholarship mostly focuses either on the challenges and controversies in CEIs (e.g., [23,26–29]) or a conceptual critique of ED (e.g., [21,22,30,31]), not much research is done about the way values relate and overlap within the complex nexus of people - technology - institutions on a pathway to the democratization of the energy sector by civic participation.

In our view, exploring value relationality is a matter of great importance as such focus would allow capturing the diversity of the value landscape of this people-driven energy transition. Values in sociotechnical systems (i.e., institutions (e.g., renewable energy policy), technology, and agents (e.g., individuals, collectives, organizations) are of different natures and origin; values may overlap and relate to one another in various ways and constitute nested systems of values. We suggest that exploring value relationality contributes to gaining insights regarding the threefold knowledge gap. First, we view local communities as social structures that are united and guided by collectively shared values. Therefore, questioning the nature of the values of these communities and the various ways in which they overlap with other values in the sociotechnical system, in our view, can help to understand the framings of what is considered a desirable energy transition [32]. Second, since communities consist of individual people whose values are informed by various cultural backgrounds, past experiences, and moral standpoints, apprehending these differences in values across contexts supports the value of diversity essential for understanding civic empowerment [33] and environmental movements more generally [34]. Third, as policy documents operationalize values (e.g., democracy, deliberation, equity, etc.) into specific goals and concrete steps to realize them, more research on values and value relationality will facilitate a better understanding of what and whose values are at stake and how they are intertwined, potentially leading to more socially acceptable regulations [35]. Therefore, our goal is to gain conceptual and empirical insights into the nature and relationality of values in the context of people-driven value change in the energy sector and answer the following research question: *What are the value sets brought together by the different sociotechnical system components of CEIs and how do these value sets interrelate?*

Our study is based on insights derived from a literature review (Section 2), a content analysis of policy documents, and two illustrative case studies of CEIs in the Netherlands (Section 4): Energie-U in Utrecht and BRES ("Bredase Energie Coöperatie" in Dutch; energy cooperative in the city of Breda; translation by the authors) in Breda. To spotlight the relationality of values, we conceptually consolidate an account of *value dynamics*—a specific "climate" contextualized within a *value system* where value interplays and interrelations (including value conflicts) occur (Section 3). We further explore insights about value dynamics in CEIs along the ED pathway in the two case studies and relevant text documents (Section 4). In addition to unscrambling the relationality of values in CEIs and ED, we finalize our paper by suggesting that insights into value dynamics could potentially inspire other researchers to further elucidate the diversity of value landscapes of people-driven energy transitions (Section 5).

2. Agents of change and the rise of social innovation in the transition to energy democracy

In the European Union (EU), ED is perceived as a climate change mitigation strategy [5,21]. It is a goal typically found in the EU policy [36,37] that is mostly focused on bringing about "participatory forms of energy provision and governance" [37] and empowering local communities to participate more effectively and have ownership in green energy transitions (i.e., bottom-up). It aims to integrate policies of social justice and economic equity within the transition to renewable energy [37] and is currently seen as a desirable direction by both the public and the EU government [36–38].

Community Energy Initiatives (CEIs) are important actors in attaining ED. The transition to ED through CEIs offers a way to address environmental concerns and carries significant long-term potential in promoting and implementing values relevant to low-carbon energy transitions [38]. In many ways, a beneficial transition to ED through CEIs empowers citizens to cooperate, decide, regulate, and engage with energy-related practices—both autonomously and relatively independently. To support this cooperation, the International Cooperative Alliance outlined several principles for CEIs (i.e.., voluntary membership and democratic member control; economic participation through direct ownership, autonomy, independence, and cooperation across cooperatives; and education, training, and informational support receptive to the concerns of the local community) [39].

CEIs' role in ED as a strategy is characterized by community participation [6] and plays a particularly essential role in expanding the scope of relevant values at stake and realizing the change in values guiding energy transitions. Burke and Stephens ([37], p. 35) note that ED can be understood as "a social movement advancing renewable energy transitions by resisting the fossil fuel-dominant energy agenda while reclaiming and democratically restructuring energy regimes", i.e., as a dynamic process. In the academic literature, a CEI represent a new type of grassroots innovation, or in other words, a social innovation that emerged in response to different energy-related controversies with the aim of achieving more democratic decision-making [40–43]. CEIs "contribute to low carbon energy transition, civic empowerment, and social goals pertaining to the general wellbeing of communities" ([7], p. 4). Moreover, as some authors point out, there is a normative dimension of such social innovation because it can be seen "as a form of 'social', collectively beneficial, desirable action" ([32], p. 3).

Although environmental philosopher David Schlosberg already stressed in 1999 [34], nowadays, one more commonly sees that communities are proactively seeking out normative change informed by values such as sustainability, equity, diversity, recognition, social justice, empowerment, and care [19,22]. Empowerment is an important value of this normative change and is seen as "as the process of an individual, group or community increasing their capacity and contextual power to meet their own goals, leading to their transformative action." ([33], p. 6) and eventually transformative change. In the EU, value-driven policy goals of ED encompass empowerment and community participation, but to a lesser extent, include a diversity of values with regard to CEIs that inform visions of socially desirable normative change.

Local energy communities—actors muted in decision-making procedures concerning energy generation, production, and distribution—introduce their values to constitute new visions, strategies, and plans to change the energy sector [19,44]. These visions and values are typically different from those held by energy regime incumbents (e.g., efficiency, optimization, and profit maximization values [11–14]). They are generally not (or only half-heartedly) supported by the centralized energy system model. The design of centralized energy systems is interwoven with that of the market, economy, and social order, making

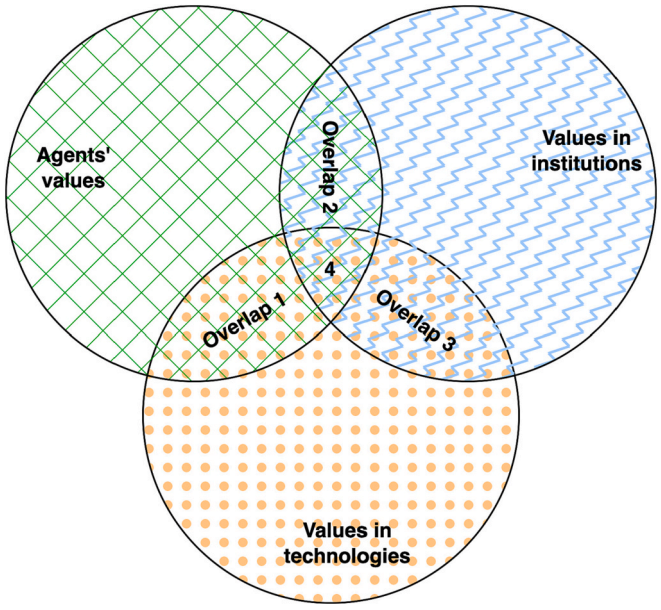

Fig. 1. Values and value overlaps in sociotechnical systems.

it challenging to accommodate these visions about important values. Some scholars frame this situation as (carbon) "lock-in" [14], or resistance to change from the regime [13]. Thus, values occupy an important role in the energy transition related to CEIs: they navigate transformative change in energy systems by guiding the interplay between communities, technology, and institutions [19,45–47]. This nexus between community (agents) – technology – institutions is what we refer to in this paper as a sociotechnical system [48–50].

