



A literature review for the EVALOC project
Social network theory and analysis

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Written by:
Karen Lucas and Ruth Mayne
Lower Carbon Futures, Environmental Change Institute
University of Oxford
South Parks Road, Oxford OX1 3QY
karen.lucas@ouce.ox.ac.uk
ruth.mayne@ouce.ox.ac.uk



OXFORD
BROOKES
UNIVERSITY



Abstract

This literature review is part of a wider three-year study, EVALOC, which has been set up to evaluate the impacts of low-carbon community groups on individual, household and community energy use. One strand of the project seeks to investigate the ways in which individuals living in six low-carbon communities in the UK have responded to the introduction of domestic energy saving measures in their homes and other community facilities. The review provides a broad conceptual overview of the theories and methods that underpin Social Network Theory (SNT) and Social Network Analysis (SNA) and how these might be appropriately applied within the EVALOC. It will be used to help develop the fieldwork design and a set of research questions for the household interviews that are key component of the EVALOC study. While SNT has many possible applications the review focuses mainly on how it has been applied to community, social capital and social learning because this is considered to be most relevant to the EVALOC study which seeks to explore the role of community groups in reducing local energy use.

Social network theory and analysis: a review for the EVALOC project

1. Introduction

This literature review is part of a wider three-year study, EVALOC¹, which has been set up to evaluate the impacts of low-carbon community groups on individual, household and community energy use. One strand of the project seeks to investigate the ways in which individuals living in six low-carbon communities in the UK have responded to the introduction of domestic energy saving measures in their homes and other community facilities.

One aspect of the EVALOC study is to consider the ways in which individuals make use of their social networks to communicate about energy issues. It will explore the structure, extent, nature and content of residents' personal networks and how this might in turn influence their energy awareness, attitudes and behaviours (including the uptake of new technologies). The study will also seek to better understand the relationship between residents' personal/informal social networks and the more structured networks used by low carbon community groups to engage and motivate residents to take action, as well as the networks that exist between community groups, other local actors and national government. It will also explore the interrelations between these networks and their

¹ EVALOC is a collaboration between Oxford Brookes University, Oxford University and six (DECC funded) low carbon communities. It draws together an interdisciplinary team of researchers to assess the impacts of the Low Carbon Communities (LCCs) on individual and community behaviours and energy use, and the communities' success in achieving sustained and systemic change. The project also seeks to explore the role played by social learning, energy feedback devices, social networks and knowledge transfer in achieving these changes. See <http://www.evaloc.org.uk/> supported by the Economic and Social Research Council (Grant reference: RES-628-25-0012). Any views expressed are those of the authors alone and do not necessarily represent the views of the funders

effect on the social capital and resources that are available to promote energy saving and low-carbon technology adoption within the communities and further afield.

In this review we use the term ‘energy (related) behaviours’ to include the purchase, lease, uptake, maintenance and use of energy-using technologies or services. They might include practices that: use fuel or electricity directly (eg lighting, heating, cooking, driving); take advantage of ‘passive’ services, such as solar gain, insulation or shading; or involve embodied energy, (eg the energy in food, waste, or consumer goods). They might be one-off or habitual, simple or complex.

Energy behaviours are influenced by a range of interpersonal/group and structural factors (whether social, economic, technical, political, and/or cultural). These are discussed in a complementary review for this project² so we do not specifically dwell on them here. However, it is worth noting that social networks are only one of a range of possible influences on energy behaviours, and that these are likely to vary according to the specific energy behaviour, individual and context in question. In this paper, we hypothesise that social networks are likely to have a relatively strong influence on individual’s awareness, attitudes, communications and social norms about energy, and hence on their *predisposition* to change their energy behaviours. We also suggest that social networks might also have a direct influence on simple behaviours, such as washing clothes at 30°C or one-off inexpensive purchases. We are aware, however, that the direction of influence might be reversed when, for example, with new behaviours or technologies influencing awareness, attitudes and social norms about energy.

The review provides a broad conceptual overview of the theories and methods that underpin Social Network Theory (SNT) and Social Network Analysis (SNA) and how these might be appropriately applied within the EVALOC. It will be used to help develop the fieldwork design and a set of research questions for the household interviews that are key component of the EVALOC study. While SNT has many possible applications the review focuses mainly on how it has been applied to community, social capital and social learning because this is considered to be most relevant to the EVALOC study which seeks to explore the role of community groups in reducing local energy use.

