Involvement in bottom-up energy transitions

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3 A SOCIAL NETWORK PERSPECTIVE ON INVOLVEMENT IN COMMUNITY ENERGY INITIATIVES: THE ROLE OF DIRECT AND EXTENDED SOCIAL TIES TO INITIATORS

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Abstract

This study investigates the role of social networks in influencing individuals' decision whether to participate in a community energy initiative (CEI), by incorporating different types of social contact between community members and CEI initiators. Engagement of community members is crucial for the success of a CEI and thus a key question is how the initiators can reach community members and stimulate involvement. By analyzing the community's social network we investigate how the structure of social relationships between community members and initiators influences participation. We take both existence and number of strong and weak direct personal ties into account. In addition, we investigate the role of extended ties community members have to initiators, operationalized via indirect links through co-membership of local associations. Data were obtained from eight communities in the Netherlands where a CEI was recently initiated (N= 467 respondents in total). Our results demonstrate that community members' willingness to participate in a CEI is positively associated with direct ties to the initiators, both weak and strong, but there is no association with extended ties to initiators. Possible strategies how initiators might best utilize their social ties are discussed.

3.1 Introduction

Local communities, scientists, and policy makers are increasingly interested in the potential of local communities to initiate and run their own energy saving and production programs as a means to promoting a sustainable energy transition, dubbed bottom-up community energy initiatives (CEI's hereafter) (IPCC, 2018; Middlemiss & Parrish, 2010).

Usually one or more community members take the lead in setting up a CEI. They shoulder the "start-up costs" of the initiative, initiating a process potentially generates a critical mass (Marwell & Oliver, 1993; Schelling, 1978) of participating community members. In this respect, CEIs resemble certain collective action (Bell et al., 2005; Brewer & Stern, 2005; Kalkbrenner & Roosen, 2016) and social movement dynamics: setting up a CEI and pushing it past the threshold of viability is a "lumpy" problem requiring a significant initial investment of resources. Below the threshold CEIs wither away, but past it they can spread and bloom comparable to Step-Level Public Goods (cf. Dijkstra & Bakker, 2017). One of the main challenges of setting up a successful CEI is for the initiators to engage other community members. Importantly, CEIs are not set up in a social void. They operate in local communities and entail collaboration towards achieving a common goal of the community (Rees & Bamberg, 2014). To the extent that local social networks are a recourse for recruitment, the connectedness of the community determines who can and cannot be reached by the initiators of the initiative. Indeed, "(…) the potential value of the community-led approach is partially predicated on its localness, inclusiveness, and an assumed associated ability to leverage local social networks to achieve change" (Creamer, Allen, & Haggett, 2019, p. 948). This raises the question what the conditions are under which initiators succeed in "leveraging the local social networks" in order to engage other community members in the initiative.

Members of a social network are directly, indirectly, or not at all connected to one another (e.g., Knoke & Yang, 2011). By analyzing a community's social network, in particular the local embeddedness of the initiators, we can investigate how the local social relationships potentially influence the diffusion of an initiative within the community (cf. Borgatti, Mehra, Brass, & Labianca, 2009; Degenne & Forsé, 1999). More specifically, we can investigate the role of social relations in an individuals' decision to participate in a CEI.

This study contributes to a small but growing body of work within the domain of CEIs focusing on social relations affecting participation and success of such initiatives (Bauwens, 2019; Hoffman & High-Pippert, 2010; J. C. Rogers et al., 2012; Warbroek et al., 2019) rather than focusing exclusively on individual characteristics such as personal pro-environmental motivations and strong environmental values (Dóci & Vasileiadou, 2015; Perlaviciute & Steg, 2014; Sloot et al., 2018; Stern, 2000). Preliminary findings among members of initiatives show that the presence of other members in one's network matters for involvement in early stages of project development (Bauwens, 2019). In addition, Hoffman and High-Pippert (2010) showed in a study on several initiatives in the US that recruitment depended on personal contacts and 'neighborly' relations. Despite the trend of placing increased emphasis on social relations, research into the role social networks play in CEIs remains scant. Our study contributes to closing this gap by broadening the empirical basis of research into social networks by looking at the existence and the number of both strong and weak direct ties community members have with the CEI's initiators. In addition, we examine the existence and the number of extended ties. This way, we contribute to the scientific field but also inform policy-makers and (initiators

of) energy initiatives to design effective strategies for engagement. We employ our approach in 8 communities in the Netherlands where a CEI was recently initiated (N= 467 respondents in total), including inhabitants with varying levels of intention to participate.

In the next section we develop our theoretical and methodological contribution in more detail and formulate hypotheses to be tested in this empirical study. Afterwards we describe our methodology and presents results, followed by a discussion of our findings and our main conclusions.

3.2 Theoretical and methodological contribution

Theoretical work on the role of networks in CEIs is scarce. Therefore, we turn to research on social movement and on the diffusion of innovations for theoretical guidance. According to both social movements theory (e.g., McAdam & Diani, 2003) and theory on cooperation on networks (e.g., Dijkstra & Van Assen, 2013) success of a CEI is expected to depend on successful diffusion through the community from a set of initial "seeds" (e.g., M. O. Jackson, 2008), in this case the initiators. Social movement research consistently shows the importance of social relations and social-structural positions of movement members for movement success (Fernandez & McAdam, 1989; Gould, 1991; Kitts, 1999; Marwell, Oliver, & Prahl, 1988; McAdam, 1986; Opp & Gern, 1993; Tindall, 2002). Particularly, direct social relations of potential participants with those already mobilized are of crucial importance for movement success (e.g., McAdam & Diani, 2003). Yet, there has been little attention to *which* ties matter. Particularly, the impact of the strength and number of ties between community members and initiators and the role of extended ties have remained underexposed.

First, the current literature lacks information on how different types of social relations affect participation in CEIs. Second, most social movement studies almost exclusively focus on ego-networks, measuring the connections of a person ("ego") to others in a network (e.g., McAdam & Diani, 2003). Yet, an ego-network approach alone cannot identify the extent to which initiators are embedded in their respective communities and, hence, limits investigation into how initiators' ties affect the mobilization of other community members. Specifically, for the mobilization of a community member it may not only be important whether this member is directly connected to an initiator, but also whether (s)he is linked indirectly to an initiator via a shared membership of an organization within the community, referred to as an "extended tie"(a term stemming from research on intergroup relations using contact theory (e.g., Munniksma, Stark, Verkuyten, Flache, & Veenstra, 2013)). Extended ties might be especially promising when it comes to the recruitment of community members beyond the group of initiators and their close social relations.

Earlier research largely neglected the role of the structural positions of initiators mainly because collecting complete social network data (i.e., accounting for every link among all individuals in a social system) is infeasible in many real-life communities and is usually limited to relatively small or online social networks (Bale, McCullen, Foxon, Rucklidge, & Gale, 2013). Therefore, we propose an alternative approach for addressing the role of direct and extended ties between community members and initiators that allows for scrutinizing strong and weak direct ties, as well as extended ties.

Our effort to map extended ties leverages the fact that people usually do not randomly meet each other. Through their memberships in formal and informal associations in the community (sometimes referred to as foci), individuals are embedded in many associational networks (Feld, 1981; McAdam & Paulsen, 1993) which can be used to map the wider community social structure. Taking such associational networks into account, in addition to direct personal ties to the initiators, allows us to identify extended ties of community members to the initiators via these associations.

