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Chapter 4

DISTRIBUTED GENERATION OF SUSTAINABLE ENERGY AS A COMMON POOL RESOURCE: SOCIAL ACCEPTANCE IN RURAL SETTINGS OF SMART (MICRO-)GRID CONFIGURATIONS

Maarten Wolsink

INTRODUCTION: GRID-IQ AND RENEWABLE ENERGY

From the middle of the 1980's onwards, the major development in energy supply and consumption has been the splintering of central power grids and the simultaneous evolvement of regional, decentralised configurations. Traditionally power plants are large centralised units; however, the current trend is moving towards having much smaller energy conversion units, which are located with an enormous geographical spacing. This type of generation capacity in numerous generating units situated close to energy consumers is called *"Distributed Generation"* (Ackerman et al., 2001). Distributed generation is increasingly associated with a more sustainable type of power supply. With atmospheric CO_{2eq} still increasing rapidly, there is an urgent need for climate change mitigation, the primarily tool being a switch to low carbon energy. Applying renewables, in particular in electricity supply, has become a pressing issue and most renewable energy units must be considered forms of distributed generation. A system with a large amount of distributed generation in combination with improvements that serve efficiency and reliability is considered an environmentally friendly alternative to the traditional power supply system (Alanne and Saari, 2006).

According to the major trend in the literature on distributed generation adoption of composite multi-generation systems may yield significant benefits in terms of energy efficiency and reduced carbon emissions. This is suggested, because distributed generation comprehends combined geographically dispersed decentralised generation from preferably renewable sources. Most renewable sources require generation units that are much smaller than conventional, existing power generating units. The prime example here is the standard PhotoVoltaic panel with a size smaller than 1 m^2. And even up-to-date reliable wind turbines may have a capacity of about 2MW and more, and they may be sited in wind farm configurations with more than one unit, but even then this is still fairly small compared to the conventional central power plant. Furthermore, small hydro power, geothermal power, and local biomass based combined heat and power (CHP) units may emerge, all with rather small size. Within small micro-grids, newly developing techniques of storage (batteries) and fuel cells may become increasingly important in relation to the intermittent energy sources (Tanrioven, 2005). All these assets, in particular the renewable power generating units will therefore become sited as decentralized units and usually be located closer to the end-users.

The literature on distributed generation tends towards exploring ways to realise the emerging potential of distributed generation in smart combinations with the associated loads of consumption. This is why "micro-grid" subsystems are promoted (Marris, 2008; Jiayi et al., 2008). The micro-grid is a cluster of loads of electricity users and micro-sources that operate as a single controllable system for generating and using power. It enables the production and storage of renewable energy, as well as the exchange of electricity between energy providers and consumers to take place locally. Such micro-grids can combine distributed generation from several energy sources with generating units and storage capacity owned and/or managed by groups of multiple consumers (households and others), all becoming small scale co-providers of energy (Hammons, 2008). The term *"smart grid"* generally refers to the larger grid which integrates these micro-grids. For the existing, in developed countries centralized power supply systems, application of individually distributed generators per se can also cause reliability problems, because of the problem of intermittent supply of most renewable sources (Pepermans et al., 2005). Therefore, the emerging micro-grids and the way these can be integrated are a relevant question for power supply, whereas existing energy providers tend to indicate that distributed generation produces reliability problems. These generation units are outside of the control of conventional grid operators (Pepermans et al., 2005). On the other hand, the emerging distributed generation and micro-grids may also provide solutions for instability if we would be able to deal with the intermittency of the distributed power generating units already at the local level, within the micro-grid.

The question that will be discussed in this chapter is what the determinants are of rural communities that may form micro-grids that are essential to distributed generation applying renewable energy sources. The determinants will appear rather geographically defined. Conditions for application of solar power (PV), on-land wind power, geothermal energy, small hydro, organic agricultural waste and biomass fuelled CHP, all show a wide geographical variety. Furthermore, as the supply of distributed generation must be locally and regionally attuned with electricity demand in local micro-grids, the systems also depend on the composition of the group of users. When innovations in energy are analyzed, and also innovations more broadly, reflection upon the users is limited, very much unbalanced, and the term *"user"* is in fact ambiguous when considered in the relation to technology production (Jelsma and Rohracher, 2003). If micro-grids arise, they will connect a group (of very different types) of users, probably located close to each other, that should organize themselves around a common system of power generation and electricity consumption. Hence, they form a micro-grid community. Such a system of community energy requires a form of governance of local smart micro-grids with a combination of consumption and small-scale generation close to the consumers and by the consumer (*"prosumer"*) that can be viewed as self-governance in a system of a *common pool resource* (Dietz et al., 2003). The management of the natural resource of renewable energies shows similarities to the management of common pool resources. As mentioned, there will be wide variety of such micro-grids, and here we will focus upon such systems in rural settings.