2. A brief overview of Social Network Theory

SNT and SNA have been widely used to study the *structure of relationships* between individuals, groups, or organisations; not so much to explain who these actors are (although this too can be a feature of SNA) but particularly to describe and map how they *interact* with each other. As such, SNA is expected to offer some fruitful new insights into the dynamic relationship between collective and individualised drivers of energy behaviour change that we are particularly interested in within the EVALOC project.

A core concern of the SNT is to understand how social networks facilitate and constrain the flows of information and resources between actors, and hence also cognitions, opportunities, and behaviours (Tindall & Wellman 2001, p. 256). By focussing on the social links between people, SNA complements and enriches analysis based on the socio-demographic and economic attributes of individual actors, groups and/or external

² <http://www.evaloc.org.uk/content/literature-review-evaloc-project-individual-and-social-influences-energy-use>

structures. (Tindall & Wellman 2001: p.256). As another early pioneer of the approach, Bott (1957) argued that an individual's interactions with others are better understood in the context of their social environment rather than their physical one.

Barnes (1954) is often credited with first practical application of *social network analysis*, which he used to analyse the social organization of a Norwegian island community. SNT has come to be seen increasingly relevant as economies have shifted from vertical corporatist and command and control structures of the Fordist period, to more horizontal and networked structures of the Post Ford period (Castells, 1996). Social networks have also become closely related to the concept of social capital, which Putnam described as social networks, norms and trust. (e.g. Putnam 2000).

Over time SNT has been developed and applied across a variety of research domains (Chowdhury et al., 2011, Scott 1988). These including family and neighbourhood community structure (eg Wilmott 1987, White and Green, 2011; Kasarda and Janowitz, 1974 quoted in Clark 2007), group dynamics, social mobility, social stratification, policy networks, elites and power, global economy (outlined in Scott, 1988), health (Fowler and Christakis 2008; Bagley-Jacobson et al., 1973) and transport (Lovejoy and Handy, 2011; Lee, 1980). It has also developed its own specific terminologies to discuss this research, which are not widely recognised outside the discipline (see appendix 1 for a summary of some of the more regularly used terms). A fuller history of SNT can be found in Borgatti et al. (2009).

Some of the specific uses of SNT that are most relevant to EVALOC include how social networks influence the engagement and retention of group members, the flow of information, skills and resources, how people collaborate and provide each other with social support, the spread of social and/or technological innovations, and the attitudes and behaviours of group members (see Tindall and Wellman, 2001; Clark 2007 for a fuller review).



3. Network characteristics

Much of SNT and SNA analysis (also discussed later in this paper) focuses on understanding the characteristics of networks, and the way this influences people's understanding, preferences, opportunities and behaviours etc. A *social network* can be defined as a set of entities (people, organizations, etc.) that are connected through their social relationships (friendship, information exchange, or other) (Garton et al., 1997). Networks are seen to consist of both actors (*nodes*) and the links (*ties*) between them. Essentially, three types of networks have been described, whole networks, personal networks and partial networks.

SNT emphasises the importance of both the *structure* of the network and the *quality* of the interactions between actors within it (Caniels and Romijn, 2008). The *structural* properties of a network relate to the number and 'centrality' of different actors within a network and the proximity, 'density' or 'connectedness' of different actors within the network.

The *quality* of interactions refers mainly to the *strength of ties* between different actors which is understood to depend on "the (probably linear) combination of the amount of

time, the emotional intensity, the intimacy (mutual confiding) and the reciprocal services' between two individuals". (Granovetter, 1973: 1361)

Granovetter has summarised some of the key properties of social networks as follows:

Bott (1957) argued that the crucial variable affecting the structure of a social network is that of whether one's friends tend to know one another ('close-knit' networks) or not ('loose knit' networks). Barnes developed this into a continuous variable by counting the number of ties observed in the network formed by ego and his friends and dividing it by the ratio of possible ones; this then corresponds to what is often called network 'density' (Bott, 1957 and Barnes 1969 summarised in Granovetter, 1973: 1370).

Cattell (2001) in her qualitative study of 2 deprived neighbourhoods found, for example, that residents networks in both areas generally corresponded to five network typologies or models: (a) socially excluded networks - small no of groups and isolated people e.g. newcomers, unemployed people, women with controlling partners, some elderly people); (b) homogenous networks - small number of groups but with extensive contacts within the groups of similar people e.g. extended families and smaller numbers of local friends and neighbours, (c) traditional networks –a tight knit and dense structure consisting of family, neighbours, and others from school, work, social and sports clubs; (d) heterogeneous networks - open networks consisting of a relatively large number of loose knit membership groups with dissimilar people, typically people in voluntary organisations (e) Solidarity networks – consists of a wide range of membership groups made up of similar and dissimilar people with both dense and loose network structures and contacts from formal and informal organisations.