3.2.1 Direct ties to initiators

Over the past decades there has been much attention for the role of social relations in explaining the spread of (collective) behavior such as recruitment in social movements and the adoption of technological innovations. Research has consistently shown that both ties to other organizations (Fernandez & McAdam, 1988; Gould, 1991; McAdam, 1986) and prior contact with a movement participant (Briet, Klandermans, & Kroon, 1987; Granovetter, 1978; Kim & Bearman, 1997; Marwell et al., 1988; McAdam, 1986) contribute to movement participation. In addition, adoption of renewable energy technologies specifically has been shown to be primarily determined by the connectedness of people to others in their network (Axsen & Kurani, 2012; Jager, 2006). Social networks come into play because information about others' decisions, interests, and resources matter for ego's own decision and must be accessed through social ties (Macy, 1990). In addition, processes like persuasion (others convince me that I should adopt), coercion (ther punish me for not adopting), and conformity (what I think others expect me to do) operate through social ties (Axsen & Kurani, 2012; Kadushin, 2012; E. M. Rogers, 2003; Valente, 2012). In the case of collective action specifically, direct contact with someone already participating reduces the uncertainty of mobilization (I am at least sure I will not be the only participant), influences the availability of solidarity incentives for participation (knowing a participant personally, I might feel more or less morally obligated to participate as well), and reduces the cost of coordination by rendering communication easier (McAdam & Paulsen, 1993). This leads us to the following hypothesis:

Hypothesis 1: Individuals who have a direct tie to one of the initiators are more willing to participate in a CEI compared to individuals who do not have a direct tie

3.2.2 Strength of direct ties

The strength of ties can vary based on the emotional intensity, reciprocity, degree of intimacy, and frequency of contact (Granovetter, 1973). One can distinguish between relationally weak ties such as acquaintances, and strong ties such as close friends. While on the structural level weak ties matter because they serve as bridges between otherwise isolated parts of a network, at the relational (dyadic) level weak ties are important because they are more likely to provide people with novel information (Burt, 1997; Granovetter, 1973). Thus, weak ties are thought to provide access to external resources of various kinds, to new ideas and information (e.g., Burt, 1997; Granovetter, 1973). Weak ties have been proposed to accelerate diffusion processes like the adoption of new technologies (E. M. Rogers, 2003), and foster the coordination of collective action (Macy, 1990).

Although weak ties may generally matter, "[…] this is not necessarily true for whatever is to be diffused" (Centola & Macy, 2007, p. 703) and just receiving information rarely is enough to adopt a certain behavior (Gladwell, 2000). To engage in an innovation is costly, especially for early adopters due to the uncertainty of success. Costs and risks (not restricted to finances) are generally lower for those who wait, since they can make a better estimate of the innovation's chances of success based on its history. This cost-pattern certainly holds true for the field of rapid technological, legal, and political transformations in which decentralized CEIs operate. In addition, it is hard for individual community members to foresee how dependable the new energy cooperation will be (e.g., how well organized they will be), and energy prices, determining the profitability of participating, are equally hard to predict. Yet, once these start-up costs have at least in part been covered by others and the risk of failure has been substantially reduced, participating in CEIs becomes more attractive. This pattern of costs and risks gives incentives to all community members to "wait and see" (cf. Granovetter & Soong, 1983; Valente, 1996). While in a low risk condition weak ties and low social pressure might be enough to draw people into participating, in high(er) risk conditions strong ties have been found to matter most for involvement in social movements (Della Porta, 1988; McAdam, 1986; Opp & Gern, 1993; E. Ostrom, 1990). Strong ties require repeated social interaction and are often found in more homogenous, tightly-knit groups. They facilitate diffusion because next to information they provide trust, and social support and can be used to impose social pressure (McAdam, 1986; McAdam & Paulsen, 1993; Passy, 2003). Strong ties have also been shown to be important for the start of cooperation in institutions for collective action more generally (E. Ostrom, 1990). Thus, we expect that strong direct ties to initiators have a unique effect for participation in a CEI over and above weak direct ties. This is not to say that weak direct ties do not matter. However, acknowledging the importance of strong direct ties takes into the account the relative importance of social reinforcement versus information in mobilizing action (Macy, 1990). We thus distinguish two types of direct ties to initiators, strong and weak direct ties. We hypothesize that:

Hypothesis 2a: Individuals who have a strong tie to one of the initiators are more willing to participate in a CEI compared to individuals who have either a weak tie or no tie

Hypothesis 2b: Individuals who have a weak tie to one of the initiators are more willing to participate in a CEI compared to individuals who have no tie

3.2.3 Number of direct ties

Not just the mere *existence* of direct ties can be expected to relate to community members' willingness to participate, but also the *number* of ties to initiators (so-called network degree). Following Centola and Macy (2007) a contagion process is complex if the spread requires an individual to have interaction with multiple "infected" contacts who have adopted the behavior. Generally, individuals are more likely to adopt a new behavior when they have higher network exposure to it (Valente, 2010). This notion is at the heart of the complex contagion idea, as "hearing the same story from different people makes it seem less likely that surprising information is nothing more than the fanciful invention of the informant" (Centola & Macy, 2007, p. 708). This suggests that exposure to the CEI via multiple ties and through separate channels in the network increases the chances that a community member will participate

(cf. Tindall, 2002). At the starting phase of a CEI, the initiators themselves are the only direct sources of information about the initiative, and thus having multiple ties with them directly increases exposure to their ideas and behaviors. Thus, the number of ties to initiators should be positively associated with a community member's willingness to participate in the initiative. We hypothesize that especially the number of strong ties has an effect, leading to the following hypotheses:

Hypothesis 3: Individuals who have more direct ties to initiators are more willing to participate in a CEI compared to individuals who have fewer direct ties

Hypothesis 4: Individuals who have more strong ties to initiators are more willing to participate in a CEI compared to individuals who have fewer strong ties

3.2.4 Extended ties

Participating in CEIs is a high threshold behavior requiring (preferably multiple) direct strong ties. As previously mentioned, weak and extended ties can be expected to have little direct impact in such a situation (Easley & Kleinberg, 2010). Yet, weak and extended ties can still play an important subsidiary role. While strong ties reduce the risk of participating, increase trust in the information provided by the source, and are generally conduits for other social motivations (pressure, support, etc.), these ties also often contain redundant information. Weak and extended ties can then provide additional, more (seemingly) independent sources of information needed to "(…) reinforce both the credibility of the information and the normative importance of taking action" (Centola & Macy, 2007, p. 730). When theorizing the diffusion of participation in CEIs, we are thus led to investigate extended ties, as well.[8]

Extended ties to initiators can affect community members' willingness to participate the CEI in two ways. First, extended ties independently create exposure to the initiators' ideas about sustainable energy and provide channels for the flow of information about the on-going CEI. People are unlikely to deliberately act in a pro-environmental way if they know nothing about the problem or possible solutions (Gifford & Nilsson, 2014). Specifically, without knowledge of the existence of and general information about the initiative, people cannot become involved.

Second, extended ties may coexist with direct ties (Munniksma et al., 2013). When combined with direct ties, extended ties provide verification of the information acquired through the direct tie; a community resident may need the exposure to initiators via multiple strong ties (for e.g., trust, social pressure, and support) but also the lower level exposure (merely information) provided by extended ties. Thus, although an independent positive effect of extended ties on participating the initiative is not excluded by our reasoning, we certainly expect a positive effect of such a relation when combined with existing (strong) ties. Our theoretical reasoning leads to the following hypothesis.

Hypothesis 5a: Individuals who have an extended tie to one or more of the initiators are more willing to participate in a CEI compared to individuals who do not have an extended tie

Hypothesis 5b: Having an extended ties to one or more of the initiators increases an individual's willingness to participate more when also having a direct tie

8. Extended contacts in our framework are indirect ties to the initiators which can be composed of various combinations of weak and strong ties. In this study we do not focus on that composition and treat all extended ties equally.