BEYOND THE TECHNOLOGY FIX: SOCIAL ACCEPTANCE

Currently "smart grid" is a buzz word lacking an agreed upon definition. In fact, there is no example of a smart grid currently in operation. Despite these ambiguities, there is substantial and accelerated technology driven progress towards developing smart grids (Coll-Mayor et al., 2007). Here we try to address the development of micro-grids that include substantial amounts of renewable distributed generation, but we focus upon the question how such new energy systems are socially constructed and embedded. The most fundamental changes in power supply concern in particular the institutional conditions for the development of such systems of micro-grid/distributed generation. Whereas designing smart grids is fundamentally different from the existing power supply and distribution system, the crucial differences are not only technical; the institutional differences are even more important. All of the actors in power production and consumption would play entirely different roles in a developed smart grid system, especially if significant distributed generation from renewable sources is included.

Currently, almost none of the existing social scientific knowledge is applied in the development of smart grids. The technology developed follows strong but highly questionable assumptions of expected social acceptance of the basic principles and of the crucial elements of these smart grids. There are two possible paths for development: either

a. Policies will be increasingly designed to enhance the autonomy of (local) groups of end-users to further their options to apply renewable sources and sustainable energy use; or

b. The options for decentralised generation capacity and smart metering will be used for regulating individual consumption behaviour by increasing the surveillance of domestic consumers by network managers with the aim of regulating demand in line with central policy prescribed levels.

Most studies on energy consumption behaviour in households tend to see consumption in terms of individuals "responding" to information, price, social norms in order to getting the need for demand reduction or load-shifts accepted. Reliability issues concern regulation of energy flows as well as market balancing, and for both it is essential to install and use *"smart meters"* as part of a "smart grid" (Charles, 2009). Currently, most references to consumer behaviour in 'smart grid' configurations focus exclusively on 'Demand Side Management' (DSM) by energy providers. This approach of consumers as on-demand receivers seems to fall in line with (b), but the expectations about acceptance and actually occurring changes in consumption as a result of utility-controlled smart meters are generally naïve (Darby, 2010). Approach (a) is more in line with the smart grid as a collection of integrated micro-grids (Marris, 2008) and this approach requires even more social science research supporting the social foundations of the development of smart grids. If we aim for optimal application of low carbon generation by renewable energy sources, this kind of knowledge is essential. Based on the existing knowledge about the deployment of renewables, it seems that option (a) provides a much wider scope of possibilities for applying renewables in distributed generation (Hammons, 2008). For analysing what constitutes a "smart grid" we need a so-called socio-technical perspective.

SOCIO-TECHNICAL CONFIGURATIONS: INSTITUTIONS

An infrastructure system should be seen as combinations of certain elements and characteristics that are technical and of characteristics of social organising that make the technology active (Guy, 2006). From this viewpoint, a smart grid is a *socio-technical network characterised by the active management of both information and energy flows, in order to control practices of distributed generation, storage, consumption, and flexible demand*. The characteristics of such systems should be considered as "institutions". By definition, institutions are patterns of social practices and thinking (North, 1990). For example, one of the main patterns of thinking in existing power supply is challenged, because a smart grid is a drastic departure from the currently predominant centralised power supply systems, because it can become a network of integrated micro-grids that are internally regulated whereby power from different sources is fine-tuned to local supply and demand by consumers of different types. Figure 3.1 shows the smart grid, according to this description.

Smart grids are needed to fit renewable sources into energy provision for two reasons: (a) there are large numbers of energy supply units that are generally small and spatially dispersed, and (b) their production levels do not follow demand but rather fluctuating seasonal weather and other natural conditions (Charles, 2009). Smart meters will become the major nods in the networks of energy flows and information, between supply, distribution, demand, and storage. In all views on future power grids, smart metering is a no-regret option (Van der Veen and de Vries, 2009). The intelligent monitoring systems utilised in the smart grid, in fig. 3.1 represented as "sensors" and "processors", keep track of all energy flows and capacity loads. They are crucial for optimising supply within the micro-grid, to optimize consumption to supply in the micro-grid, to optimize the integration of the micro-grid in the larger network, and to optimize the supply by additional possibly larger scale remote power generating units such as large scale wind farms (e.g. offshore), large scale PV plants (e.g. abroad or in desert areas) and more conventional central power plants supply units (notice this "central power plant" in fig. 3.1 is no longer at the centre of the system). The smart meters do not only measure consumption, but they monitor supply and demand and attune both all scale levels, both from a user/consumer and a micro-grid point of view as well as seen from the central grid. Smart metering consists of wide range of equipment, from sensing, measurement (energy, loads, weather etc.), and control devices.