In general it is expected that the speed and scope of information diffusion in a community will be related to the quantity and quality of existing ties in a community – the larger the number of ties in a network the greater the number of routes for diffusion. An important variable affected the *quality* of ties is their strength i.e. whether they are 'strong' or 'weak ties' (Granovetter 1973). Strong ties are, by definition, expected to offer more opportunities for information diffusion in a given time period than weak ones. However, because strong ties tend to cluster into sub groups or cliques they can also reduce social cohesion (ibid). They might also be used to perform negative acts, e.g. anti-social behaviour, organized crime) (Granovetter 1973, Clark 2007) impose strict social norms that discourage experimentation and/or encourage 'homophily', which is the tendency of a group to become less diverse over time, and to distrust "others." (Newman and Dale, 2005)

Granovetter (1973) argued that 'weak bridging' ties may be more useful than strong ties for allowing widespread information dissemination and hence social mobility (although this only holds true in so far as the weak ties do actually link or build bridges across members of different groups. Burt (1992) also suggests that innovation is most likely to occur where members of the network are active in different social circles outside of that group. Furthermore, understanding weak ties may also lend itself better to an analysis of relations between sub-groups and hence to an analysis of overall social structure (ibid).

Heffron (2000: 255) argues that public access to the resources 'locked up' in networks is conditioned upon the kind and degree of social capital involved. Five features are of particular note: i) whether the network is of the bonding type (and thus more particular and ingrown) or of the bridging type (and thus more expansive and accustomed to

working through 'networks' of trust and cooperation); ii) whether its ties are strong (intensive and repeated) or weak (temporary and contingent); iii) whether ties are vertical (operating through formal hierarchical structures) or horizontal (in which authority is more decentralized); open (civically engaged and exercising open membership) or closed (protective and exercising closed membership); iv) if the ties are geographically dispersed or circumscribed; and v) whether membership is instrumental (used as social collateral for individual wants) or principled (used for bounded solidarity)'.

3.1 The purpose and content of ties

While much of SNT focuses on the characteristics of networks, others argue the purpose or functions of the network, and hence their content, are equally important (Bulmer 1985; Clark 2007). As Bulmer comments "[a] map of the ties connecting one individual to others in their network, or of the ties connecting a particular collectively, is of little use unless one also knows what the content of these ties is" (1985: 437). Eve (2002) and Grieco (1987) have argued that it may not be the number or type of tie that is important, but rather its function. Even then, the perceived presence of a tie is no guarantee that it can enable any material or emotional output, such as appropriate support.

In relation to broad network functions, Putnam (2000) has suggested that social connections, or networks, along with social norms and trust, help build social capital, which is in turn correlated with various positive social outcomes including higher levels of civic participation and educational attainment. Borzel (1998) has argued that networks can be viewed as providers of order in society. As relations between actors in networks are typically more flexible and less structured networks can constitute an alternative to command and control hierarchies and/or markets (in which the order and governing rules are based on *supply and demand* relations). Conversely, networks also have the potential to replicate and/or exacerbate existing social inequalities within and between communities, i.e. those individuals with influential social contacts will be able to secure pathways to power, while those without them will be left-outside important decision-making networks and processes. There is less research about the way network ties may also facilitate or reflect less utilitarian purposes such as a sense of belonging, community, identify or self-respect, or as likeability, loyalty and love (Clark 2007).

In relation to specific network functions, much of the literature suggests that social networks serve various positive *utilitarian – or instrumental –* functions, e.g. as a means to gain influence, increase access to resources, reduce transaction costs, build interest based coalitions. One study identifies five possible network functions between stakeholders in community-based projects: i) exchanging ideas; ii) disseminating or diffusing knowledge; iii) providing funds; iv) providing other tangible resources; and v) exerting influence (Lauber et al 2008). However, many networks studies tend towards a focus on the *supportive and positive functions* of networks and, therefore, ask participants to report on positive relationships and friendships. For example, Nye and Burgess (2008) explored how behaviours can change through an eco-team (an environmental minded group) and as well having many positive effects (social support, diffusion of knowledge, etc.). However, they (among others, e.g. Clark, 2007) have suggested that this tends to neglect or omits the *unsupportive, detrimental or destructive* effects of social networks. For example, their study also found that people were often left with a feeling that one is not living up to certain expected standards of 'green behaviour'.