3.3 Method

3.3.1 Mapping the community social network

The empirical mapping of community social networks seems to require the collection of complete network data, i.e., data on all existing connections between all community members. However, collecting such data in real-life communities as we studied them in this research is practically hardly feasible. The communities we studied consist of between 240 and 3200 households. In this study we offer as an alternative what we deem a feasible and effective way of mapping a community's social structure beyond direct ties to the initiators of the CEIs, without collecting complete network data.

Individuals are embedded in many organizational or associational networks (McAdam & Paulsen, 1993). They organize their social relations around certain social, psychological, legal, or physical foci (workplaces, voluntary organization, hangouts, family, etc.) which shape the opportunities of people to meet and interact (Feld, 1981; McPherson, 1982; Mollenhorst, Völker, & Flap, 2008). Through shared (formal and informal) associational memberships, community members can be indirectly linked to initiators of the CEIs.

The associational memberships of community members shape a community's affiliation networks. An affiliation network consists of two kinds of nodes: a set of actors and a set of events (in casu associations), resulting in a two-mode network (Faust, 1997). We endeavored to obtain an approximate picture of the structure of the community social network in which the CEI is embedded by taking a sample of the community members, eliciting their direct ties to the initiators and their associational memberships as well as those of the initiators (see Figure 1 for the affiliation network in one of the communities included in this study).

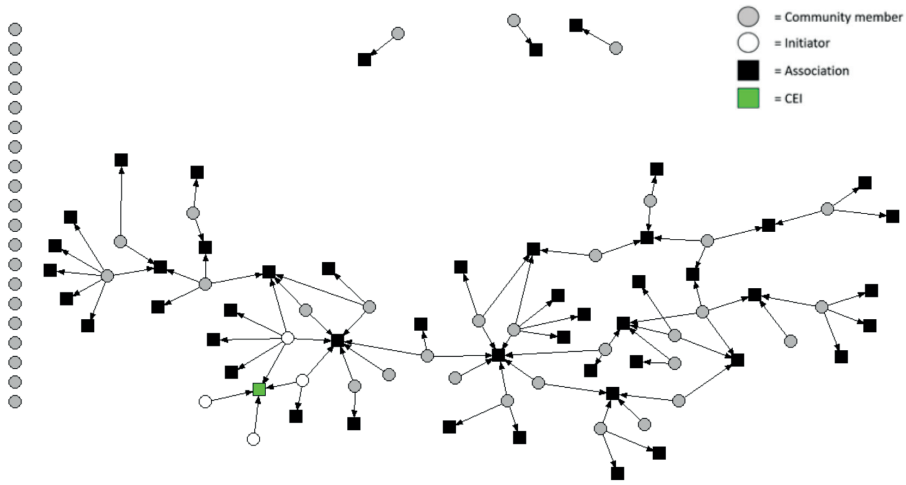


Figure 3.1: Affiliation network of one of the sampled communities (excluding direct ties to initiators); an arrow reflects a membership of a community member in an association

3.3.2 Sample and procedure

Data were collected via self-administered questionnaire in eight local communities in the Netherlands in which a CEI had recently started, comprising seven villages and one city neighborhood. All initiatives aim to make their local community energy neutral within the next ten years. The communities were supported by the Dutch foundation "Together Towards Energy Neutrality" (Stichting Samen Energieneutraal, n.d.), which provided advice and functioned as an umbrella network organization for all the local initiatives. Data was collected within these communities between 2015 and 2018, after an information evening about these initiatives had been organized.

First, an information letter about the upcoming study with a short initial survey containing a request for participation was sent to community members door-to-door (administered in Dutch). We asked one adult resident per household to fill out the survey and send it back to us, to indicate whether they were willing to participate in the study. These invitations were accompanied by a prepaid response envelope. In the short survey, people could indicate whether they would like to receive an email with a link to an online questionnaire or request a paper version of the questionnaire that would be sent to them via regular mail; in this case, they needed to fill out their address details. In addition, questionnaires were delivered door-to-door to a random sample of initially approached households who had not responded to our initial request for participation.

The total number of households approached for the main questionnaire was 2159, of which 617 completed a questionnaire (response rate 30% for the main questionnaire; ranging from 26% to 44% across communities). We removed all respondents who indicated to be initiators of the initiatives (as they were already part of the initiative), 48 in total, which reduced the sample to 569 respondents. To facilitate comparisons between the different analysis steps, the sample is limited to respondents who have non-missing values on all variables used in this study, resulting in 467 cases[9], of which of 59.8% are male and 40.2% female, with a mean age of 57.48 (*SD* = 14.38). The median household income level was 2.000-2.999 euros net per month (see for all descriptive statistics Table 3.1).

3.3.3 Measures

All variables used in our analysis are measured at the respondent level. However, especially the variables referring to network ties with initiators are derived from information we obtained from the relations between respondents and initiators, as well as between respondents and associations within a community (descriptive statistics can be found in Table 3.2).

9. The relatively high number of missing scores is mainly due to the fact that respondents needed to complete both questions concerning knowing initiators and indicating their associational memberships in order to be included in the sample used for analysis.

Willingness to participate in the community energy project. We first briefly informed respondents about the local initiative via the following statement: "The following questions are concerned with energy saving and sustainable production via community energy initiatives. The research focuses specifically on an initiative that started recently in this community named [add name]." Willingness to participate was then measured via two questions: "Do you want to volunteer in this community energy initiative" and "Do you want to financially invest in this community energy initiative?". Answers could be (0) no; (1) maybe; (2) yes; (3) already participating or already financially contributing; this last category was excluded from the analyses because only initiators were "already participating" at the point of data collection. These questions were strongly positively correlated r_s (467)= 0.55; $p < .01$. As answering either one of these questions indicates a willingness to become involved, we combined these two items by using a maximum score, that is, using the highest score on either of the two questions for each respondent.

Initiative meeting attendance. A further item asked respondents whether or not they had attended an information meeting about the initiative (which was always organized prior to sending the questionnaires). Respondents could respond with (0) no or (1) yes.

Existence and number of direct ties was measured via providing a list with the names of the initiators to the respondents. Respondents could indicate whether or not they knew one or more of the initiators. The number of initiators that could be nominated varied from 6 to 9 per community. To measure the mere existence of direct ties we dichotomized this variable with (0) having no direct ties and (1) having at least one direct tie.

Existence and number of strong and weak ties were measured asking respondents to indicate per initiator how close the respondent was to the initiator. Answers could range from (0); not close at all; (1) not very close; (2) neutral; (3) close; (4) very close. Strength of ties was then categorized in three levels: (0) weak (not close at all or not very close), (1) neutral, and (2) strong[10] (close or very close). Number of strong ties is the sum score of all strong ties a respondent indicated having. To measure existence of strong ties we again dichotomized this variable into (0) having no strong ties to initiators or (1) having at least one strong tie to an initiator. Number of weak ties is the sum score of both weak and neutral ties. Again, we created a dummy measuring mere existence of weak ties, distinguishing between no weak ties to initiators (0) and having at least one weak tie to an initiator (1).