In the current institutional framing these appliances are essentially seen as tools that are operated by the energy supplier or the grid manager (DSM). The crucial social issue, however, is whether to see the smart grid as fostering two-way communication as well as operation and control primarily by energy users, who would have themselves become producers. When users are also producers, as is the case in distributed generation, it is likely that they will also exercise control and management over information, as well as energy flows. A smart grid incorporates consumer equipment and behaviour in grid design, operation, and communication. These distributed "assets" must be considered to be the most important characteristic of smart grids (Brown et al., 2010: 68). These assets provide consumers with control over "smart appliances" in homes and businesses. They also interconnect energy management systems in "smart buildings" and enable consumers to better manage energy use and reduce energy costs. We define smart meters as *"socio-technical devices which act as hubs for information flows, while serving domestic practices (programmed off-on switching) of energy consumption. Contrary to conventional meters, smart meters monitor, control, and display the energy demand and supply from various sources and manage storage capacity and loading processes."*

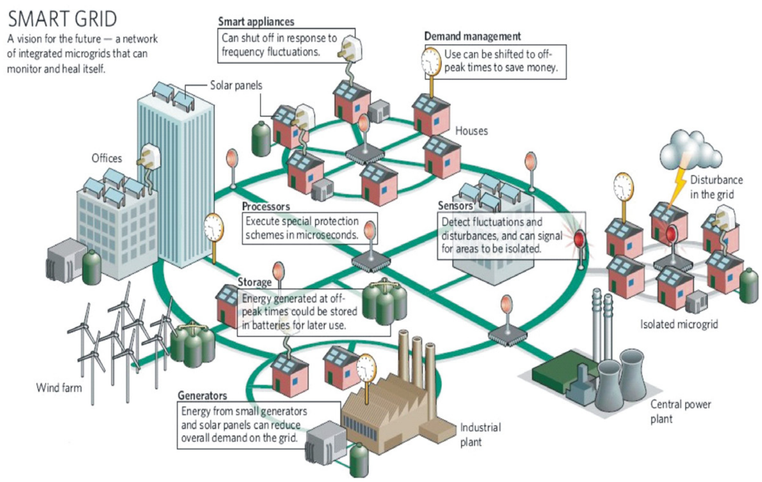

Figure 3.1: Smart grid: a 'network of integrated micro-grids that can monitor and heal itself'
Source: Marris (2008: 570) ©Nature

After *"distributed assets"*, *"incorporating distributed energy resources"*, and *"smart metering"*, the next important issue is: *"Is the utility willing to give the consumer 'limited' or 'total' control of load and generation"* (Brown, 2010:74). Though this control is essential in micro-grids, it is definitely not self-evident. Implementation of user-control would be nothing less than a complete institutional revolution, but it would be an important change. However, the developments in renewable energy implementation show that such institutional changes are very hard to achieve. The users' control in the micro-grid also includes control over the distributed generation units and over facilities for *"distributed storage"*, including different types of devices for demand side management. Such storage capacity is currently neither available and nor economically feasible, but this is likely to change with the introduction of electric cars, which will bring in extra load as well as storage capacity into households (Srivastava et al., 2010).

By replacing the conventional consumer-producer relationship with the relationship of the consumer with himself and the partners in the micro-grid as a distributed generators (becoming co-producers), entirely new relationships are created. The term "consumer" may refer to different types of energy users, such as individual households, companies, or a group of individuals that co-operate as one single actor. Consumers will get other relationships with grid managers and utilities. The consumer's relationship with other partners in the micro-grid will also change significantly, as they may become producers delivering power to their neighbours, but existing institutions in energy provision absolutely do not support these new relationships.

Innovation is rather the introduction of a new *socio-technical system* (STS) instead of simply the introduction of new technology. An STS consists of new scientific and technical, as well as socio-economic and organizational components, that both reflect new ideas and concepts on the proffered design of such new systems (Geels, 2004). The willingness among different actors and markets (authorities, utilities, enterprises, agencies, different publics, civil society organisations, etc.) to accept key aspects of the innovation can be subdivided into two broad segments: (a) acceptance of the creation of socio-economic conditions needed for implementation, and (b) acceptance of the consequences (the ways in which implementation will affect and change current practices in society).