Whereas ED is often criticized for conceptual ambiguity and weak theoretical foundation [21,22,31], in the European Union, ED is an umbrella term that unites policymakers, activists, and local communities engaged in energy transitions [22]. It is a policy goal that manifests a set of values deriving from social movements and is used to guide the energy systems' change [22]. Furthermore, ED allows more room for CEIs to contribute through civic participation, while facilitates the emergence of intermediaries that support interaction between CEIs, mobilization of resources, and capacity building (e.g., Energie Samen, the federation of community energy in the Netherlands) which directly or indirectly represent CEIs and assists local communities. In the Netherlands, for instance, residents of the city of The Hague collaborated with local municipalities and interest groups, and managed to set-up CEIs to support the city in reaching its target of zero emissions goals [51]. These initiatives can be considered agents of sociotechnical change who realize new values in the energy sector by greening and decentralizing energy systems serving their neighborhoods. They exemplify a normative take on social innovation as a response to morally problematic situations raised by existing sociotechnical arrangements [32] and are driving the ongoing transformation of the energy sector—a people-driven process of value change with the goal of reaching energy democracy [32,46].

However, since ED, as a policy goal, also aims to facilitate decentralization and digitalization (e.g., energy platforms, peer-to-peer transactions, smart grids, etc.) of the energy sector top-down, it may feel demanding to some local communities [24,52]. Choices about energy technologies and the degree of governmental support for a local energy transition to CEI also vary across the EU [33,53]. Because the transition to ED brings together different sets of values, tensions and controversies may arise at the point of intersection with CEIs' set of values (Fig. 1).

On the one hand, CEIs bring a set of values important for people and communities (i.e., agents' values in Fig. 1), like democracy, social justice, equity, recognition, diversity, trust, and transparency [5,7,20–22,31,33,43,54]. On the other hand, there are sets of values related to technology and decentralized energy systems, such as sustainability, autonomy, reliability, and affordability [3–5,7], and digitalization, like privacy, safety, security, and autonomy [19,52,55–57]. These overlaps might be triggering dynamics in energy communities' visions and values [58]. Other values relevant to institutions that may raise community concerns are legitimacy [59,60], sovereignty [37], energy sobriety [61], and energy autarky [62,63]. Such a complex combination of value sets may create a multifaceted challenge in the form of disagreements about values, typically framed in the literature as controversies [23] or value conflicts [25], since communities, as well as their members, also hold on to values that are often informed by (a variety of often differing) cultural backgrounds and moral standpoints [23,25,58,64].

Indeed, numerous combinations of factors can lead to each CEI having distinct cultural and moral patterns, making them unique, one-of-a-kind while having a distinguishable value landscape. Whereas various important distinctions can be made regarding the nature of local communities and their social relations, one distinguishable value intrinsic to all communities is diversity. While at the heart of the larger lacuna of environmental justice scholarship [34], in the existing literature on CEIs, traces of diversity are present only implicitly. Differences begin with the reasons behind community emergence and continue to regional and cultural aspects, personal values, distinctive traits (e.g., age group), political and economic sources of influence, ethnic, gender, and educational backgrounds, and technological literacy [33]. Some communities emerged, and occasionally became cooperatives, around energy and climate change issues, with CEIs becoming a stepping stone for their internal social relations. Others may have already existed for decades, with the energy component simply offering an additional layer to their existing social and economic relations. Other scholars pointed out that it is important to identify and include motivations on why people decide to join CEIs. Bauwens [42] finds that there are three main reasons. First, people care about the environment and want to encourage renewable energy development. Second, because of interpersonal trust, which he defines as "mirroring an expectation of trustworthiness," meaning that a person shows their trustworthiness ([42], p. 280). The third reason is social identification, which means that people feel a sense of belonging to a certain group.

Even within a single country, CEIs often have very different natures and are motivated by different values varying from sustainability and climate justice to affordability and other financially-related concerns [53]. Some studies have pinpointed this in the context of the EU while examining heterogeneous reasons that motivate people to join a CEI [22]. Van Veelen and Van Der Horst concluded that these are not always aligned with the visions and values shared by social movements striving to achieve ED [22]. Hence, asserting that there is an overarching value system that guides people-driven value change in the energy context is problematic. Long ago, in his critique of this idea, Schlosberg ([34], p. 28) suggested that only having a uniform perspective on value systems may downplay "potential and actual conflicts over values (e.g., ecocentrism/technocentrism, spirituality), issues (e.g., population, multiple use), and tactics (i.e., lobbying, boycotts, or direct actions)."

3. Conceptual background: values and value relationality in sociotechnical systems

In this section, we will elaborate on the idea of value relationality in the sociotechnical system. We will propose an account of value dynamics as a contribution to the energy scholarship ([35], p.5). In order to develop such an account, it is important to look into what values are, on which levels they occur, where they stem from, and how they relate to one another.

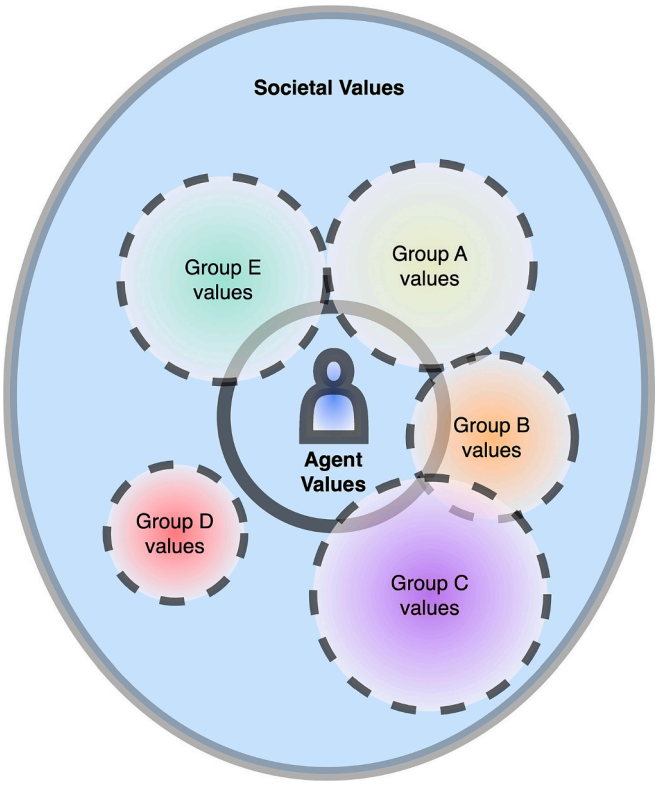

Fig. 2. Values on different levels.

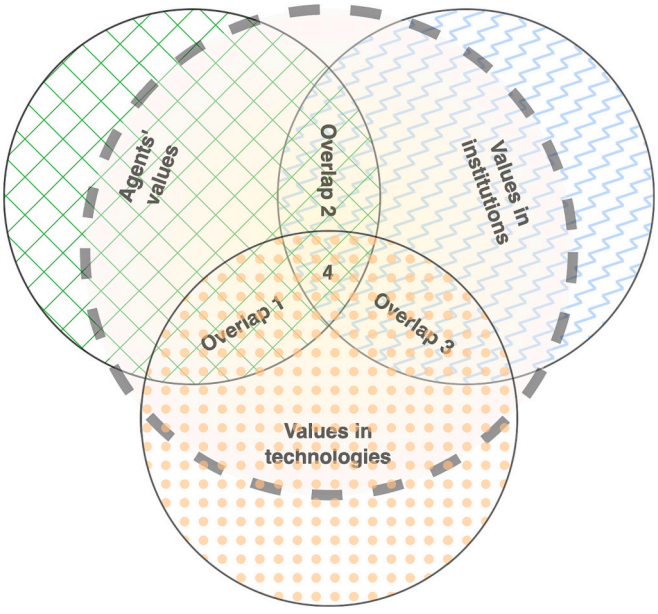

Fig. 3. Values in a dynamic sociotechnical context.