Existence and number of extended ties to initiators were measured using the previously mentioned affiliation networks. First, community members and the initiators[11] of the CEIs were asked to indicate whether or not they were a member of a formal or informal group, club or association in their community such as a church, village association, soccer club, or food sharing (app) groups. When people indicated they were a member of at least one association, they were asked to write down up to seven of the groups, clubs or associations they were a member of. We asked them to be as specific as possible. Afterwards, all associations were assigned different codes. For reliability reasons, this was always checked by the co-authors and/or trained research assistants. Yet, it still occurred in some instances that respondents indicated to be a member of a "church" or "neighborhood association" without specifically

10. Respondents also indicated what type of relation they had with the initiators via an open question (e.g., family members, acquaintance, and friend). When comparing these answers they yielded comparable results to the strength of tie measure; family members and friends were often indicated as a strong ties whereas acquaintances as a neutral or weak ties.
11. Team of initiators varied from 5 to 9 in size. Of these initiators max. 2 were missing per community (see Appendix 2).

stating which one. If more than one of these associations existed in the community (for example multiple churches existing in a certain village) these associations were all assigned a different code (church 1, church 2). If there existed only one such association within the community, all associations mentioned loosely referring to this association where counted as one membership in this same association. By doing this, we (might) underestimate instead of overestimate the actual co-memberships between respondents. In addition, the CEI itself was not coded as an association, since only initiators could be a members of this group and by default all initiators have a connection to each other.

We represented the *affiliation networks per community*, by using $(p + n)*(p + n)$ matrices where p indicates the number of persons (the respondents) and n the number of associations (Borgatti & Everett, 1997). This resulted in a matrix M per community that can be separated into four blocks, of which the bottom right quadrant ($n * n$ cells) is empty because associations could not be directly linked to other associations. The top left quadrant ($p * p$ cells) only contains direct links from respondents to initiators, because links between respondents could not be reported in the questionnaire. The other two blocks of M have ($p * n$) cells indicating whether a specific respondent (including initiators) was member of a specific association (coded "1" if this was the case, otherwise "0"). We calculated the distance from community members to each of the initiators by counting the shortest paths[12] in the network defined by the matrix M. For operationalizing extended ties, we needed to distinguish them from direct ties. In the literature on extended ties (Cameron, Rutland, Hossain, & Petley, 2011; Pettigrew, Christ, Wagner, & Stellmacher, 2007), earlier studies usually addressed this problem by including in statistical models of the effect of the number of extended ties also a control for the number of direct ties. However, this is not sufficient; people with extended ties can also have direct ties and results can be wrongly attributed to extended ties, or vice versa due to multicollinearity problems (Munniksma et al., 2013). By looking at the shortest path to each initiator we excluded the possibility of people having both a direct and an extended tie to *the same* initiator; when people had both types of ties with the same initiator merely the shortest path counted. This implies that the co-occurrence of direct and extended ties mentioned in H5b pertains to ties to *distinct* initiators.

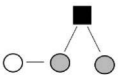
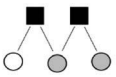
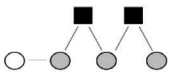
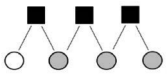
Table 3.1 depicts in more detail what different distances mean in the networks we constructed. A distance of one from a community member (grey circle) to an initiator (white circle) shows a direct tie between them, indicated by the nomination of the initiator by the community member. Distance two shows a co-membership between a community member and an initiator, both having a membership in the same association. Distance three shows a co-membership of a community member with another community member who in turn has a direct tie to an initiator and so forth.

Since we only wanted to include extended ties to initiators via other respondents and not via other initiators, and direct ties between respondents were not measured, we captured extended contact only via memberships in associations. Ties between initiators themselves and co-memberships between them were therefore also not taken into account, to prevent respondents from automatically being assigned an extended tie to all other initiators when

12. Path length is the distance between two nodes, measured as the number of edges (the ties in Figure 1) between them. A path between two nodes in a network is a shortest path if no other path between these two nodes has less edges. Thus, when in our case a community member has two paths to the same initiator, one of distance of 2 (2 edges separating him/her from the initiator) and one of distance 6, the path of distance 2 is the shortest path (see figure 2).

they indicated knowing one of the initiators directly. We calculated the distances via an iterative process, based on an adaptation of the breadth first search graph algorithm. In the first round we calculated the distances to the initiators using the complete ($n + p$)*($n + p$) matrix to find all direct ties and co-memberships between initiators and respondents (Table 3.1, distance 1 & 2). Respondents with distance one were flagged and in a next step all respondents who had a co-membership with these respondents got a distance of three (Table 3.1, distance 3). In this next step, instead of the complete ($p + n$)*($p + n$) matrix, we use merely the affiliation network excluding the direct ties to initiators. This way, we avoid respondents getting extended ties via other initiators instead of other community residents. Next, all community members (those who were not previously flagged) with distance two were flagged and we calculated the co-memberships to these respondents and marked this as distance four (Table 3.1, distance 4) and so forth. Distances longer than six did not occur in the data and so this is the cutoff point for the extended ties. The number of extended ties then comprises all shortest paths from a respondent to initiators with distances larger than one. Again, to measure the existence of extended ties a dichotomy was made with (0) having no extended ties to the initiators and (1) having one or more extended ties to (multiple) initiators.

Table 3.1: Direct and extended ties from community members to initiators[13]

Distance extended tie	Graphical representation
Direct tie distance 1	
Extended tie distance 2	
Extended tie distance 3	
Extended tie distance 4	
Extended tie distance 5	
Extended tie distance 6	

Note. Grey circles represent community members, white circles represent initiators, and black squares represent associations. Black lines indicate the undirected connections between the nodes.

13. All ties are either indicating a membership in a club, organization or association, or indicating a direct tie from a community member (grey circle) to an initiator (white circle).

3.3.4 Control variables

First, in all analyses we controlled for the nested structure of the data (community members within communities) via community fixed effects using dummy coding for the communities. Fixed effects models are fruitful for analyses with a relatively small number of communities to examine the effect of individual level variables controlling for other factors and 'random noise' related to the community level (Allison, 2009). Second, merely analyzing the relationships between a community member and an initiator is not sufficient (McAdam & Paulsen, 1993). We controlled for the number of associations community members are a member of, reflecting network range. Range contributes to the diversity of interactions one engages in, and it has been found that the number of organizations one is a member of is positively related to social movement participation (e.g., Fernandez & McAdam, 1988). In addition, it may reflect a more general commitment to the community. Third, we also included a measurement of respondent's personal sustainable energy motivation as further control since individuals are more likely to become involved in CEI's when they have a stronger personal pro-environmental motivation (Hoffman & High-Pippert, 2010; Kalkbrenner & Roosen, 2016; Sloot et al., 2018, 2019; chapter 2 this dissertation). Due to *homophily* tendencies in the formation of social relationships (often based on similarity in certain socio-demographic, behavioral, and intrapersonal characteristics) (McPherson, Smith-Lovin, & Cook, 2001), these personal motivations may also be a basis to form social ties, rendering them important to control for. Personal sustainable energy motivation was assessed via three items: "I find it important to be conscious about my energy behavior", "I find it important to reduce my energy consumption", and "I find it important to use sustainable energy". Answers were provided on a 7-point scale ranging from (1) completely disagree to (7) completely agree ($\alpha = 0.81$). Finally, we took various socio-demographic factors into account. Education has been shown to be related to concern about the environment with highly educated people being more concerned compared to people being lower educated. Level of education was measured using the following question: "What is your highest level of education obtained" which could be answered on an 8 point scale ranging from (0) no education to (8) a university degree. Level of education was categorized in three levels: (0) low, (1) medium and (2) high. Since women generally report stronger environmental behaviors compared to men, we also took gender differences into account with (0) male and (1) female (see Gifford & Nilsson, 2014 for an overview).