The decisions that affect implementation of distributed generation in micro-grids do not only concern the technologies of PV, wind, smart metering, or electric cars, but especially the institutional setting in which implementation will take place. By definition, the existing patterns of behaviour and organisation are called *"institutions"*. According to North (1990: 4) institutions are the *"rules of the game"* and these rules have emerged over time under different conditions with different goals. The existing rules have come into being in history, serving other aims than the new ones. Such *"path dependency"* (Thelen, 1999) is often responsible for unfavourable conditions that forestall the introduction of a new STS. This may easily lead to deadlocks in the development of the new system, generally known as institutional *"lock-ins"*.

ACCEPTANCE SMART MICRO-GRIDS: SIMILARITIES WITH ~~OF~~ RENEWABLES

This institutional setting is framing the acceptance to reserve space for distributed generation units and the willingness to invest in wind power, PV or any other distributed renewable generation unit. Obviously, geographical characteristics are very important for the acceptance of options for the application of distributed renewables' generation, as well as for the institutional landscape that determines this social acceptance. The distributed generation units can be placed, for example, on rooftops of houses, on farmland, on companies' rooftops, school's rooftops, alongside roads, etc. Clearly these options are very different for rural areas as compared to urban settings. The density of local electricity demand is also very different, so attuning local electricity demand and generation becomes a different question too. Beside that, the institutional landscape in rural settings is very different from urban areas as well, as there are historical and cultural differences, for example with regard the acceptance of PV and other renewables by actors. This acceptance is determined to a considerable extent by the institutional arrangements of ownership and control of the appliances (e.g. for PhotoVoltaics in households: Sauter and Watson (2007) and ownership and control over the space where the units will be placed. In general, the acceptance will also be shaped by the trust the actors have in the institutions and the actors that guide the transformation of the conventional energy grid into a "smart grid".

It is tempting to define the micro-grid merely in technical terms. When looking at it that way, it consists of two networks of electricity producing units (with their capacity) and consumption (with their loads) and a parallel information network with flows generated by smart metering devices.

This technical definition is a trap, because there will be no smart grid when there are hardly actors that are willing to become part of it. The participants in these networks are social actors, and their role in establishing a smart grid has been largely ignored thus far. It is the decision of those actors to become part of the micro-grid in the first place and if they are not willing to do so, or only accept certain aspects of it, the smart grid will become very different. Here we are facing a large number of questions, such as:

- Under what conditions are users willing to install their own generating capacity?
- What variants of control over generating capacity do these users accept?
- Under what conditions are they willing to accept smart metering?
- Under what conditions, and to which degree are they willing and able to change their behaviour shaping different electricity consumption patterns?
- Who will be owners and/or managers of the power generation units
- Who has property, management, and control over the smart meters?
- Who owns or has control over the data that are provided by smart metering?
- Who can use these data, and for what purpose?
- On what optimization is the regulating function of smart metering directed, and does this prioritize the application of renewable energy sources effectively?
- What is the role of the public grid manager in micro-grids or in the public grid that is integrating many different micro-grids?
- What types of organizations exist for the communities that are connected by a micro-grid?
- How should the mutual delivery of energy be regulated, including the rates?
- Are the payments within micro-grids public transactions, or may these be considered internal transactions? (e.g. with consequences for taxing?).
- What will be the diversity in future large numbers of micro-grids, technically as well as socially?

Beyond all these practical questions, there is a fundamental question: is the establishment of a smart grid directed at optimizing patterns of supply and demand that fit the energy company, or patterns that would fit the power generated by themselves and by their micro-grid partners?

The emergence of smart micro-grids is fully dependant on social co-operation and on the outcomes of behaviour within the new configuration. Because the literature on smart grids heavily focuses on technology, it does not reveal much awareness of social acceptance issues among the actors involved in the establishment of smart micro-grids. This will probably rapidly evolve into a bottleneck in the development of smart grid. Experiences with renewables deployment have shown the strong impact of social acceptance on the rates of implemented renewable energy sources.

The challenges of implementing renewables demonstrate the importance of addressing the social acceptance and adoption of the crucial elements of smart micro-grids. The establishment of infrastructure that is necessary to achieve sustainability goals in various policy domains formulated by national governments, is often not supported by existing institutions, including the policy frameworks defined by the government (Wolsink, 2010b).