3.1. What are values? From descriptive to normative perspective

Values hold a distinguishable role in the academic scholarship on climate change and sustainable energy transitions as a means to deal with it (e.g., [45,47,65–75]). According to climate ethicist Dale Jamieson ([67], p. 79), values are an important research focus because climate change goes much deeper than fixing a problem by accumulating scientific information; it concerns how people relate to one another and the environment.

Whether discussed in social, public, or individual contexts, values are complex notions with rather ambiguous conceptual foundations that depend on the scientific standpoint. Within the social sciences, for instance, the meanings of values typically vary "from cognitively held beliefs to cultural principles embedded in social structures" ([66], p. 60). Social psychologists, who refer to the universal nature of human values, often capture values as individual beliefs [76–79] and claim values to be important for understanding pro-environmental attitudes and behaviors [80]. Various studies explored individual values as cognitive attributes of agents (people) who are important stakeholders in the context of energy transitions [58].

Sociologists commonly see values as a product of culture as opposed to cognition [81]. Such perspectives on values can be further traced in the environmental justice debates on the values of actors participating in environmental movements [34]. Positions in these debates typically refer to "post-materialism" values like self-expression, quality of life, and community [82]. Similarly, according to the different schools in New Institutional Economics, values are of social origins [83]. In the book "Understanding Institutional Diversity," Ostrom [84] implicitly elaborates on the nature of values, referring to them as dynamic and plural (p. 107), undoubtedly heterogeneous (p. 102) and resulting from iterative interactions of humans and their social environment (p. 106). This perspective was further developed in the context of energy technologies and institutions [45,85].

In the anthropological tradition, where two main conceptions of values are typically seen as derived from the structuralist approach and the action-based approach, values are mostly seen as a noun (e.g., privacy, trust) and refer to something that is related to a standard which is considered desirable and meaningful. Since that standard is what is desirable, everything is compared to this benchmark [86]. The placeholder of value can be an object, action, or practice. The proponents of the structuralist approach are coming close to sociologists by suggesting that values should be studied as social structures [86]. On the other hand, proponents of the action-based approach take a step away by arguing that certain objects obtain a value by doing an action with an object; hence the source of the value is the action [87].

What is common in social science visions on the nature of values is that values are often depicted descriptively. These perspectives cover at least three levels on which values can be studied: individual, group, and societal levels [88] (see Fig. 2).

At the same time, moral philosophers, who also contributed to a conceptual landscape around values, often suggest that the notion of values can also be seen as a normative phenomenon [89] indicative of the moral desirability of a certain action or state of affairs. Moral values typically refer to what is considered to be good or valuable as well as what is considered to be right or evaluated as right or wrong [90]. Similar to anthropology, moral values can be seen as the standards, criteria, and merits and thus contain normative power in terms of which evaluation, comparison, and assessment of certain choices are made. They may manifest certain goods, duties, and obligations and therefore prescribe a fundamental basis for individual or collective moral compass [91]. Many philosophers further distinguish between intrinsic and instrumental values as "ends in themselves" as opposed to "means to an end" [68,90,92]. These discussions can be traced in numerous philosophical debates around the value of nature [68] as well as debates within the ethics of technology (for instance, in the context of information ethics, see [93–95]). Moral values can be conceived as abstract nouns (e.g., good), concrete nouns (e.g., justice), or verbs (valuing activity) and are often framed as evaluative and deontic ways of understanding values [91]. Kroes and Van de Poel [96] distinguish between evaluative and deontic statements in which moral values can be depicted. They emphasize that moral values have a judgmental force that is executed by evaluative judgments of at least two kinds: i) as evaluative statements that evaluate state-of-affairs in terms of goodness (e.g., sustainability as new criteria evaluating what are the good technologies); and ii) as deontic statements that are about the rightness of specific

actions (e.g., one should not kill/lie) [96].

But what is distinguishable from the philosophical point of view is that is typically overlooked in the social sciences is that personal (moral) values may deviate from social (moral) values [88]. In other words, values that people find morally relevant on the individual level might not correspond with normative expectations of what a group or a society considers morally desirable values.

3.2. Values in sociotechnical systems

Numerous scholars emphasized the role of moral and public values in social acceptance [66] and the ethical acceptability of energy systems [24,25,45,65,74,97]. These studies typically refer to values embedded in different components of sociotechnical energy systems whose performance, following Hughes [50], depends on the dynamic interaction of technology, agents, and institutions (see Fig. 3). In our view, understanding the complexity behind values might be relevant in researching academic and public debates around CEIs and ED, as well as during empirical analysis (e.g., when conducting stakeholder interviews). We suggest that researchers see CEIs as always existing in a dynamic sociotechnical context that brings together different values stemming from technology, institutions, and people.

To understand the dynamics in sociotechnical systems, ethics of technology typically takes a more interactionist approach where values are seen as dynamic, formed as products of interactions between a context and the technologies and regulations implemented in that context. In the literature, this relates to the idea of perceiving values as a verb or an action attributed to certain technologies with evaluative (normative) power, where values can be conceptualized as lived experiences and a product of valuing activities [98] resulting from the dynamic interaction of a sociotechnical system's components. From this perspective, values stem not just from agents (individuals) but are also introduced by technologies and institutions. They shape and are shaped by practices taking place in a particular sociotechnical context. Moreover, values can also emerge within these practices, such as the conceptualization of privacy (e.g., [99]).

In the EU, for example, the Responsible Research and Innovation (RRI) framework is inspired by the fundamental idea that technologies and institutions are value-laden [100–104]. It is an influential paradigm that reflects the idea that in order to meet socially desirable expectations of responsible innovation practice, designers, engineers, and policymakers should consider and anticipate societal implications and consequences of new and emerging technologies with respect to moral values [103,105,106]. This perspective is rooted in the idea that new and emerging technologies can both afford (enable or allow) and foreclose human practices [107], and thus, to steer the innovation process, values can be embedded during technological or/and institutional (see [69,85]) design processes [96,102,108].

Indeed, as various scholars pointed out, the dynamic interaction of the components of the sociotechnical system often results in ethical implications which are not limited by physical damage but are so-called soft impacts (i.e., morally undesirable effects on identities, behaviors and values) [109,110]. Therefore, attention to moral values embedded in these components is considered essential. Within this nexus, the impact of technologies is often seen as uncertain, which may change people's understanding of what is important, meaningful, desirable, or valuable. Dynamics in sociotechnical systems may also cause moral change, which is extensively covered in the literature on technologically induced moral change that includes changes in values, identities, and habitual practices [98,110,111] and value change that focuses more exclusively on changes in values relevant for technological design and governance (e.g., [47,112–116]). Embedding moral values into technologies and institutions may help to design sociotechnical systems that would be (more) socially and morally desirable.

3.3. Value relationality in sociotechnical contexts

In the context of energy scholarship, value relationality is often discussed as value conflict between members of communities as well as between regional and national policies (e.g., [19,24,25,64]. In these contexts, value conflicts are typically defined as "two or more values [that] conflict in a specific situation if, when considered in isolation, they evaluate different options as best" ([108], p. 997). De Wildt et al. [24] provide a comprehensive overview of value conflicts that arise during the design of a smart grid which trigger community acceptance issues. The authors emphasize that technologies can help solve value conflicts but can also contribute to their very emergence [24]. For example, smart grids may help to address the conflict between reliability and efficiency, on the one hand, and environmental sustainability on the other hand. At the same time, these technologies raised challenges between "justice on the one hand and reliability, competitiveness and environmental sustainability on the other" ([24], p. 188). The study showed that parameters like income, education, and the type of housing greatly impact individual access to these technologies.