3.2 Actors' characteristics

An axiom of the social network is that structured social relationships are a more powerful source of sociological explanation than the personal attributes of network members (Tindall & Wellman 2001: 256). As such some SNA methods treat all actors within the network as equals. However, it is also recognised that the flow of information diffusion can also be affected by the characteristics of network members. For example it is recognised that shared demographic characteristics such as class, gender, race, religion, make people more likely to form networks with each other, which is known as *homophily*. As McPherson and his co-authors (2001:428) note:

'People who are more structurally similar to one another are more likely to have issue-related interpersonal communication and to attend to each other's issue positions, which, in turn, leads them to have more influence over one another. There are powerful homophily effects in who we consider to be the relevant others in our organizational environment: those to whom we compare ourselves, those whose opinions we attend to, and simply those whom we are aware of and watch for signals about what is happening in our environment.'

They found that race and ethnicity are the biggest divides in people's social networks in the United States. This is perhaps slightly less the case in the UK context, but will nevertheless have a role to play within some of the EVALOC case study areas. Many of their observations are likely to hold true in relation to the influence of gender, age, education and social class, ethnicity, religion and geographical location on the homophily, nature and strength of people's social networks.

While gender may not divide networks so much, it still has a strong influence on the role of different members, with homophily occurring in the play patterns of young children: girls tend to operate in smaller groups and to be more likely to drop a friendship from their network if others around them do not include that person, whereas boys are more likely to include friends into their network on this basis. Both girls and boys are more likely to drop a friendship across gender boundaries (ibid).

Age is also an important variable in determining the composition of people's social networks. People tend towards ties of the same age within two or eight years of each other, especially in closer confiding relationships, but less so in financial arrangements or when family ties are removed. Marriage, friendship and confiding relationships show religious homophily effects in all societies and across all age groups, although this may be somewhat decreasing for some religious groups in recent years. Ties between people of the same religion are more likely to be close ties of lending money, giving trusted advice and therapeutic counselling, while work and hobby networks show less religious homophily and may not matter at all in relationships of less closeness (ibid).

Beyond these more inherent factors, education, occupation and social class can also have a huge effect on the nature, role and extent of a person's social network. Social class often determines where a person lives, works and plays. About 30% of networks are homophilous on education (Marsden, 1987), Wright (1997) found significant boundaries to friendship across property, skill and authority boundaries (except in Sweden) and kinship ties tend to introduce educations and class homophily into confiding and support networks (Kalmijin, 1998).

Granovetter (1983) reviewed a number of studies and found that poor people rely more on a small number of strong ties as a response to economic pressure than do others, which can be detrimental to their social and economic position.

3.3 Actors' roles, strategies and power relations

The *role* played by different actors is also important in understanding knowledge and resource flows. Curtis found that stakeholders played different roles in collaborative processes and that a framework that helped to establish appropriate roles was a key element to success (Curtis and Lockwood 2000; Curtis and others 2002). Others have identified the role of 'hubs', 'gatekeepers' and pulse takers' within networks (e.g. Bacon et al., 2008). EVALOC research will seek to explore the differing influences of formal and informal role holders.

Actors' strategies, and the power relations between them, may also influence knowledge and resource flows, and behaviours. Carrasco et al (2009) argue that as some actors may be more influential or active within a group than others and so it is important to adopt an *agency* perspective when considering the influence of social networks on individual behaviours. Dowding (1995), for example, has argued in relation to policy networks, that it is the actors' characteristics relating to power sources and bargaining strategies, and hence the power distribution between actors, that can explain policy making rather than the structure of the network per se (although this may have an influence).

Van Warden (1992) catalogues networks along seven dimensions according to actors, function, structure, institutionalisation, rule of conduct, power relations and actor strategies. Power sources may include money (or the ability to raise, aware or withhold money), legitimacy, coalition strength and knowledge (Cunningham, 1992). Thus networks can either be seen as consisting of 'voluntarily chosen, egalitarian, symmetrical ties, or asymmetric ties [that] unevenly distribute resources in complex hierarchical structures of power and dependency (Tindall and Wellman 2001: 4). For EVALOC this suggests that our SNA needs to be balanced by an understanding of actor's attributes and agency, power relations and strategies as well as network structure. Some of this information will be gathered through community level research.

3.4 The wider social context

Carrasco et al. (2009) recognises that individuals' decision-making is influenced and constrained by external structural factors (e.g. income, locations) and responsibilities (e.g. child care, work), their individual characteristics (e.g., age, gender), as much as the attributes of the network itself. In addition, social networks are a product of the residual trends of individuals' past social engagements and their resulting future expectations, rather than a static object exerting a constant weight on [travel] decisions.