Deployment of renewables faces many problems connected to social acceptance, which is a commonly used term in practical policy literature. The elaboration of the concept (Wüstenhagen et al., 2007) distinguishes three dimensions of social acceptance of renewable energy innovations: socio-political acceptance, with a focus on decisions that create (un-)favourable conditions for the other two forms of acceptance; community acceptance, which concerns decisions regarding the integration of renewable power generation at a specific location; and market acceptance, which deals with the willingness to pay or to invest in innovation and implementation among actors. In most countries the deployment of renewables has progressed rather slowly compared with the policy targets for wind power. Studies that compared the large differences in applying innovation in the electricity supply among various states have revealed that strong institutional factors determine implementation rates (Breukers and Wolsink, 2007a, Fischlein et al., 2010; Toke et al., 2008). In the first decades of the reintroduction of wind power, for example, energy companies, authorities, and private local investors thought that implementation would not face any problems with acceptance. High public acceptance would easily translate into implementation, but this has shown to be a simple and naïve assumption. Only recently, acceptance issues and their geographical diversity have been widely recognised as crucial for the development of renewable energy (Wüstenhagen et al., 2007) and still, within policy persistent misconceptions exist. The perspective of what is actually needed to transform the energy supply and demand systems of developed countries into sustainable systems, in particular regarding the spatial requirements for the generating units, is poorly understood and largely underestimated (MacKay, 2008).

Today's power grids are highly centralised. The emergence of micro-grids and distributed generation runs counter to the existing system, therefore heavily impeding socio-political acceptance. Similarly to implementing fully supportive policies for renewables (Sovacool and Watts, 2009) the full socio-political acceptance of institutional changes needed for developing smart grids will probably eventually reveal as the main bottle neck. Regarding innovation, close connections of incumbents with policy makers induces strong inertia and retards the processes of innovation (Walker, 2000). In the case of distributed generation, the system of the community based micro-grid, which utilises as many renewable sources as possible, is still poorly understood in an environment where all thinking about the electricity supply is centrally organised. With the onset of distributed generation this centralised view no longer applies.

The problem is that the centralized view is institutionally anchored and therefore solid like concrete. *"Many scholars consider the very concept of organization to be closely tied to the presence of a central director who has designed a system to operate in a particular way. Consequently, the mechanisms used by organized systems that are not centrally directed are not well understood in many cases"* (Ostrom, 1999: 520). This clearly applies to renewable energy deployment, where collaborative planning and community involvement have shown to be the key to effective implementation. Simultaneously, community support for renewable energy projects, even when rooted within the community, is neither automatically guaranteed (Walker et al., 2010: 2662). There are no simple formulas of "what works", and community projects cannot simply be replicated from one place to the next. Because studies on embedding renewable energy sources in communities are quite recent, our understanding of this subject matter is limited and requires substantial attention. A determining factor is the geographical identity of host communities, as the potential for access to the renewable sources is its spatial requirements (MacKay, 2008).

GEOGRAPHICAL IDENTITY

Distributed generation is at small geographic distances to the users. This implies that power generation physically takes place in the close vicinity of the users, but it also increasingly implies that generation is at small *"social distances"* when users become the owners or managers of the production units in the micro-grid. Because the assets for power generation become essential cornerstones of the micro-grid, there is a real option of an increasingly important role for the users in the establishment of the micro-grid itself. The existing body of knowledge on renewable energy innovation shows that one of the essential factors is how well the new system "fits" to the *community*, and in particular to something that can best be called *identity*. These two terms must be elaborated.

First, we should notice that these concepts emerge when we consider the literature on the process in which *decisions* about the establishment of renewable power generation are taken. For example, international comparison of decision-making on wind power schemes, has shown that collaborative approaches employing effective forms of community involvement, have proven to be crucial for successful deployment (Toke et al., 2008). It concerns the fairness of process in these decision-making processes and the extent of “trust” that is created, or unfortunately destroyed in many cases, among the community members, the investors, and the authorities involved in decision-making (Wolsink, 2007; Walker and Devine-Wright, 2008). The participants in the process must have a strong conviction that the new energy system will also serve their benefit, as well as that the organisation facilitating the process will act in their best interests (Aitken 2010). *“Trusting social relationships support and enable cooperation, communication and commitment such that projects can be developed and technologies installed in ways which are locally appropriate, consensual rather than divisive, and with collective benefits to the fore”* (Walker et al., 2010: 2657).