While some scholars use theoretical and conceptual frameworks that allow them to deal directly with conflicts [117], others emphasize the democratic value of social conflict as a form of self-organized participation which is often rooted in disagreements about values [64]. In philosophy, opinions diverge on the relationality of values, specifically value conflict between moral values. Some philosophers, for instance, defend the idea that values are irreducibly plural and sometimes are in unresolvable tensions with other values [118]. Others [116,119] propose the opposing perspective that stresses that values are inseparably connected to fulfilling their social functions while enabling the emergence of practices, social structure, and institutions. Dworkin [119], for example, claims that understanding values is only possible in the context of other values; the fulfilment of one value depends on the inclusion of other values. In other words, values do not exist in a void; they are relational and compatible and constitute networks or systems ([119], p. 120).

Hence, a *value system* is an intertwined network of different values that correlate and interlink. This is a fundamental notion that is present in the climate ethics literature [34,67,120] as well as the ethics of technology [116,121]. Van de Poel [121] argues that values emerge in systems that he calls clusters. Such clusters pertain to "a number of values that are a response to similar types of moral concerns and express similar moral reasons" [121]. He furthermore argues that transcending from framing issues as mere value conflicts to framing them in a value system allows: i) to consider a broader range of values; ii) to accommodate a context where an issue occurs; and iii) to better understand what is at stake in the conflict. While this analysis occurred in the context of cybersecurity, one can imagine that this perspective is also applicable to dynamic sociotechnical systems in an energy systems context.

Following Van de Poel [121], in the present paper, we suggest situating the analysis of value conflicts in the context of other values and their relations to prevent narrowing down the focus to the notion of conflict. We argue that focusing on value systems and value relationality provides researchers with a fruitful ground for scientific exploration which go beyond conflicts and controversies raised in various sociotechnical contexts. The idea that values are relational and constitute a value system is essential for the proponents of the structuralist approach in anthropology [86]. An important insight from the structuralist approach is how values exist in a value system and can structure social order, which acknowledges the power that values can have in changing and structuring a social order based on value hierarchy [86,122]. Following the idea of a value system, a value such as sustainability can bring along other values such as justice, sobriety, and care for the environment or future generations (implicitly illustrated by [123]). At the same time, in our view, the system created by values should not be understood as one that is set in stone with a particular hierarchical order

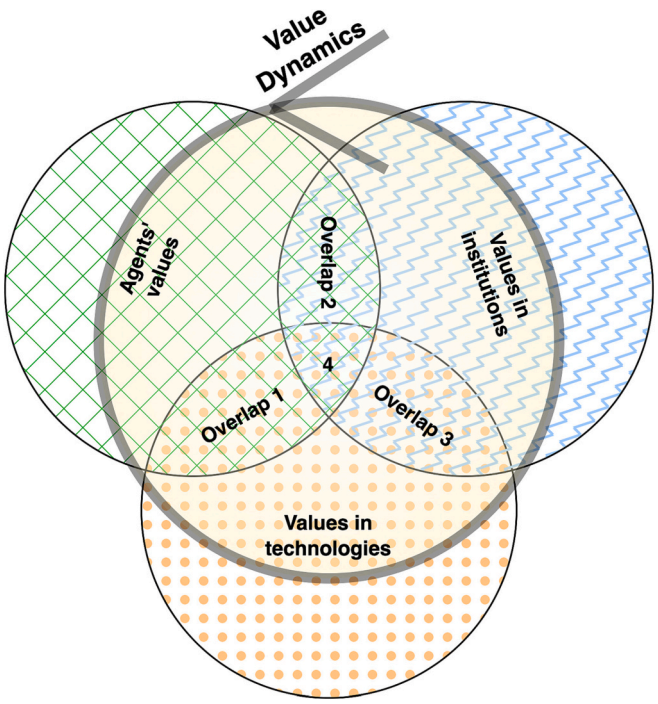

Fig. 4. Value dynamics in a sociotechnical context.

of values (as Dumont [122] would argue[2]). Instead, it should be used as a frame for understanding the nature, structure, and relations of values that compose these systems within the nexus of technology - institutions - agents.

In our view, it is particularly insightful to understand the relational dynamics in a value system as a sort of "climate" that is specific to each particular sociotechnical context. Similarly to Van de Poel [121], we suggest that by studying value systems, one opens up a space for exploring value relations and interactions that may condition controversies and value conflicts—and thus gains insights into the "climate" within the system where these controversies occur. A specific "climate" resulting from the complex interaction of technology, institutions, and people is what we call *value dynamics* (Fig. 4).

Hence, based on the previously discussed perspectives on values and value relations, we suggest an account of value dynamics. This account holds that, in the context of the people-driven energy transition, the occurrence of moral and non-moral values may overlap on different levels (e.g., individual, group, society) and stem from the interrelation between people, technology, and institutions. In our view, applying this account to CEIs helps to capture the diversity in the value landscape of this people-driven process, which can contribute to a better understanding of the framings of what is considered to be a desirable energy transition and how to create more socially and morally acceptable regulations.

4. Converging empirical and conceptual explorations to elucidate value dynamics

Building on the conceptual understanding of value relationality in a sociotechnical system, in this section, we will further explore the diversity of the value landscapes in the two illustrative case studies framed as sociotechnical systems. We collected data by conducting semi-structured interviews and executing content analysis in selected policy documents to further explore the conceptual insights about value dynamics in two illustrative cases of CEIs.

The interview data were gathered in two CEIs in the Netherlands: 'Energie-U' in Utrecht and 'BRES' in Breda. Both initiatives were selected because they were set up by citizens (i.e., social innovation), they represent bottom-up initiatives, and their aim is to contribute to democratic decision-making along with a transition to sustainable energy. The two case studies also have their differences, which make them relevant for the exploration of value dynamics. For one, 'Energie-U' has existed since 2010 while 'BRES' was only initiated in 2014. Secondly, and most importantly, the two initiatives are located in different regions in the Netherlands; this means they are subject to different regional policies, a different degree of urbanization, and different socio-economic environments and cultures [124,125]. As we pointed out earlier in Section 2, various combinations of factors can lead to unique patterns in CEIs, and distinct values and value systems. The differences explained above show the diversity of the two case studies chosen and were important to understand the context and the unique pattern of the CEIs in which the values that we encountered occur. Furthermore, the interviews gave us insights into values not only on the individual level but also group level, as well as insights into the value dynamics. The interviewees expressed personal values but also values they considered to be the cooperative's.

A content analysis was conducted using different policy documents (i.e., [126–129]) and the websites of 'BRES' and 'Energie-U' to study values and value dynamics on the societal level (i.e., which values and value sets are present in policy documents and the CEIs' communication to external parties). This content analysis included the EU directive (Directive (EU) *2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources*') since it provides the guidelines and context for the Dutch National Climate Agreement and, subsequently, regional policies. We extracted values that are considered to be societal from the policy documents, whereas the websites of the case studies were used to extract values that the case studies feel are important to communicate or with which they hope to connect to people.