Table 3.2: Descriptive statistics of the variables included in the analysis [14] (*N*=467)

Variable name	Value	Percent	
Willingness to participate	No	25.5	
	Maybe	59.1	
	Yes	15.4	
Meeting attendance	No	80.9	
	Yes	20.1	
Direct ties	No	36.0	
	Yes	64.0	
Extended ties	No	57.9	
	Yes	42.1	
Strong ties	0	82.3	
	≥1	17.7	
Weak ties	0	36.8	
	≥1	63.2	
Education	Primary	10.9	
	Secondary	29.5	
	Tertiary	59.6	
Gender	Male	59.8	
	Female	40.2	
		Mean	S.D.
Number of direct ties		1.95	2.16
Number of extended ties		1.79	2.47
Number of strong ties		0.25	0.62
Number of weak ties		1.86	2.09
Number of clubs		1.43	1.64
Personal sustainable energy motivation		5.47	0.98

As can be seen from table 3.2 more than half of the respondents indicated knowing one or more initiators, on average having around two direct or extended ties. It is somewhat surprising that community members seemed to have more direct ties compared to having extended ties. This may have several reasons. First, having a direct and extended tie to the same initiator(s) is not possible (see measurements). Second, we constructed extended ties via memberships in clubs and associations. As a result respondents who were not a member of any of these were excluded from having an extended tie. Third, most of the communities in this sample are relatively small and located in rural areas making it more likely that community members know one or more of the initiators directly. In addition, while the mean of personal sustainable energy motivation was high (*M* = 5.47*; SD* = .98) this did not translate directly into willingness to participate, which merely 15% of the respondents indicated to be (See Table 3.2).

14. Descriptive statistics per community can be found in Appendix 1.

3.4 Plan of analysis

We used ordered logistic regression to examine the relationships between direct ties, extended ties, and willingness to participate in a CEI and employ logistic regression for initiative meeting attendance. While tie dependences may violate the underlying assumption of independent observations, we employed a random selection of respondents and controlled for community fixed effects, which reduces the extent to which this is the case. All continuous predictor variables were centered around the mean before conducting the regression analyses.

First, we examined the existence of ties and estimated the effect of having at least one direct tie compared to having no ties to initiators for both willingness to participate and initiative meeting attendance (Table 3.3 & 3.5, model 1a) and included control variables (Table 3.3 & 3.5, model 1b). In a second, step, strong and weak ties were added to the model (Table 3.3 & 3.5, model 2a). Third, we added the existence of extended ties to this model (Table 3.3 & 3.5, model 2b) and included control variables (Table 3.3 & 3.5, model 2c). In a fourth step, to test if direct and extended ties are mutually reinforcing one another, we added an interaction term between direct and extended ties (Table 3.3 & 3.5, model 3a). Here number of strong ties was removed from the analyses because we did not make a differentiation in our hypotheses with regard to the interaction effects between strong or weak ties but merely the number of direct ties. Finally, we added all control variables to this model (Table 3.3 & 3.5, model 3b). Next, we included the number of ties instead of mere existence (Table 3.4 & 3.6) and went through the same steps. Coefficients are shown in ordered log-odds[15]. Thresholds indicate the cut-off values of the latent variable that is used to make the different levels of willingness to participate.

15. Since the proportional odds assumption (Brant, 1990) was violated for several variables we used a partial proportional odds model in which one can relax this assumption for relevant variables using the VGLM function from the VGAM package in R. This model allows the covariates that meet the assumption to have the same estimates across response categories, whereas for the covariates that do not meet the assumption different effects are estimated for different levels of willingness to participate. Note that in partial proportional odds models the natural logarithm of the odds of being in a category higher than j, instead of lower, which is usually the case in proportional odds models, is estimated. Thus, the estimates are actually reverse, due to this difference in model specification. Yet, because the estimates remain the same, for reasons of interpretation, results are shown in a similar way as in a proportional odds model, where a positive effect means an increase in the probability of willingness to participate (see Yee, 2010, 2015 for more information).

3.5 Results

3.5.1 Willingness to participate

A strong positive effect was found for having a direct tie to an initiator compared to having no tie for both transitions of willingness to participate (Table 3.3, model 1a, b = 0.86, p < .001; b = .89; p =.004) and this effect remained significant for the transition from no to maybe when including control variables (model 1b, b = 0.71, p =.013) but not for the step from maybe to yes (b = 0.60, p =.094). Thus, partly in line with H1, having a direct tie to an initiator seemed to increase people's willingness to participate. Differentiating between strong and weak ties (Table 3.3, model 2a) showed that having a strong tie had a statistically significant effect on willingness to participate for the transition from maybe to yes (b = 0.77, p =.024), but not for the transition from no to maybe (b = 0.61; p =.111). We did not find support that a weak tie increased willingness to participate for any of the two transitions when controlling for the effect of having a strong tie (b = 0.44, p =.113; b = 0.61, p =.088), contrasting H3b. Furthermore, having an extended tie compared to having no extended ties (Table 3.3, model 2b) did not have a significant effect on willingness to participate (b = 0.45, p =.086; b = 0.15, p =.644). When adding control variables (Table 3.3; model 2c) only the effect of having a strong direct tie for the transition from maybe to yes remained significant (b = 0.78, p =.037) which is partly in line with H2a, stating that individuals having a strong tie to an initiator are more willing to participate. However, we did not find support for H5a, meaning that individuals with one (or more) extended ties are not more willing to participate compared to individuals not having one (or more) extended ties. Next, to test H5b, we included an interaction term between direct and extended ties (Table 3.3, model 3a & 3b). H5b stated that individuals who have an extended tie to one of the initiators are more willing to participate if they also have a direct tie to one of the initiators. The interaction was positive but non-significant for both transitions refuting H5b.

Next, considering the number of direct ties (Table 3.4, model 1a & 1b), we obtained quite similar results. Also here, in line with H3, a significant positive direct effect remained for the transition from no to maybe after adding control variables (model 1b, b = 0.28, p <.001; b = 0.10, p =.149). When making a distinction between the effects of the numbers of strong and weak direct ties (Table 3.4 model 2a, 2b & 2c), the effect of strong ties remained significant for the transition from maybe to yes (model 2c, b = 0.52, p =.018) but not for the transition from no to maybe (b = 0.31, p =.218), which is partly in line with H4. Contrary to our findings with dichotomized tie variables, weak ties were found to be positively and significantly related to willingness to participate (model 2c, b = 0.21, p =.006; b = 0.09, p =.266). Again, the number of extended ties did not seem to have an effect on willingness to participate (b = 0.05, p =.541; b = 0.14, p =.106), and did not alter the relation between the number of direct weak or strong ties substantially, refuting H5b.

Next, we included an interaction term between the number of direct and the number of extended ties (table 3.6, model 3a & 3b). This interaction was positive and significant for the transition from maybe to yes. However this effect disappeared when including control variables (model 3b, b = 0.03, p =.324; b = 0.02, p =.623), also refuting H5c.

3.5.2 Initiative meeting attendance

Similar to our findings above for willingness to participate, results showed that having a direct tie was positively significantly related to initiative meeting attendance (Table 3.5, model 1a; b = 1.28, p <.001). Adding control variables does not alter this effect substantially (b = 1.25, p =.002), providing support for H1. Adding existence of strong ties and weak ties (Table 3.5, model 2a), showed a positive significant effect on initiative meeting attendance for both types of ties (b = 1.37, p <.001; b = .99, p =.003), which is in line with H2. In addition, extended ties were also positively significantly related to meeting attendance (model 2c, b = 0.69, p = .021) which was not the case for willingness to participate. However, when adding control variables, this effect became insignificant (b = 0.07, p = .919), whereas the other estimates did remain significant (and quite similar in effect size), refuting H5a. Also here, an interaction term was included (models 3a & 3b) but again this did not have a significant effect on involvement (model 3b, b = 0.84, p = .204).