Second, successful projects usually are those projects that the community can strongly identify with. This may be a result of effective involvement and participation in the siting process, but high community involvement in the management and/or ownership can also be helpful (Rogers et al., 2008). A study in remote communities in the UK revealed that among the residents and their community representatives that were involved in the process, the benefits for the community were also better recognized (Giddings and Underwood, 2007). Warren and McFadyen (2010) found that sense of ownership resulted in greater community acceptance of wind farms in rural areas of Scotland. Generally, the issue of deployment of renewables shows the importance of securing good fit between the energy schemes and the host communities. Investments and schemes initiated by community outsiders (such as energy companies) are much more likely to face resistance by the community (Walker and Devine-Wright, 2008). As wind power shows, the ways of how decision-making is organised, and how social networks at the level of the local decision are involved and used to organise the initiative, strongly shape the possibilities for identifying with the project. This applies to all community actors, because this identification is not primarily restricted to residents, but it is applicable to local enterprises and authorities alike. For other types of distributed generation than wind power, such as PhotoVoltaics or small hydro, it will be equally important how the geographical identity is interpreted and valued by members of the community.

As Giddings and Underwood (2007: 413) conclude in their exploration of renewable energy options for remote communities: *"Vital to the success of introducing renewable energy is the support of the local community. A primary aim of local scale renewable energy is community ownership and control of the system through community participation."* This observation is strongly connected with the vital role of identity factors for community acceptance of any innovation related to renewable energy, and even when this issue is restricted to rural areas, the variety in the social context is huge compared to the variety in the technologies that can be applied. Establishing micro-grids in rural areas is much more an issue of social construction than a technological issue (Gómez and Montero, 2010). The question here becomes what the essential variables are in the identity of rural communities with regards the establishment of micro-grid connected to renewable energy deployment.

IDENTITY IN CASES OF RURAL RENEWABLE DEPLOYMENT AND MICRO-GRID DEVELOPMENT

Local and community identity will probably also apply as a key to local smart grid developments, because identity is a strong factor for the determination of the kind of actors that will get the opportunity to participate in the investments and the establishment of the micro-grid. The rural identity resembles some particular factors that determine how communities will look at the ways to shape their environment (Alkon and Traugot, 2008). Within a community such decisions obviously concern the option for households to participate in any kind of distributed generation that is applicable in the local geographical conditions. Equally important is the presence of significant actors in the community who determine the community identity for other reasons. These might be, for example, typical community oriented enterprises, which in rural areas particularly concerns farming, local shops, but also schools (Economou, 2011). Implementing a particular energy project is thus, among other things, an ownership and community involvement issue, versus the acceptance of outside investments and ownership of the assets of the new development (generating units, smart meters, etc.). For example, at present about the issue of land use for photovoltaic plants there may be an impression that PV would consume "too much land" to be practical. However, whether that impression is correct will depend highly upon the willingness of rural communities to use farmland for such PV plants and how this significant change in the character of the landscape is appreciated (Chiabrando et al., 2010) versus the availability of other places for PV units, such as rooftop of houses, stables, school and factories.

Obviously, the settings of rural communities show a wide variety. Seen from the viewpoint of power generation, in many developing countries in vast rural areas many remote communities are not yet connected to a public electricity grid (Karekezi and Kithyoma, 2002). Here, the establishment of a solar or wind powered micro-grid, supported by battery storage or a small scale CHP (possibly fuelled with on organic waste or manure, but often based on diesel) in a local micro-grid means real community progress in the first place. In developing countries, however, such micro-grids primarily exist because they operate in isolation, separated from the general grid. In most developed countries the public grid already covers all rural areas, although even in urbanized countries communities in rural areas can still be remote. In the UK, the study by Giddings and Underwood (2006) showed that in the current situation rather remote villages with an industrial base had a good potential for a micro-grid. Beside high energy demand, their identity of these communities is characterized by both vulnerability and community involvement.

Cooperation and involvement is the foundation of all views on rural environmental development that exist within rural communities themselves, and in all these views agriculture is usually a main factor. With regards environment-agriculture discourses Alkon and Traugot (2008) found that within rural communities different discourses exist, but in all stories collaborative solutions to agricultural-environmental conflicts are prominent. In each discourse the importance of agriculture to the identity of any place character is emphasized, but the ability of well-intentioned county residents to work together is also recognized and put forward as a key factor in this identity. Local distributed generation is a major new development in the trade-off between agriculture and environment, and both the historical identity of rural communities as well as the strong focus upon the merit of collaboration within communities will become determinants for shaping distributed generation within a community's micro-grid. The development of wind power in some countries with relatively high installed capacity has shown the significance of the involvement of the civil society in building wind farms. This applies in rural areas to the role of farmers in particular (Morthorst, 1999; Martinot et al., 2002). In wind power deployment the strong impact of the fit between the character of landscape as a determinant of rural community identity and the wind power facilities has come to the fore (Woods, 2003).