Cattell's (2001) qualitative study of two deprived areas also explored the influence of neighbourhood characteristics, poverty/social exclusion and social consciousness on local networks and social capital. She found that the features of the networks associated with their neighbourhood context, such as its social and employment history, its services, facilities, housing, opportunities for casual meetings and for participation in associations, as well as the area's reputation all played a role in their nature and content.



4. Social network analysis

SNT comes with its own set of fairly well described methodologies, both in terms of how data is analysed and the way in which it needs to be collected for these analytical purposes. SNA has steadily grown in its levels of sophistication with the advent of advanced analytical computer software tools for the management of large datasets (Hogan, 2007). As Scott (1988) identifies in his seminal overview of SNA, researchers have largely been preoccupied with identification of the structural properties of networks, including the 'centrality' of different actors within a networks and the 'density' or 'connectedness' of the network itself, rather than with the content of its interactions.

The key feature of SNA methodology is that unlike standard research techniques such as surveys or interviews, which treat individuals as the main unit of analysis, SNA have developed techniques to map and interpret *patterns of interrelations* among actors (Tindall and Wellman 2001). Beyond these superficial visualisations of networks, analysts mostly tend to focus their efforts on describing the density or sparseness of the networks and their clustering effects, i.e. how well they are connected.

When the clustering coefficient is large it implies that a network is highly clustered around a few nodes, when it is low it implies that the links in the networks are relatively evenly spread among all the nodes (Hanneman and Riddle, 2005). Centrality scores are used to describe the relative prominence of a given node in comparison to others. The average centrality score is also known as a centralization score, and indicates how strongly weighted the graph is towards a single node (Hogan, 2007). Measures of community detection can be used to partition the overall network into sets of 'dense relations' and/or 'cohesive sub-groups' methods can used to identify dense 'pockets of links' within an overall network.

Essentially, three types of networks have been described, whole networks, personal networks and partial networks. In whole network analysis, the goal is often to describe the characteristics of a complete network within a clearly demarked population, and to ask why certain individuals occupy a particular location within it. Personal network analysis has tended to examine the differences in the size, shape and quality of a number of personal networks based on sub-samples of the population. Partial networks are usually the result of using snowballing sampling techniques, where not all the individuals in a network will be captured but the analysis goes beyond the comparison of personal networks towards the identification of important actors and strengths of ties between actors.

Although not inherently mathematical in its approach, there has been a strong tendency towards the quantification of network qualities, with a large body of research concerned solely with the translation of modelled formulations into grounded theories based upon empirical observation (e.g. Wellman, 1981; Berkowitz, 1982). Whether qualitative or quantitative in its design, SNA seeks to understand how a given social structure both facilitates and constrains opportunities, behaviours and cognitions (Tindall and Wellman, 2001).

4.1 Data collection methods

Hanneman and Riddle (2005) provide a comprehensive course guide to social network methods. In summary, most social network data is collected via a specific survey or

interview design and increasing through the Internet. Network analysis traditionally focuses on the relations between actors: the strengths and natures of their friendship ties, the frequencies and locations of their interactions and so forth.

It is usual (but not essential) to track down other people in the network and ask them a set of reciprocal research questions. For practical reasons of resources constraints, we will not be pursuing this approach in the EVALOC study. However, we do intend to analyse the personal networks of our participants with those of the community networks of the LCCs in their area. This will allow us to determine the connectedness and effectiveness of these wider LCC networks in their communication of energy messages and advice to different local residents in their areas.

The populations studied within networks can be myriad and diverse, so in each case the elements of the population to be studied are defined as falling within some pre-defined boundary. Often the network data describes the nodes and relations among nodes for a single bounded population, e.g. all children in a classroom, or all the member of an organisation, or all the players in a football team. This makes it important to be clear about the boundaries of the sample and how individual units within it are to be selected from within that boundary. In the EVALOC study this is the immediate local area in which the survey participants reside.

It is usual to consider only face to face interactions between members of the network, but increasingly virtual interactions through the Internet are also considered (Hogan, 2007). It is also common to consider individuals as embedded within a set of nested networks, e.g. within the home and family, within their work lives, as part of their caring responsibilities (particularly if they are parents or look after elderly or sick relatives) and as a feature of their leisure and social activities.