Next, the number of direct ties was found to be positively significantly related to initiative meeting attendance (Table 3.6, model 1b; b = 0.30, p <.001), which is again in line with H3. When we differentiated between the number of strong and weak ties (Table 3.6, model 2a, 2b & 2c), results showed that both have a positive significant effect on meeting attendance, and these effects are robust when including control variables (model 2c; b = 0.59, p = .009; b = 0.29, p = .001), which is again in line with H4. Extended ties were found to be positively significantly related to initiative meeting attendance, however this effect disappeared when we included control variables (model 2c, b = 0.06, p = .471), again refuting H5b. In addition, also here the interaction between the number of direct and the number of extended ties (Table 3.6, model 3a & 3b) was small and again non-significant (model 3b, b = 0.01, p = .803), which is not in line with H5c.

3.5.3 Covariates

The coefficients of the control variables were generally in line with the results found in previous research. Membership of associations seemed to be positively related to willingness to participate and initiative meeting attendance (although the former was not significant). In addition, the bivariate results (see Appendix 3) showed that the correlation between associational memberships and strong ties, but especially extended ties, was significant and quite strong. For extended ties this may partly be an artefact of the way that they were measured (only extended ties via associations were taken into account). Furthermore, people with a stronger personal sustainable energy motivation were more likely to get involved and attend an initiative meeting, just as people who were highly educated. Finally, women were less likely to get involved in a CEI compared to men.

Table 3.3: Partial proportional odds model of willingness to participate. Unstandardized coefficients (N=467)

	Model 1a		Model 1b		Model 2a	
	No vs. Maybe	Maybe vs. Yes	No vs. Maybe	Maybe vs. Yes	No vs. Maybe	Maybe vs. Yes
	Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)
Threshold 1	–0.01 (0.26)		–2.21 (0.70)		–0.38 (0.28)	
Threshold 2	–3.04*** (0.34)		–5.44*** (0.76)		–2.87 *** (0.37)	
Direct ties [no ties= ref]	0.86*** (0.25)	0.89** (0.31)	0.71** (0.26)	0.60 (0.32)		
Strong ties [no ties= ref]					0.61 (0.38)	0.77* (0.34)
Weak ties [no ties= ref]					0.44 (0.28)	0.61 (0.36)
Extended ties [no ties= ref]						
Direct ties * Extended ties						
Associational memberships			0.15* (0.06)			
Personal motivation			0.44*** (0.11)			
Education [low= ref]						
Medium			0.15 (0.36)			
High			0.48 (0.36)			
Female [Male = ref]			–0.64** (0.21)			

Note. *p < .05. **p < .01. ***p < .001. Standard errors in parentheses.
All models are additionally controlled for community fixed effects.

Model 2b		Model 2c		Model 3a		Model 3b	
No vs. Maybe	Maybe vs. Yes	No vs. Maybe	Maybe vs. Yes	No vs. Maybe	Maybe vs. Yes	No vs. Maybe	Maybe vs. Yes
Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)
–0.23 (0.30)		–1.81* (0.79)		–0.08 (0.28)		–2.31** (0.62)	
–2.88*** (0.39)		–5.08*** (0.85)		–3.12*** (0.38)		–5.47*** (0.79)	
				0.52 (0.31)	0.93* (0.36)	0.47 (0.32)	0.74 0.38
0.54 (0.38)	0.79* (0.35)	0.49 (0.40)	0.78* (0.37)				
0.36 (0.28)	0.66 (0.36)	0.32 (0.29)	0.47 (0.39)				
0.45 (0.26)	0.15 (0.33)	0.24 (0.32)	0.47 (0.37)	0.16 (0.37)	0.08 (0.57)	–0.02 (0.43)	–0.21 (0.61)
				0.67 (0.49)	0.10 (0.65)	0.50 (0.51)	0.19 (0.67)
		0.13 (0.08)				0.17* (0.08)	
		0.41*** (0.11)				0.45*** (0.11)	
		0.16 (0.40)				0.09 (0.37)	
		0.74* (0.37)				0.54 (0.37)	
		–0.73** (0.23)				–0.65*** (0.21)	

Table 3.4: Partial proportional odds model of willingness to participate. Unstandardized coefficients (*N*=467)

	Model 1a		Model 1b		Model 2a	
	No vs. Maybe	Maybe vs. Yes	No vs. Maybe	Maybe vs. Yes	No vs. Maybe	Maybe vs. Yes
	Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)
Threshold 1	–0.58** (0.22)		–1.67** (0.70)		–0.28 (0.27)	
Threshold 2	–2.48*** (0.26)		–5.02*** (0.74)		–2.69*** (0.32)	
Number of direct ties	0.31*** (0.07)	0.16** (0.06)	0.28*** (0.07)	0.10 (0.07)		
Number of strong ties					0.35 (0.24)	0.47* (0.19)
Number of weak ties					0.20** (0.07)	0.10 (0.07)
Number of extended ties						
Direct ties * Extended ties						
Associational memberships			0.12 (0.06)			
Personal motivation			0.43*** (0.11)			
Education [low=ref]						
Medium			–0.19 (0.37)			
High			0.55* (0.37)			
Female			–0.63** (0.21)			
[Male = ref]						

Note: $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$. Standard errors in parentheses.
All models are additionally controlled for community fixed effects.

Model 2b		Model 2c		Model 3a		Model 3b	
No vs. Maybe	Maybe vs. Yes	No vs. Maybe	Maybe vs. Yes	No vs. Maybe	Maybe vs. Yes	No vs. Maybe	Maybe vs. Yes
Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)
–0.49 (0.28)		–1.94* (0.75)		–0.52* (0.22)		–1.79* (0.70)	
–2.66*** (0.34)		–5.28*** (0.83)		–2.59*** (0.27)		–5.17*** (0.75)	
				0.34*** (0.07)	0.20** (0.07)	0.30*** (0.08)	0.12 (0.08)
0.42 (0.25)	0.58** (0.21)	0.31 (0.25)	0.52* (0.22)				
0.20** (0.07)	0.10 0.07	0.21** (0.08)	0.09 (0.08)				
0.06 (0.05)	0.10 (0.07)	0.05 (0.06)	0.14 (0.09)	0.13* (0.06)	0 .04 (0.07)	0.09 (0.07)	0.10 (0.08)
				0.05 (0.03)	0.04 (0.04)	0.03 (0.03)	0.02 (0.04)
		0.11 (0.08)				0.11 (0.08)	
		0.43*** (0.12)				0.44** (0.11)	
		–0.23 (0.41)				–0.14 (0.37)	
		0.56* (0.41)				0.84** (0.36)	
		–0.76** (0.23)				–0.64** (0.21)	

Table 3.5: Logistic regression of initiative meeting attendance. Unstandardized coefficients (*N*=467)

	Model 1a	Model 1b	Model 2a
	Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)
Constant	–2.49*** (0.39)	–4.82*** (1.27)	–2.63*** (0.42)
Direct ties [no ties= ref]	1.28*** (0.32)	1.25*** (0.40)	
Strong ties [no ties=ref]			1.37*** (0.33)
Weak ties [no ties= ref]			0.99** (0.35)
Extended ties [no ties= ref]			
Direct ties * extended ties			
Associational memberships		0.47*** (0.10)	
Personal motivation		0.29 (0.17)	
Education [low= ref]			
Medium		0.64 (0.64)	
High		1.42** (0.61)	
Female [male = ref]		–1.68*** (0.34)	

Note: $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$. Standard errors in parentheses.
All models are additionally controlled for community fixed effects.