4.1. Empirical exploration of conceptual insights into value dynamics

The values that were identified through the literature review, content analysis, and the exploration of two case studies can be categorized based on the three levels (i.e., individual, group, and societal) and discussed according to where the values stem from (i.e., agents, technology, or institutions). However, as the academic investigation and the illustrative case studies confirmed, this does not mean that every values can be categorized in only one level. For example, the illustrative cases of 'Energie-U' and 'BRES' showed that the value of trust could originate from both an individual level (as an interpersonal trust) and from a societal level (as trust between cooperatives). It is, therefore, important to carefully indicate the level at which the values occur to capture potential overlaps.

4.1.1. Societal values relevant to CEIs and ED

Societal values are made explicit in policy documents. For this reason, the content analysis on EU policy and specifically Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources has been a useful start to understanding how societal values are expressed on an EU level. Consequently, the content analysis on national policy gives insight into the transposition of the EU directive and, consequently into societal values that are deemed important on a national level. The content analysis of several policy documents supporting the development of CEIs—an EU energy directive, the Dutch National

[2] Dumont [122] argued that values are hierarchical; in this hierarchy, the one value that is most important is desirable. He claims that other values are consequently compared to the paramount value and given a certain rank. However, the research for this paper does not fully follow this line of reasoning. The idea that values are hierarchical and that some values are more important than others only adds complexity to this discussion.

Table 1
Classification of the account of value dynamics.

Types of values	Non-moral values
	Moral values
Levels on which values occur (Fig. 2)	Individual
	Group
	Societal
Stemming from? (Fig. 1)	Agents (individuals or groups)
	Technologies
	Institutions
Overlaps and interrelations (Figs. 2 & 4)	Agent-Group-Society
	Agent-Technologies
	Agent-Institutions
	Technologies - Institutions
	Agent-Technologies-Institutions

Table 2
Value-related concepts to explore values on different levels (based on Fig. 2).

Levels	Value-related concepts
Individual	Experiences
	Motivations
	Practices
	Values
	Goals
	Own expectations
	Emotions
Group	Challenges
	Tensions
	Values
	Changes
	Technology
	Expectations from others
Societal	Practices
	Values
	Initiative
	Collaborations
	Expectations from members
	Goals

Climate Agreement, and regional energy strategies relevant to 'Energie-U' and 'BRES'—showed some movement toward ED. The EU directive (i.e., REDII) addressed CEIs by giving a generic definition of renewable energy communities (e.g., [126], p. 103). While this directive should influence national policy documents, CEIs are not explicitly mentioned in the Dutch National Climate Agreement [129], an agreement between many companies and organizations aimed to reduce greenhouse gas emissions in the Netherlands by 49 % by 2030. It is a part of Dutch climate policy. However, values such as citizen participation which refer to CEIs, are present (e.g., [129], p. 23) and could be interpreted as values embedded in policies to support CEIs.

Following the idea of ED as a policy goal, the Dutch National Climate Agreement aims to achieve ED through a process of citizen participation and social acceptance in the renewable energy transition (e.g., [129], p. 25–26). These values originate from policy documents or, in other words, institutions, thus, bringing it back to the sociotechnical context in which we discuss values. However, CEIs as an actor are captured rather abstractly in their role in the energy transition. Additionally, it could be explained a bit more exactly how they should engage in the process to achieve democratization of the energy sector. In contrast, some regional policy documents (i.e., regional energy strategies; for details, see [130]) pay attention to the inclusion of citizens and public participation (e.g., [128], p. 27; [127], p. 21). Overall, there is more focus on transparency. The documents also differ in some respects; the plan for the region where 'BRES' is located (i.e., West-Brabant) provides more details about how to include citizens as well as CEIs. This is a clear acknowledgment of the position of CEIs and their potential role in the energy transition.

There is an overlap between some of these values in institutions and individual components of sociotechnical systems. Values such as transparency, inclusion, and participation are values which members of the CEIs also expressed. Thus, on the societal level we can find values that are also shared by agents on the individual level. This gives us the understanding that societal values can be shared by individuals (which does not necessarily have to be true all the time [88]). When focusing on where these values originate from, on the societal level values such as participation and inclusion originate from institutions. However, when expressed explicitly, values from certain individuals also influence values that stem form institutions [47]. Therefore, participation, inclusion, and transparency are values that exist in the overlapping areas between institutions and individuals (see overlap 2 in Fig. 4) and between collective and individual levels.

Interviews revealed that on the societal level, values such as recognition, care for the environment, expertise, transparency, financial security, participation, and trust seem important to both 'Energie-U' and 'BRES' as a cooperative in relation to external actors. However, these values often have slightly different meanings for energy community members. For example, the value of trust was expressed differently in each initiative. For 'Energie-U', trust was indicated as an issue between the cooperative and the municipality. Here trust was expressed as something desirable, but it was not there yet: "…they [the cooperative] really should be given the benefit of the doubt" (interviewee 1, Energie-U).

For 'BRES', trust was a value that was identified as important and present. There was a lot of trust between the cooperative and the municipality. Interviewees linked this mostly to the continuation of financial security and communication during a time of crisis. The COVID-19 pandemic period has confirmed their 'bond of trust':

> "As far as I can judge, they [the municipality] are really helping us and now, in the crisis, we cannot do everything we said we wanted to do. But they said [to] just look for other things and we will keep the funding going, and we don't, we won't go investigating exactly what you did. But that is a real bond of trust, yes."
>
> (interviewee 9, BRES)

Some values were found in only one of the two case studies, e.g., autonomy ('BRES'), honesty ('BRES'), clear communication ('BRES'), locality ('Energie-U'), and awareness ('Energie-U'). This shows that the values are indeed dependent on the sociotechnical contexts, which are very individual to each community and, therefore, cannot be generalized.

From the interviews, we also encountered values on the societal level that were influenced by institutions and technologies (see overlap 3 in Fig. 4). While institutions emphasize the need for knowledge and expertise for CEIs to develop, technologies also require the user to have sufficient knowledge to be able to work with them. At the same time, both 'Energie-U' and 'BRES' expressed the (lack of) knowledge and expertise that they have and share with their members and other local energy cooperatives. More specifically, although allowing energy autarky, promoted by policies digitalization of the energy sector requires certain expertise to understand how these technologies actually work. A lack of such expertise may potentially refrain community members from the decision-making process and thus lead to less inclusive deliberation. This overlap of institution and technology creates opportunities for CEIs to act but, at the same time, constraints and challenges when this particular form of expertise is absent or is not supported within the CEI community.

4.1.2. The group level: values in CEIs

On the group level, the values shared across the two cases were transparency and independence. These values were experienced on a relational level between members of the cooperative. Transparency on this level came across as being transparent to members about the actions and decisions that board members took. As one interviewee (#9, BRES) indicated, "we want to explain why we [i.e., the board] made these decisions." Independence emerged as a value when talking about the

expectations people had of each other. Some interviewees expressed that they expected everybody to be independent when doing their job in the energy cooperative. For example, one interviewee noted that, "we have some tension between some people who are not experienced in working together. Or not experienced in…working well without a leader, without having a boss" (interviewee 3, Energie-U).

On the group level, we can also see how individual values such as care for the environment, activism, and social engagement come together in, for example, socialization. Even though an interviewee expresses it as being able to find people with similar interests, it shows how a CEI is a place where people-driven change can begin and take off. People with similar interests and values find each other and act collectively, instead of individually.