4.2 Mapping the network

Individual respondents are generally asked to generate the names of all the people who are 'close to them' (with whom they are either in frequent contact or who they discuss important matters with or who they can call on for help) and those that are 'somewhat close' but more than casual acquaintances (see Hogan, 2007 for more extensive information on this). This is usually achieved in a face-to-face interview with the respondent using some form of 'name generator tool', produced either manually or using a computer programme (see Figure 1).

A common first step in network analysis is then to visualise the relations between these names in terms of the closeness of the ties (see Figure 2). This step is also performed in collaboration with the 'ego' (main respondent).

Visual maps can also be desirable to determine where the different people in the network are situated in relation to each other geographically. Although this is not a necessary or essential step, it can be useful for the purposes of assessing how people make contact with each other through the transport network, which is an important consideration in determining their energy consumption patterns in relation to the maintenance of their social networks. Such visualizations are common in social networks papers and presentations. However, as Hogan (2007) points out, it is possible to 'oversell' the visual aspects of a network and thus bias the analytical stages of the research, unless this is tightly controlled for within the analytical framework.

They also suggest that further research is also needed on the proposed strategies or mechanisms that network actors use to engage and mobilise people e.g. through communication, appeals, social influence, incentives and sanctions, social support, information, norm appeals, trust etc. (Tindall and Wellman, 2001).

5. Some specific uses of SNA relevant to EVALOC

In this section of the review, we identify of some of the ways in which SNA studies have addressed the issues most relevant to the EVALOC study. In particular, we focus on use of SNA in the study of communities, social support, poverty and exclusion and in the study of collective action (see also see Annex 2, which provides some examples of its specific practical application).

5.1 SNA and communities

Traditional views of communities portrayed them as spatially bounded, tight knit networks that act as structural supports for friendship, kinship and place attachment. It is now argued that either such supports are less important they once were, or that they have become much less spatially orientated (Larsen et al., 2005). The use of SNA has come to be seen as increasingly relevant to the study of communities because of a perceived decline of geographically based communities, or face to face networks (e.g. Putnam, 2000) arising from the separation of home and workplaces, growth of public and private transport, suburbanisation, growth of telecommunications, international travel, etc. (Clark, 2007). SNA is particularly relevant here as it shifts the emphasis from the study of communities as geographic places to studying them as networks of social ties that may or may not be geographically based. 'An approach formulated in terms of primary group relationships seems more fruitful than one tied problematically to geographical space' (Bulmer, 1985, p434).

Frankenberg (1966) argued that traditional notions of community may be subsumed by social networks, which are seen to transcend physical boundaries and can often be more resilient depending on the closeness of their 'knit'. However, others argue that geographical communities' do also still exist if you look for them in the right place e.g. home-based women, childcare, social groups such as elderly, young or poor, people who have restricted access to transport etc. (Clark, 2007)

5.2 SNA and social learning about energy behaviours

SNA can also contribute to understanding how social learning and the adoption of innovation or ideas (social learning) occurs, via social interactions between different actors, e.g. whereby one individual imitates or is influenced by or receives something from another (Borgatti 2003). As noted above whilst social networks can influence the adoption of new energy behaviours, this needs to be understood and assessed in the wider context of the numerous other individual, interpersonal/group and structural influences.

The role of social norms, trust and credibility are particularly relevant to understanding the influence of social networks on social learning about new behaviours. As discussed in

other EVALOC reviews, 3 people are strongly influenced by 'social norms', i.e. by how they believe their behaviours will be viewed by others (Festinger, 1954; Cialdini 1993). They are, therefore, more likely to adopt pro-environmental behaviours if they think others like them are doing the same, particularly those people they like or share commitments with (Kahan, 2010). The literature on organizational psychology and social learning shows that individual behaviour is highly influenced by interpersonal relationships and group identity as individuals face the sanction of being ousted from the group if they do not adhere to accepted standards (Tajfel, 1982 quoted in Jackson 2005; Lewin, 1952). Research has also shown that messages from trusted or credible sources are likely to increase the uptake of novel technologies or new behaviours (Stern, 1992, Perez-Lombard et al., 2009, Harting et al., 2009, Greenhalgh et al., 2004), as well as being influenced by respondents' perceptions of the motivations of information providers (Frewer et al., 2003).

Building on the discussion about the role of weak and strong ties, Weenig and Midden (1991) have made a useful distinction between the role of social networks in diffusing information and/or persuading people to adopt certain technologies or behaviours. In a study of two nearly identical communication programmes in two separate Dutch neighbourhoods, they showed that information diffusion was related to the number of network ties in the community, whereas adoption decision (programme effectiveness) were related to the quality or strength of network ties. Social networks have also been found to be significant in influencing adoption decisions relating to energy efficiency and/or behaviour (Newman and Dale, 2005; Scott, et al 2001).