Model 2b	Model 2c	Model 3a	Model 3b
Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)
–3.04***	–4.46***	–3.10***	–4.06***
(0.48)	(1.12)	(0.51)	(1.09)
		1.42**	1.56**
		(0.44)	(0.50)
1.24**	1.16**		
(0.34)	(0.38)		
0.96**	0.84*		
(0.36)	(0.40)		
0.69*	0.07	1.16*	0.99
(0.31)	(0.38)	(0.52)	(0.61)
		0.18	0.84
		(0.61)	(0.66)
	0.43***		0.37***
	(0.11)		(0.10)
	0.37*		0.41*
	(0.17)		(0.17)
	0.47		0.74
	(0.67)		(0.66)
	1.27*		1.42*
	(0.64)		(0.62)
	–1.62***		–1.61***
	(0.37)		(0.35)

Table 3.6: Logistic regression of initiative meeting attendance. Unstandardized coefficients (*N*=467)

	Model 1a	Model 1b	Model 2a
	Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)
Constant	–1.81*** (0.32)	–5.22*** (1.17)	–2.49*** (0.40)
Number of direct ties	0.36*** (0.07)	0.30*** (0.08)	
Number of strong direct ties			0.63*** (0.19)
Number of weak ties			0.27*** (0.07)
Number of extended ties			
Direct ties * extended ties			
Associational memberships		0.38*** (0.09)	
Personal motivation		0.39* (0.16)	
Education [low= ref]			
Medium		0.54 (0.64)	
High		1.35* (0.61)	
Female [male = ref]		–1.52*** (0.34)	

Note: $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$. Standard errors in parentheses.
All models are additionally controlled for community fixed effects.

Model 2b	Model 2c	Model 3a	Model 3b
Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)
–2.81***	–6.50***	–2.20***	–6.39***
(0.45)	(1.29)	(0.37)	(1.28)
		0.46***	0.36***
		(0.08)	(0.10)
0.58***	0.59**		
(0.19)	(0.23)		
0.32***	0.29**		
(0.08)	(0.09)		
0.16**	0.06	0.22***	0.12
(0.07)	(0.09)	(0.07)	(0.11)
		0.03	0.01
		(0.03)	(0.04)
	0.37***		0.31**
	(0.11)		(0.11)
	0.46**		0.39*
	(0.18)		(0.14)
	0.49		0.64
	(0.69)		(0.64)
	1.49**		1.43*
	(0.65)		(0.61)
	–1.55***		–1.53***
	(0.37)		(0.35)

3.6 Conclusion and discussion

In this study we assessed whether social ties matter for involvement in CEIs and which ties matter most, measuring community members' direct and extended ties to initiators. By doing so, we showed that investigating the network structure within communities can contribute to understanding which community members are attracted to CEIs, going beyond measuring individual (pro-environmental) motivations. Importantly, when examining the effects of direct ties, we controlled for the number of associational memberships, hereby taking mere involvement in the community into account.

Our results demonstrate that willingness to participate in a CEI is positively associated with the existence and number of direct ties community members have to the initiators of these initiatives. This shows that insights from social movements research extend to participation in CEI's, indicating that prior contact to movement participants contributes to participation (e.g., Briet et al., 1987; McAdam, 1986) and provides some support for complex contagion (Centola & Macy, 2007). Notably, our results also show that the connections people have with the initiators affect whether they become involved over and above their personal sustainable energy motivation. In addition, considering the strength of ties, we generally find both strong ties and weak ties to matter for initiative involvement. Yet, for willingness to participate, weak ties seems to play a less pronounced role compared to strong ties. In addition, while both types of ties are important for initiative meeting attendance, strong ties play a more pronounced role. This tentatively suggests that weak ties matter for getting interested (Granovetter, 1973), but strong ties seem to matter most for getting involved (Della Porta, 1988; McAdam, 1986; Opp & Gern, 1993; E. Ostrom, 1990). This underlines the importance of social influence relative to information diffusion through social ties in the mobilization of collective action (Macy, 1990; McAdam & Paulsen, 1993). It also underlines the importance of relational ties for recruitment found among members of CEIs in previous research (Bauwens, 2019; Hoffman & High-Pippert, 2010).

Next, we find little evidence for extended ties to have an effect on willingness to participate in a CEI. If anything, extended ties seem to be associated mainly with initiative meeting attendance. We also find little support for complex contagion when it comes to extended ties (Centola & Macy, 2007); extended ties do not seem to matter more when people already have one or more direct ties. One reason could be that the presence of an extended tie may signal active avoidance of a direct tie between these people in the network (Munniksma et al., 2013). Especially in smaller rural communities people are likely to meet and know each other directly, even if they are not intimately related. More than half of the respondents indicated to know the initiators directly, showing that initiators are often people who are well known in their communities. Thus, one possibility to explain the lack of support for an effect of extended ties might be that respondents who have a co-membership with an initiator without at the same time being interpersonally related have made a deliberate choice to not be directly connected, perhaps even to actively avoid a direct tie to the initiator. If this is the case, it could be expected that the respondent may also not be open to being socially influenced by that initiator.

Furthermore, we find that community members with more associational memberships are more likely to participate. This suggests that mere memberships of other associations

within the community are more important than having extended ties via these associations with initiators. Thus, it seems that next to degree, network range is important, increasing the diversity of interactions within the community. However, the number of associational memberships and extended ties are quite strongly correlated and thus may partly suppress each other's effects. Our results regarding associational memberships are in line with previous research findings indicating that people may not only participate because they are interested in sustainable energy behavior but also for becoming more involved in the community and that some people are inclined to participate in any community activity (Sloot et al., 2019; Chapter 2 of this dissertation). Finally, men are more likely to participate compared to women, just as community members who are highly educated and adhere to higher personal sustainability motivation, although this does not seem to matter for initiative meeting attendance.

A tentative conclusion from these findings is that people are drawn into these CEIs via other people within their direct social network who are already involved, suggesting that a community-led approach might indeed be "partially associated with the ability to leverage local social networks to achieve change" (Creamer, Allen, et al., 2019, p. 948). In addition, in line with previous research from Hoffman and High-Pippert (2010), we showed how local associational networks matter for involvement.

3.6.1 Limitations and possible directions for future research

This study has various limitations presenting new directions for future research. Direct ties between community members other than the initiators were not taken into account. This might have led to an overestimation of the distances of the extended ties larger than two (co-memberships with initiators). For instance, community members who were assigned a distance of four could potentially have had an extended tie with a shorter distance via other community members. Such extended ties went undetected in our approach. Yet, it seems plausible that associations are meaningful places to meet and connect. Furthermore, people within the same association do not necessarily always connect personally. Individuals may share membership in an association and yet never interact face-to-face (Passy, 2003). However, we contend that sharing foci creates opportunities to get acquainted with ideas of others even when not becoming interpersonally tied.

Additionally, social ties to other relevant groups like parents, peers, friends or co-workers were not included. However, with regard to social movement participation, previous research showed that additional ties to parents and friends next to initiators, merely had an additive effect over and above the effect of having ties to people already participating in the movement (McAdam & Paulsen, 1993). Since the CEIs considered in this study are located in a specific geographically defined local community, we can expect that other community members form the most relevant ties through which peoples' decisions regarding involvement are influenced.

Furthermore, people are embedded in many associations or relations that may expose an individual to conflicting pressures and could enable as well as constrain participation (McAdam & Paulsen, 1993). However, in our sample respondents on average indicated to be a member of one or two associations, rendering these competing pressures less relevant. In addition, our findings suggest that having multiple associational memberships actually contributes to involvement. Yet, it might be that it is especially the absence of strong opposition from others (directly or via associations) in an individual's network that is important for participation.