4.1.3. Individual values of CEI members

On the individual level, members of 'BRES' and 'Energie-U' expressed personal values such as care for the environment, solidarity, expertise, participation, and socialization. Other values expressed individually were affordability (e.g., it was important that investments in making homes sustainable were affordable); gender equality (one of the few women expressed that she thought having more women in the cooperative would be beneficial); activism (some interviewees explicitly called themselves activists); and social engagement (some interviewees joined the cooperative in order to be more socially involved).

As we can see in this overview of values on the individual level, there are overlaps at both the societal and group level, such as expertise and participation. When looking at the values discerned from the perspective of a sociotechnical system, we observe that there are individual values, e.g., participation, which are shared by institutions, as addressed in the analysis of the policy documents (see overlap 2 in Fig. 4). We discern values that are not shared between individuals, institutions, and technology, for example, gender equality. This value is not present in institutions related to CEIs, nor in technologies for CEIs, which can cause challenges and constraints for individuals to achieve the goal they deem important.

4.1.4. Relationality of values and value dynamics in the CEI value system

Interestingly, none of the values described above, from the three different levels, are experienced by stakeholders in isolation from other values. To illustrate this, we zoom in on the values expertise (on both the societal and individual level), financial security, and recognition (both at the societal level). Interviewees expressed the need for more knowledge (expertise) and funding in order to be taken more seriously and gain more recognition. Yet, the interviewees also argued that funding should be spent on the right things, such as member education, so that the cooperative could gain knowledge rather than relying on external experts. Other values linked to recognition are responsibility and independence. Interviewees say that people should feel responsible for the things they do, and these responsibilities should be recognized. When jobs are done well, this helps an energy cooperative improving its image. In turn, this also helps them gaining more recognition from other stakeholders. Many of the values at different levels are clearly linked within a value system. This, therefore, supports our conceptual claim about the relevance of the notion of *value systems* for capturing the value landscape of each particular CEI.

The empirical data further indicated that within a value system, values interact with each other and consequently form various value relations. For example, one interviewee reported that, "some residents are not interested in sustainability, but only in living conditions, work, and safety" (interviewee 3, Energie-U). In this example, the values of sustainability, safety, and comfort are present. In a situation where people make energy-relevant decisions (e.g., how to conserve energy at home), these values interact with each other. While these values do not consequently conflict, one value might *override* the other one in given situations. After all, safety and comfort are considered more important than sustainability to some residents. This is an example of value relations between the agents' individual values, located at the individual level. However, this also has implications to the group level and societal level, as it could make it more difficult for both the energy cooperative and the municipality to increase public awareness and active participation in the energy transition and to achieve their societal values.

This example also reveals that the conceptualization of values and their relations are subject to change. In one situation, the value of sustainability could override the value of comfort or vice versa. However, these values can also *complement* each other. One interviewee installed thermal insulation to express care for the environment. However, after installment, the interviewee noticed how insulation also provided both extra comfort and financial savings. At that point, the different values experienced by the interviewee complemented each other: care for the environment, comfort, and affordability. This shows that it is possible to indicate that the relationality of values generates a climate within a value system. This climate can transform along with how the context in which the values are experienced changes, and with how values interact with each other when a new technology or policy is being introduced due to certain climatic disruptive events, and so on.

However, since external factors can influence a climate in the value systems and can induce change in value relations, a longitudinal study of value dynamics is necessary to capture various changes. Indeed, as was shown in the content analysis of the REDII, the Dutch National Climate Agreement, the two regional energy strategies and the analysis of the interviews, the situational context of a CEI can influence its relations and experiences over time. For example, a CEI may feel acknowledged and supported by the region or municipality in which it finds itself, but this may change both ways after municipality meetings and other interactions. This was also showcased in the two CEIs; while there were indicated issues about transparency and recognition in the city of Utrecht, there was a lot of hope for solving these issues in the future. At the same time, this was less of a problem in the city of Breda, where there was a high degree of transparency and recognition between the energy cooperative 'BRES' and the municipality. These values, however, emerged between the cooperative and the municipality over time. This again shows the importance of diversity in approaching CEIs, where CEIs exist out of individual people with personal values and are influenced by their contextual institutional values and values coming from various renewable energy technologies.

4.2. Reflection

With the insights provided by the account of value dynamics (Section 2), we further explored the nature of values and value relations in two case studies and conducted a content analysis of relevant policy documents. In the development of CEIs in the Netherlands, value dynamics generated at the individual, group, and societal levels appeared to be rather complex. Based on observations made in the 'BRES' and 'Energie-U' CEIs we captured different dynamics across levels and value sets that led to various unintended outcomes and controversies. Indeed, the members of 'Energie-U' and 'BRES' identified some problems; they felt they were not taken seriously by the municipality (interviewee #3, Energie-U) and wanted the municipality to better recognize their values and take their initiative and projects more seriously (interviewee #5, Energie-U). Some interviewees mentioned that despite technologies were allowing to pursue values like sustainability, autonomy, energy autarky and sovereignty, community members lacked technological expertise which could be a reason why they were not taken seriously. At the same time, members of the two energy cooperatives stated that they needed some form of support from the municipality to build up their expertise, which meant they were also dependent on the municipality. Focusing on the value dynamics, therefore, allowed us to reveal underlying value relations between agents' sets of values, technologies' sets of values, and value sets in institutions. We observe that these different sets of values intersect and sometimes lead to various tensions and challenges, typically framed in the literature as controversies [23].

An additional factor that possibly contributes to these issues is a tension in the overlap between institutions and agents (see overlap 2 in Fig. 4), in which the EU REDII Directive recognizes CEIs but only loosely defines the term itself. The policy document does not incorporate the value of diversity nor does it explain what these initiatives are or how and where they could be valuable. Although EU Member States are compelled to transpose these directives into national legislation, this gap seems to lead to only abstractly mentioning of CEIs in national policies. So, while the Dutch National Climate Agreement mentions the importance of the value of citizen participation in the energy transition [129], this is the only mention that comes close to the discussion of values relevant to CEIs.

Furthermore, there is clearly a gap between what value sets are brought by regional policies (i.e., at the societal level) and the value sets of CEIs (i.e., at the group level). What they have in common, is the value of democracy. CEIs want to be included, and policies want to include CEIs, aiming to realize a democratic transition. Still, there are differences in which other values (or value sets) relate to democracy. The policy documents show that participation is an important value to the state, while community energy refers to a broader range of values (e.g., transparency, recognition, expertise, sustainability, decentralization, autonomy, gender diversity, etc.). There are many different values at stake that are not being recognized by both groups; this means that not all values on the group level are also prioritized on the societal level.

5. Conclusions and future research agenda

We argued that understanding value relationality in the context of community energy initiatives (CEIs) as a pathway to energy democracy (ED) is a matter of great importance as it allows one to capture the diversity of value landscapes of each particular CEI. Building on a literature review, we suggested that the transition to ED by means of civic participation is a people-driven process of value change that brings along socially desirable value sets previously overlooked by regime incumbents (e.g., sustainability, recognition, diversity, empowerment, social justice, enthusiasm, democracy, autonomy). Further analysis of academic scholarship allowed us to capture the different sets of values that come together (e.g., community values, decentralized energy systems values, digitalization values) and to frame them as value overlaps in sociotechnical energy systems (i.e., agents, institutions, technologies). Considering how complex these overlapping sets of values are, we accentuated the relationality of values as an essential notion to understand the diversity of value landscapes of CEIs on the pathway to ED.