5.3 SNA, social support, poverty and exclusion

The literature on exploring the role of personal networks and social support is also relevant to EVALOC, as some community groups are not just seeking to change energy behaviours but also build more cohesive communities and/or build cultures of greater sharing and resilience in the face of climate change and economic shocks. Tindall and Wellman's (2001) review of the role of networks in providing social support shows how network members provide emotion aid, material aid, information, companionship and a sense of belonging, and how social support is one of the main ways that households obtain resources to deal with daily life, seize opportunities and reduce uncertainties. The review also shows how different members of a network provide different forms of support: friends and siblings provide companionship, whereas parents and adult children tend to provide large services and financial advice and support.

Cattel's (2001) study of two deprived neighbourhoods also found that certain health protecting or damaging attributes were linked to network type. Those with most restricted networks were likely to feel anxious, depressed, headaches and stomach complaints as well as experience feelings of fatalism and hopelessness. In contrast, residents who were more involved in local activities tended to have higher self-esteem and hope for the future. She recognises that those who feel healthy and happy in the first place are more likely to participate in social networks. However, she finds evidence of how friendship networks had transformed their lives for the better. However, the author also cautions that even if:

³ <http://www.evaloc.org.uk/content/literature-review-evaloc-project-individual-and-social-influences-energy-use>

'... networks can ameliorate the harsher effects of poverty and deprivation, they are nevertheless no substitute for a more equitable distribution of resources nationally', [but] 'the processes within different social typologies may simply be a reflection of the class structure [and] a certain level of pre-existing resources are required to build social capital'. (Cattel, 2001: p1513)

5.4 SNA and collective action

SNA is useful for understanding the networking and engagement strategies used by community groups. Scholars of social movements recognise that network ties are essential for recruitment and mobilisation of people. Thus the nature of community groups' organisational networks will influence the effectiveness of their efforts to engage and mobilise people to take wider action e.g. participating in collective community based action, protests and/or influencing policy. Moreover, the power of any particular group to achieve change will be in part influenced by the size of its membership and support base and the density of social ties within in it, among other sources of power (Tindall and Wellman, 2001).



6. Implications of our review for the EVALOC's social network study

Our review of the literature suggests that people's awareness, attitudes and social norms in relation to energy services and technologies are likely to be influenced by their social networks. Thus, in order to encourage the adoption of new energy behaviours, low carbon communities (whether community groups, local authorities or partnerships) need to understand the characteristics of residents' social networks, and use this understanding to develop strategies to build and shape networks to communicate energy messages and influence energy behaviours. For example, a strategy aimed at informing local residents about the availability of a local energy programme will look quite different to one aimed at encouraging residents to take up new technologies or to change their energy related behaviours. This is a distinction already well understood by many community groups and reflected in the different strategies they use for 'community engagement' and 'energy projects' relating to energy efficiency behaviour change, renewable energy.

The review findings suggest that if existing network characteristics are not conducive to creating effective and equitable information flows and influencing technology uptake and behaviours within the community, then low carbon communities will need to be resourced to help build social networks in the first place, if they are absent, or to reshape existing ones. Newman and Dale (2005) postulate that successful networks need to maintain a diversity of linkages between stakeholders including both bonding links (among members of groups), which can help to maintain trust, and bridging links (between groups), which can help to make resources more accessible.

Nevertheless, as we have previously noted, community-level social networks are only one among a range of influences on energy behaviours. If community groups are to help address some of the wider structural influences on energy behaviours they might also need to be resourced to invest time in strengthening relationships with other local and national actors, to develop a more supportive, equitable and predictable policy framework to support local action.

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Annex 1: Terminology

There are some specific technical definitions that are worth describing here first because of their proliferation within the SNA literature and consequently the text that follows (primarily taken from Wasserman and Faust (1994) but are also supported by other relevant literature).