Future research could disentangle to what extent people additionally experience opposing pressure to CEI involvement and assess how this relates to their own involvement.

Additionally, in this study we did not differentiate between initiators and assumed that all exerted the same influence. However, initiators may differ with regard to for example their centrality in the network. The most intuitive conception of centrality is the number of ties individuals have in a network (degree; see Freeman, 1978; Freeman, Roeder, & Mulholland, 1979). Not all initiators are equally well connected and the presence of some actors with many ties can dramatically alter diffusion patterns (Barabási, 2002). Future research should consider taking such centrality differences into account. Similarly, the type of influence emerging from associations may differ depending on their connectedness (see Paxton, 2002, 2007). More generally, while ties to initiators seem to matter for involvement, these might be clustered in certain subgroups of the community, which does not necessarily lead to increased participation beyond these subgroups and may even inhibit the diffusion of the initiative (cf. Gould, 1993; Granovetter, 1983). Future research could examine the meso level structures of these communities and the embeddedness of the initiators within such a network and how this may affect involvement in CEIs.

Another limitation is that due to the cross-sectional design our insights are based on correlational evidence, which does not allow for strong causal conclusions. Notably, people generally associate with others with whom they share similar characteristics (McPherson et al., 2001). Thus, evidence of an association between CEI involvement and connectedness to initiators may be explained by selection mechanisms; people similar to the initiators are more likely to join the same associations as them. Although we partially controlled for this by taking respondents' personal sustainable energy motivation in account, longitudinal data is needed to truly disentangle these different mechanisms (influence vs. selection).

Finally, more systematic research is needed within urban contexts. Rural areas often benefit from higher levels of interpersonal contact and social cohesion compared to urban areas and community boundaries are more difficult to define (Völker et al., 2007). Exploratory findings (see Appendix 1) indeed suggest that person-to-person social networks are sparser, and community involvement in terms of associational membership is lower in urban communities compared to rural ones. Network sparseness and low social connectivity in turn seem to render the spontaneous network diffusion of a CEI less likely.

3.6.2 Practical implications

The findings in this study emphasize the role social ties between community members and initiators play for involvement in a CEI, next to mere personal (pro-environmental) motivations. We acknowledge the difficulty of network interventions especially concerning strong contacts; it may be hard to manipulate local social networks (Bodin & Crona, 2009). However, facilitating the right "boundary-spanning" network activities might be feasible (Schneider, Scholz, Lubell, Mindruta, & Edwardsen, 2003). A particularly cost-effective strategy could be to actively look for diversity with regard to the local social embeddedness of initiators when starting an initiative, next to a diverse skill-set (ranging from technological knowledge or negotiation skills, among others; Middlemiss & Parrish, 2010). This is especially important since initiators are usually often relative newcomers to the community and as such and as such may not the most socially embedded within a community (Creamer, Allen, et al., 2019).

Our results further point to the possible pitfalls of merely attracting others via (close) personal networks. In line with critical mass theory, CEIs are frequently led by small groups of highly committed resourceful individuals (Aiken, 2012; Barr & Devine-Wright, 2012; DuPuis & Goodman, 2005) who tend to be highly educated, white males of above average age (Van Der Schoor & Scholtens, 2015; Van Veelen, 2018; Warbroek et al., 2019; Chapter 1 this thesis). Especially, due to homophily tendencies in the formation of social relationships (McPherson et al., 2001), initiators run the risk of primarily attracting similar community members within their close social networks. This way, they might fail to reach other community members. Since our results showed how being a mere member of another association within the community increases initiative involvement, it is recommended to additionally use the existing local associational networks in order to recruit community members from various subgroups. Policymakers could foster such processes by for instance making funding available for the coordination of such activities or facilitate expertise. Taking above mentioned considerations into account, this seems a fruitful starting point from which dissemination might take place.

Appendices

Appendix 1. Descriptive statistics per community

Table 3.7: Descriptive statistics per community

	Com 1 RURAL Percent	Com 2 RURAL Percent	Com 3 RURAL Percent	Com 4 RURAL Percent	Com 5 URBAN Percent	Com 6 RURAL Percent	Com 7 RURAL Percent	Com 8 RURAL Percent
Willingness to participate:								
No	41.7	20.0	15.8	24.0	19.0	24.8	31.2	20.3
Maybe	51.0	70.0	57.9	44.0	48.6	66.4	64.9	74.6
Yes	7.3	10.0	26.3	32.0	32.4	8.8	3.9	5.1
Initiative meeting attendance:								
No	83.7	90.0	82.0	72.0	81.6	84.0	84.5	96.5
Yes	16.3	10.0	18.0	28.0	18.4	16.0	15.5	3.5
Direct ties:								
No	39.6	20.0	13.2	16.0	59.5	8.8	63.6	28.8
Yes	60.4	80.0	86.8	84.0	40.5	91.2	36.4	71.2
Extended ties:								
No	52.9	62.5	51.4	73.1	85.4	34.1	55.6	49.1
Yes	47.1	37.5	48.6	26.9	14.6	65.9	44.4	50.9
Strong ties:								
0	78.5	75.0	75.0	80.0	83.8	74.7	94.4	88.5
>1	21.5	25.0	25.0	20.0	16.2	25.3	5.6	11.5
Weak ties:								
0	38.4	10.0	12.5	10.0	48.0	2.7	35.3	36.5
>1	65.6	90.0	87.5	90.0	52.0	97.3	64.7	63.5

	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Number of direct ties	2.04	2.19	3.62	1.41	2.41	1.80	2.88	2.30	1.10	1.76	3.36	2.49	0.71	1.18	1.92	1.88
Number of extended ties	2.20	2.77	0.88	1.25	1.51	1.87	1.04	1.98	0.50	1.39	3.64	3.12	1.26	1.61	2.16	2.34
Number of strong ties	0.34	0.76	0.38	0.74	0.34	0.70	0.40	0.99	0.24	0.61	0.32	0.64	0.08	0.37	0.13	0.39
Number of weak ties	1.97	2.34	3.25	1.04	2.12	1.45	3.30	1.89	0.94	1.63	3.45	2.33	0.56	1.04	1.54	1.64

Appendix 2. Size team initiators and missingness

Table 3.8: Size of team and missingness on network questions

	Com 1	Com 2	Com 3	Com 4	Com 5	Com 6	Com 7	Com 8
Size team	9	7	7	6	9	9	5	6
Completed network questions	7	5	5	5	7	6	4	6
Missing	2	2	2	1	2	2	1	0

Appendix 3. Correlations between all dependent and independent variables used in the analyses

Table 3.9: Correlations between all dependent and independent variables used in the analyses

	1.	2.	3.	4.	5.	6.	7.
1. Number of direct ties							
2.Number of extended ties	–.01						
3.Number of strong ties	.34***	.09					
4.Number of weak ties	.84***	.02	.09				
5.Associational memberships	.36***	.53***	.23***	.29***			
6.Personal motivation	.09*	–.00	.11*	.02	.11*		
7.Willingness to participate	.19***	–.01	.15***	.14***	.10*	.18***	
8.Initiative meeting attendance (0=no; 1=yes)	.14**	.07	.20***	.13**	.24***	.13**	.15***

Note. *$p < .05$. **$p < .01$. ***$p < .001$. Correlations between the two outcome variables and the predictors were computed using the Spearman rank coefficient, the intercorrelation between the two outcome variables is assessed via a Cramer's V.