Based on the cross-disciplinary conceptual insights, we consolidated an account of *value dynamics* that allows capturing a "climate", that is contextualized within a *value system* where value interplays and interrelations (including value conflicts) occur. This account holds that, in the context of the people-driven energy transition, the occurrence of moral and non-moral values may overlap on different levels (e.g., individual, group, society) and stem from the interrelation between people, technologies, and institutions. In our paper, we claim that applying the account of value dynamics to CEIs helps to capture the diversity in the value landscape of this people-driven process which can contribute to a better understanding of the framings of what is considered to be a desirable energy transition and how to create more socially and morally acceptable regulations. Hence, while a majority of studies typically explore values in CEIs on the pathway to ED from a descriptive point of view (e.g., [3–5,7,20–22,28,29,31,33,43,54,66,131–134]), in this paper, we developed and explored the account which converges descriptive and normative perspectives on values. Furthermore, we gathered and analyzed data from two illustrative case studies of CEIs in the Netherlands, and analyzed EU, national, and regional policies to further explore value relationality in sociotechnical energy systems. The case studies illustrated how values coexist and relate to one another in different ways within the nexus of agents - technologies - institutions.

We demonstrated that insights into value dynamics might also advance an understanding of the reasons behind challenges with the institutional facilitation of CEIs as a pathway to ED. Notably, we pinpointed that technologies occupy an ad-hoc role. Incumbent policies often treat technologies as purely instrumental, which can lead to a very limited take on the challenges brought by new renewable technologies and related value sets. Technologies are continuously upgrading, which can lead to new user experiences that trigger adjustments in value meaning among users [98,99,115,135] and even cause moral change [111]. As the results of our study showed, the implementation of technology can cause value dynamics that transform relations between the values contextualized within CEIs. For instance, after one CEI member used thermal insulation to conserve energy at home in light of environmental values, other members saw value in lowering energy bills and having overall warmer house. Since these additional values emerged from previously unconsidered concerns, they were not reflected in the initial reasons for installing thermal insulation. Once they were present they contributed to the creation of meaning concerning acting upon environmental concerns. Installing thermal insulation therefore created new experiences that impacted the value conceptualization and subsequently affected value relations. While comfort and (financial) affordability were initially not as important as environmental values, their combination strengthened the effect of the latter (with regard to persuading a home owner to invest in thermal insulation and have it applied). Notably, whereas sustainability and affordability can be considered conflicting values in some contexts [24], the two case studies analyzed in this paper showcase that these can be complementary values in other.

At the same time, we found certain challenges resulting from institutions sometimes "blindly" promoting technofix approaches. We extracted insight into how values overlap on the societal level and are influenced by values stemming from institutions and technologies. This overlap showed that while institutions emphasize the need for knowledge and expertise for CEIs to develop, technologies also require the user to have sufficient knowledge to be able to work with them. Accommodating this in a responsible manner would require additional input to the diversity of value landscape of CEIs, demographic composition (e.g., age), and location in the digital divide spectrum (high-tech region vs. low-tech region).

Furthermore, we have indicated that insights into CEIs' value dynamics are important for the democratization of the energy sector as they allow monitoring of local self-regulation that may be conditioned by extensive digitalization of the energy sector and the value sets this transformation brings along. Such observations have significant implications for reconsidering the role municipalities play in CEIs' knowledge development. Other studies have highlighted that local government support is a crucial factor in the success story of CEIs since upskilling and informing members is essentially part of their duties [40,136]. As Kooij et al. ([136], p. 62) note, CEIs need solid connections to knowledge institutes, technology developers, and policies to "flourish" because "without institutional space, GIs [i.e., CEIs] remain subjected to the dominant power-relations, and cannot exert much influence upon the energy system." A similar observation was made by Proka et al. [137], who focus on approaching a conflict between incumbent energy regimes and niche initiatives.

At the same time, CEI may also empower regime incumbents by collaborating with them, while indirectly giving them legitimacy in doing so. Thus, in addition to contributing to the academic scholarship, studying value dynamics can potentially help municipalities and other public bodies becoming more familiar with the value landscapes of CEIs in order to be more receptive to the value of diversity that is essential for of the transition to ED.

5.1. Future research agenda

Building upon insights from our explorative study of value dynamics in CEIs as a pathway to ED, in the remainder of this manuscript, we will

elaborate on future research directions. We will present these research directions as a list of research agenda items.

5.1.1. A step beyond "value conflict"

During our literature study, we touched upon "value conflict" as a type of value relation several times. Our illustrative case studies have also indicated some tensions between values that had emerged among community members' visions and values as well as between community and local government values. Although value relations within members of CEIs and between CEIs and governmental entities and policies are explored by some researchers (e.g., [19,24,25,64]), issues are typically framed solely as value conflicts. Based on the exploration of our case studies, we showed that when it comes to interactions between community members and between communities and municipalities, not all tension surrounding values imply a conflict between them. We postulated that interpreting these dynamics as a mere value conflict reduces the likelihood of recognizing what dynamic is actually at stake. Values may relate to one another in more ways, e.g., values may interrelate by complementing or overriding one another. In the context of value conflict scholarship [19,24,25,64,138], the perspective on how values interrelate and overlap in sociotechnical systems provides a novel angle on studying diverse and dynamic value landscapes of CEIs. In this light our research is a first step in this direction which requires follow-up empirical investigations in order to validate this point in multiple contexts and cases.

5.1.2. Empirical validation of value dynamics

It has been suggested that the account of value dynamics can reveal the diversity of value landscapes of CEIs and be used to disclose the challenges to achieving energy democracy, i.e., as a policy goal. However, our study was limited to two case studies. This limited the list of value relations and the dynamics they induce for extracting cross-cultural patterns and generalizable results. We believe that more value relations can be found in different case studies and/or different contexts indicative of other challenges in achieving ED. To better understand the relationality of values in CEIs, it would be helpful to supplement our study by conducting more content and discourse analysis of policy documents as well as in-depth interviews with municipality authorities, interest groups, and policymakers. We furthermore suggest that in addition to content analysis and interviews, it is worth expanding the collection of case studies across different cultures. In such an empirically oriented cross-cultural exploration of value relationality, we encourage researchers and practitioners to focus on values, value relations, and the dynamics within the sociotechnical system of each particular CEI.

Furthermore, we recommend that researchers consider a cross-cultural study of CEIs' value systems to capture value dynamics across contexts and have a broader understanding of the communities at stake, their diverse nature, heterogeneous value compositions, and the challenges these communities are going through on a pathway to ED. Such a conceptual lens can be useful for social scientists that conduct empirical research and/or use social simulation approaches to study energy transition.

5.1.3. Compatibility with other approaches to study energy sociotechnical systems

It would be interesting to further explore the account of value dynamics as an addition to existing approaches to studying energy sociotechnical systems. For instance, an additional layer of power relations in the sociotechnical systems could be interesting to combine with the insights into value dynamics in the same sociotechnical system. As we have discussed in this paper, values can stem from agents, institutions, and technology. An analysis of these value relations with power dynamics in mind can provide additional insight into the origin of the values.

Another approach that could be interesting to explore in combination with values in the study of sociotechnical systems is sociotechnical imaginaries [139]. Questions on imaginaries in combination with values and value dynamics could give insights into the relationship between current values, what people value for the future, and how they imagine those values in sociotechnical systems.

In addition to value relations, studying value dynamics has a potential in providing one with important insights into the interaction between different types of actors. In the illustrative case studies, we indicated that whereas a conflict implies that the public and a municipality are distinct parties, understanding each other's values and the dynamics they generate can provide insight into who the relevant stakeholders actually are and how they expect to be included. Thus, studying value dynamics helps to avoid focusing on the problem on the surface while providing an opportunity to capture the diversity of stakeholders and their values. In our view, such an account could contribute to what Cuppen et al. ([23], p.7) call a "meta-analysis of the dynamics of controversies" whereby helping to extract insights about value relationality in patterns, visions, and frames as well as interactions between different actors it can aid CEIs on their way to democratized energy systems.