The question how to deal with the landscape identity issue is essential to renewables implementation. Any assessment of the congruence between local landscapes and a wind or solar power scheme may be very subjective indeed, but almost anywhere it is the most controversial aspect of those schemes and therefore it is the most important issue that should be addressed in decision-making (Wolsink, 2007). This is why collaborative decision making and a strong connection to local participants in distributed generation is important. Both factors provide better conditions for fitting the new energy system into patterns of local place identity. Concerns about places in the community representing scenic beauty or providing a restorative environment for residents and visitors are called *"place identity"* and a related psychological concept is *"place attachment"*. These are important variables explaining attitudes and behaviour of local residents towards new energy infrastructure, such as wind turbines (Devine-Wright and Howes, 2010) and hydro-power (Vorkinn and Riese, 2001).

Place attachment has two dimensions. The first is the personal and psychological dimension of individually or collectively determined meanings, and the affective, cognitive, and behavioural components of the subjective attachment to the place. The second one is the place dimension that emphasizes the place characteristics of attachment, including spatial level, specificity, and the prominence of social or physical elements (Scanell and Gifford, 2010). The latter factor concerns all elements and characteristics of the landscape broadly, which also includes the elements of the built environment.

The landscape is a strong identity factor, and any decision that addresses the identity of the landscape such as the construction of new energy infrastructure, is significant in rural areas. By definition, landscape is the part of the environment that is the human habitat as it is perceived and understood through the medium of our perceptions (Bell, 1999). In the assessment of the impact of the new energy infrastructure – wind turbine, solar panels, small hydro installation, a biogas plant, and visible appliances of the micro-grid – on the landscape it is crucial to assesses landscape quality interaction with the new elements, as they are actually perceived by the relevant viewers. These perceptions of landscapes relate to concepts such as *"stewardship"*, *"historicity"* and *"naturalness"* (among others such as complexity and coherence; Tveit et al., 2006) and eventually these are subjectivities are rooted in community values and history. The only way to handle these identity values is to recognize the essential role of the people holding these values. As the value of the landscape is *"in the eye of the beholder"* (Lothian, 1999) it is crucial to apply collaborative strategies for meaningful deliberation (Zografos and Martinez-Allier, 2009).

The landscape as part of place attachment and local identity in rural areas is not only a concern of the local population. In many cases, in particular when ecologically and environmentally highly rated values are at stake, place attachments may be found among groups in the society who do not live near to the place itself. A clear example is the conflict between developers of wind farms and parts of the environmental movement (Warren et al., 2005; Wolsink, 2010a). Another important category is tourists, who are highly valuated by the local community because of potential contributions to the local economy. With regards social acceptance to the distributed generation facilities, the "public" of tourists is significantly different from residents, and apparently the acceptance of the facilities is a major concern of those employed in the tourist industry (Dalton et al., 2008). The overwhelming perception of rural communities is based on the rural idyll concept (Cloke, 2003) and as a result in many cases hotel keepers for example, but also local authorities in tourist areas are reluctant to accept new energy infrastructure. They often expect that tourist acceptance is critical towards wind turbines and solar panels, which might result in a small negative economic impact for communities or regions (Riddington et al., 2010). On the other hand, the limited evidence from surveys on tourist attitudes also tends to show the opposite. *"...tourists know that they visit a 'solar destination' country and therefore expect some common sense RES investments to be there"* (Konstantinos et al., 2011).

OPTIMAL USE OF A COMMON RESOURCE

The characteristic of a smart grid as an integration of many different micro-grids is very interesting from a social scientific perspective. We are dealing with natural resources (renewable energy sources), with scarcity (in particular the space needed for the generating units and the time patterns of the availability of the resources) and with communities that must organise themselves around the micro-grid/distributed generation system. A promising approach to study the emergence of these socio-technical systems strongly emphasises the institutional framework for self-governance. The options for achieving optimal sustainable use of the renewable energy sources can be viewed as a governance issue of sustainable management of a *common pool resource* (Dietz et al., 2003). The knowledge of managing common pool resources which also strongly focuses on institutions (Ostrom, 1986) comes to the fore as a fruitful approach to studying the management of renewable energies. The common pool resource management approach effectively combines the two main characteristics of distributed generation in micro-grids. These two lines that particularly come together when renewables are implemented in smart micro-grids settings are:

- First: adaptive governance for natural resources is relevant to the deployment of renewable energy, because these are clearly natural resources that should be utilized in an optimal and sustainable manner.
- Second: the establishment of a micro-grid and the mutually attuned supply and demand implies a large amount of self-governance, which is a key to the management of common pool resources (Ostrom, 1999 and 2010; Dietz et al., 2003).