Table 2: SNA terminology

Term	Definition	Relevant sources
Actors	Social entities, which can be individuals, corporations, or collective social units. Research can be among similar individuals are called one mode networks (those in the same department).	(Haythornthwaite, 1996)
Ego	The actor at the centre of the social network, usually the key respondent	(Garton et al., 1997)
Alter	The other people in the ego's social network	
Nodes	The meeting points between ties.	
Ties	Nodes are linked together by ties. It is an established link between actors. There are a variety of ties, including transfer of materials, behavioural interaction, physical connection, national relations, etc.	(Feld, 1981)
Dyad	A linkage or relationship between two actors and possibly the ties between them. Some types of network analysis take the dyad as the unit of analysis only.	(Ter Wal and Boschma, 2009)
Subgroup	Pairs of actors and associated ties are dyads, and triple actors and ties are called triad. When the unit of analysis is larger (four or more), they are defined as a subgroup. Subgroups can be defined and analyzed in different mechanisms depending on the network analyst's intention.	(Wey et al., 2008)
Group	A set of actors that are treated as a set of individuals that are analyzed for conceptual, theoretical, or empirical reasons where network measurements and derivations are made.	(Ennett and Bauman 1993; Dholakia et al., 2004)
Relation	A relation is a specific kind of collection of ties among members. Examples of this include set of friendships among pairs of elementary school students, relations among pairs of countries, etc.	(Hafner-Burtona et al., 2009)
Homophily	The tendency of a group to become less diverse over time, and to distrust outsiders	(Newman and Dale, 2005)

Annex 2: Other examples of specific practical applications of SNA relevant to EVALOC

Discipline	Role of SNT	Source
Community Development	Recognised that infusing SNT into community development allows members to engage constructively towards a community goal in a collaborative format.	(Cook-Craig, 2010)
	Evaluated the community building capacity of the Bay Community Cancer Network. Found that the formation of the network lead to greater trust, collaboration, and partner building efforts using social network analysis.	(Luque et al., 2010)
	Evaluated how local communities adapt to extreme climate events. The researchers concluded that while institutional analysis and social capital provides constructive insight, network analysis can also provide innovative insights on adaptive capacity that can help develop an understanding of communication flows, actor embeddedness, as well as governance structure	(Ingold et al., 2010)
	Evaluated the effectiveness of locally based food coalitions on promoting food security. The SNA provided a foundation of what benefits occurred, it also highlighted gaps in the network and underlying tensions on group effectiveness and inclusiveness. SNA provided an innovative framework to illustrate challenges as well as ensure that democratic, social, and equitable justice is maintained	(Freedman and Bess, 2011)
Energy technologies Energy technologies	Utilized SNA to explore how communications among crews in nuclear power plants can encourage or prevent miscommunications. Researchers contextualized information in a new way that highlights the significant features of communication structures.	(Park, 2011)
	An evaluation of socio-political dimensions of emerging energy technologies was evaluated via SNT by interviewing key energy policy makers and evaluating communication linkages. Researchers	(Ragland et al., 2011)

	concluded that technical risks dominate communications about deployment and uptake	
Energy behaviours	An evaluation of how cluster policy can be utilized as a policy instrument to stimulate alternative energy uptake was made. Researchers found that collaborative investment may help improve investment functioning and achieving policy goals in various networks through SNT and SNA.	(Mans et al., 2008)
Regional sustainable development	Explores how well-functioning social networks within regions can play a useful role in achieving sustainable development because they facilitate the speedy dissemination of novel information, expertise and resources across the region in an effective and equitable way. Using insights from three network theories an outline of a regional network infrastructure is drawn. Key roles are identified: the gatekeeper; prime mover; bridge builder/intermediary; representative; spokesperson; and monitor. Smaller local scale networks need to work in harmony with larger scale ones. The article argues that it is necessary for regional institutions that are charged with implementing the government's sustainable development policy to pay attention to the social capital of the region in which they reside. It is crucial to assess how credible, consistent and equitable the actions of role players are, because poor performance is likely to have negative impacts on the functioning of the network as a whole and consequently on regional sustainable development. Mapping exercises can illustrate the quantity and quality of social capital in the region, the extent to which certain roles are being filled, any overlap between different organisations seeking to fulfil similar roles and the identification of gaps in the networks.	(Devine-Wright P., et al, 2011)
Transport	Used SNA to understand the role of social interaction in the decision to adopt new plug-in hybrid electric vehicle technologies.	(Axsen and Kurani, 2010)
	Explored the evolution of social networks	(Axhausen, 2005;

	over time and space to consider both the physical extent and strength of their influence across distance.	Carrasco, et al., 2008)
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Environmental Change Institute



For more information on EVALOC please contact:

Professor Rajat Gupta

rgupta@brookes.ac.uk

Tel: +44 (0)1865 484049

Fax: +44 (0)1865 483298

Low Carbon Building Group

School of Architecture

Oxford Brookes University

Headington Campus, Gypsy Lane

Oxford OX3 0BP

United Kingdom

www.evaloc.org.uk



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