Considering the growing interest in synthesizing literature on Energy Justice, Responsible Research and Innovation, and Value Sensitive Design [140], we also see the potential in our account to facilitate such conceptual collaboration. Responsible Research and Innovation framework as well as Value Sensitive Design aim to scrutinize moral values in the design and governance of sociotechnical systems. In particular, these approaches focus on how values can be embedded in technology and institutions [98] and recently also on how to deal with changing values [115]. Although our study has touched upon the impacts of technologies and digitalization on CEIs' values, we suggest that further research of new and emerging technologies in the energy context plays a major role in understanding the relationality of values in CEIs. In our view, such an encompassing approach to study CEIs can also reveal insights into different tenets of energy justice as well as justice issues emerging due to value overlaps between different facets of sociotechnical systems. While in this essay, we made the first step by exploring the account of value dynamics and extracted insights just from the two illustrative case studies, for the future research we recommend to focus on the diversity of value landscape of CEIs, including demographic composition (e.g., age), perspectives on the role of technologies (pro-growth vs. degrowth), and location in digital divide spectrum (high-tech region vs. low-tech region).

Last but not least, while in our case studies, not much was reported on technologically induced moral changes or moral change in general, other studies pinpointed a possibility of various types of value changes [114]. It would be fruitful to extend the account of value dynamics further to capture the dynamics of moral change and temporal interrelations of values in sociotechnical systems. Insights into these may potentially lead to, for instance, capturing the emergence of new values, changes in value conceptualization, or change in value prioritization.

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.

Data availability

The authors do not have permission to share data.

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Appendix A

A.1. Data collection and analysis

The research used semi-structured interviews and content analysis to further explore the insights about value dynamics in two cases of CEIs. Interviewing stakeholders is a relevant method as it provides a deeper and more substantiated understanding of values, an opportunity to reflect on the composition of a value system and an evaluation of the value dynamics in that system. Twelve in-depth interviews were conducted using a semi-structured questionnaire. A snowball sampling method, asking interviewees for contact details of others who might be willing to participate, was used to find more interviewees within one case study. This resulted in interviewees with different responsibilities at the cooperative: there were people from the cooperative board, long-term members, new members, and energy ambassadors. Four of the interviews were conducted with experts in the field.

Interviews mostly took place using Zoom or Microsoft Teams, and each participant signed the informed consent form. Based on the participants' permission, interviews were also audio-recorded using the same software program. Some interviews were conducted via telephone and recorded using a separate recording system. Next, we transcribed the interviews and anonymized the interviewees using names such as 'interviewee 1' or 'expert 1'. The collected data were processed and stored in accordance with the European Union 2016/679 General Data Protection Regulation.[3]

The data from the interviews, documents, and websites were coded and analyzed using Atlas's 8.4 Windows software, by Atlas's Scientific Software Development GmbH. Codes used to analyze the data were based on value-related concepts. After coding, quotes with the same codes were grouped under 'values' or 'value dynamics' to understand how people conceptualized values and reflected on value dynamics. From these quotes, we extracted additional insights into different values and value relationality that causes dynamics using the various definitions and conceptualizations given by the interviewees or expressed in the documents.

[3] While the anonymized data is available to other researchers with login access, sensitive (not anonymized) data is only available to us and the principal investigator. After the project, the anonymized data and results will be transferred to the 4TU.Center for Research Data as a secure data repository for 10 years. Sensitive data will be transferred to DANS-EASY, a secure data repository, where it will remain for 10 years. Data collection was carried out in the context of a doctoral research project that was part of a larger research project titled "Project Name" As this is an ERC advanced grant project, data will be stored on SURFdrive cloud storage until 2024. This project (application ID 1094) was approved by the Human Research Ethics Committee of "anonymized institution" on 17 March 2020.

A.2. Case study selection

A.2.1. Energie-U

Energie-U is situated in the city of Utrecht in the Netherlands. Utrecht is located in the Dutch 'Randstad,' and therefore has a more urban character. The cooperative was first founded in 2010 as an association. Three years later, in 2013, it became a cooperative. The board of Energie-U refers to the cooperative as "citizens of Utrecht who boost, organize and watch over renewable energy at home, in their neighborhood and in their city" [124]. The cooperative mostly provides public information about saving energy, sustainable energy generation, and efficient energy usage. It organizes projects, activities, and events with its members and implements (climate) actions for these three purposes. In addition, the cooperative also has some volunteers called 'energy ambassadors' who have specialized knowledge of some aspects of renewable energy. These volunteers share their knowledge with other citizens and organize events about their field of expertise (interviewee 1, personal communication, April 30, 2020). During the first few years, the cooperative initiated a windmill project on the outskirts of the city to the north in an industrial area called 'Lageweide.' But due to resistance from nearby residents, the project failed, and no windmills were placed. In response to this situation, Energie-U started to focus more on other activities, such as solar panel installation and activities to save energy (interviewee 2, personal communication, May 11, 2020).

A.2.2. BRES

The second case study, BRES, is a cooperative located in the city of Breda in the south of the Netherlands (Noord-Brabant) outside the 'Randstad.' This means it has a more regional character than Utrecht. BRES arose from a street initiative that saw residents wanting to expand their efforts to make energy more affordable and sustainable for the whole city rather than just their own street (interviewee 7, personal communication, June 8, 2020). Set up by two Breda residents, it targeted other homeowners in the city with the aim of helping them making their houses more sustainable and providing information on more energy-efficient solutions (interviewee 6, personal communication, May 26, 2020; interviewee 7, personal communication, June 8, 2020). Similarly to Energie-U, BRES provides its members with the opportunity to get help from an 'energy coach' who offers tips and ideas about sustainable energy solutions. BRES also participates in several cooperative projects with the municipality of Breda, such as a mobile Information Center (e.g., [141,142]) that they circulate through Breda to reach all residents [125].

A.3. Analytical framework

To operationalize the account of value dynamics into an empirically tangible concept, we emphasize the role of 'context' and divided it into three levels on which different values interact and value sets may potentially overlap: the level of an individual agent, the level of a group, and the level of society. These levels are based on the understanding that values can be individual, as well as collective (on the level of a group), or societal, where the group or societal values do not always need to be shared among all individuals [88]. Therefore, individual values can overlap with group or societal values, but it is not a given. Operationalizing the value system into these levels allows for a better understanding of how values coming from different sources (people, institutions, technology) can interact and overlap within and between different levels (Table 1).

To empirically explore the relationality of values and capture value dynamics in each sociotechnical context, we operationalized values into different value-related concepts based on the conceptual input we provided in Section 3 (for more details see Table 2). During the interviews, we inquired stakeholders about personal experiences (e.g., emotions, daily practices, motivations, challenges, and tensions) based on the idea that values are not just nouns but also verbs and can be captured as lived

experiences.

Similarly, in order to capture the normativity of values as attributed to what is desirable, we extracted insights about expectations and socially and morally desirable goals. In this way, in addition to capturing what stakeholders suggested being their values during data gathering, we also aimed to extract insights about values that are explicitly and implicitly embedded within practices, experiences, motivations, expectations, goals, etc. With these supporting notions, we try to be sensitive to the value-ladenness of technology and institutions during interviews and content analysis.

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