Similar institutional conditions that are important in common pool's management are also essential here: *ownership* (of the micro-grid, distributed generation units, smart meters), *access regulation* (who participates, under which conditions), *system boundaries* (micro-grid versus public grid/utility), *compliance rules* (internal regulation within the micro-grid community), *trust* (of the regulating authorities, among partners in the micro-grid community), and *reciprocity* (among partners in the community). For example, though renewable sources like the sun and wind are hardly limited, the real access to the resource is limited, because of the spatial requirements linked to limited resource-rights (Vermeylen, 2010), property (rooftops, land) and place identity (e.g. landscape viewsheds, sound, wildlife, tourist value etc.).

All core attributes of the new system of a micro-grid/distributed generation fit to the usual collective-action problem that we find in a common pool. Developed for an entirely different public policy issue (police services) but nevertheless very much applicable to natural resources, these are (Ostrom, 2010: 5):

- A large number of participants (potential producers, in all types of involved actors);
- Legal and institutional uncertainty (there are many existing legislations applicable to smart grids, without any of them clearly designed to support the emergence of smart grids);
- Asymmetric interests and unbalanced power (e.g. of existing utilities, of different authorities, and of consumers/citizens);
- Lack of fit between “problem” and governmental units (all governing bodies involved are larger than the geographical area of a micro-grid community).

DOWN WITH CENTRALIZATION

With regards effective common pool resources management almost any assumption about the effectiveness of central direction and the possibilities of stimulating good governance with uniform and simple incentives remains fully unsupported by empirical data (Ostrom, 1999). Again, here we encounter a significant aspect of the distributed generation in micro-grids: it is inherently decentralized and community self-governance is probably more effective than central regulation. Research on implementation of renewable energy systems generates similar conclusions regarding incentives and centralised guidance (Wolsink, 2011).

The same holds for citizens (only seen as consumers) behaving like “norm-free maximizers of immediate gains” (Ostrom, 1999: 493). People are willing to invest in renewables without optimising financial/economic gains (Wolsink, 2011; Sauter and Watson, 2007), however preferably *on their own terms*. As Ostrom (2010: 10) puts it for common pools: *"Citizens are an important co producer. If they are treated as unimportant or irrelevant, they reduce their efforts substantially"*. If there is any occasion where citizens literally become co producers, it is in a micro-grid with small scale renewable energy facilities that are built, owned, and managed by themselves, in their own neighbourhood. By organizing their own micro-grid community, and adding their new power generating capacity to the common pool, they all become co producers.

With the existing centralised power supply systems, it can be hypothesized that policies will tend to adopt a frame of generic, undifferentiated approach to promoting renewables. This creates the risk of standardising the initiatives, with frames that particularly frustrate the essential *"prime movers"* (Jacobsson and Johnson, 2000). And the result would be that *"the proliferation of exogenous and invasive projects that are completely disconnected from the socio-economic and environmental local context may generate negative impacts, not only at local scale but also at supra-local scales"* (Bagliani et al., 2010: 468). The merit of self-governance in common pool resources management comes to the fore in renewables deployment. The countries that have been successful in implementing renewable energy initiatives (e.g. Germany, Spain, Denmark) are distinguished by the fact that they created optimal conditions for the civil society to organise itself and implement the renewables by itself (Hammons, 2008; Breukers and Wolsink, 2007b; Toke et al., 2008).

Summarizing, the social foundations of smart grids: they consist of decentralised socio-technical networks that underpin the electricity consumption of groups of consumers/end-users who are increasingly becoming autonomous. These socio-technical networks form a community that exhibits high levels of interaction and integration between the actors, while the social construction of smart metering is key factor in determining the character of the smart grid. Most existing institutions, which are designed to support the centralized power supply system, will prove to be unfit for emerging micro-grids within an integrated smart grid. This will likely to impede the deployment of distributed generation, in particular renewable energy. Hence, such centralized institutions should be changed entirely, as the deployment of renewables is a key to a low carbon energy provision.

Further reading on specific aspects, like general social acceptance of renewables in smart grid configurations: Wolsink (2012 Renew Sust Energ Rev; and 2013 in EDI quartely) and on justice aspects of introduction of smart microgrids in Wolsink (2013, in Energy, Justice in a changing climate).

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