What roles for energy cooperatives in the diffusion of distributed generation technologies?

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Abstract

Whereas a centralized model of electricity infrastructure is still dominant today, many scholars advocate the diffusion of distributed generation technologies, implying geographically dispersed and small-scale generation units located close to consumers. However, there exist various barriers of different natures to a large-scale penetration of these technologies. In this article, we focus on the behavioral and psychological ones, emphasizing the roles that citizens have to play in this issue. More specifically, we explore a specific way of involving citizens in such diffusion, namely energy cooperatives. After presenting the driving forces of the emergence of cooperative firms in the energy sector, we examine the assets of the cooperative ownership structure from the perspectives of behavioral economics and social psychology. Our analysis enables us to build a model of how cooperatives may enhance consumer engagement in the diffusion of distributed generation technologies. This provides a basic theoretical framework for future empirical research.

Keywords: cooperatives, distributed generation, renewable energy, consumer engagement.

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1. Introduction

The limits that the energy sector is confronted with, e.g. oil dependency, reliability of supply or climate change, are today widely recognized. Consequently, there is growing interest among researchers, policy-makers and NGOs in the concept of energy transition, that is, a transition toward a sustainable model of energy supply characterized by "universal access to energy services, and security and reliability of supply from efficient, low-carbon sources" (Bridge et al., 2013: 331). This transition is based, in particular, on the development of renewable energy sources, energy efficiency and a better management of energy demand and supply.

The potentials of such transition are substantial. As regards global warming, graph 1 shows that the power generation sector is the largest contributor (42%) to the decrease in carbon emissions required to limit the rise in global temperatures to 2°C.

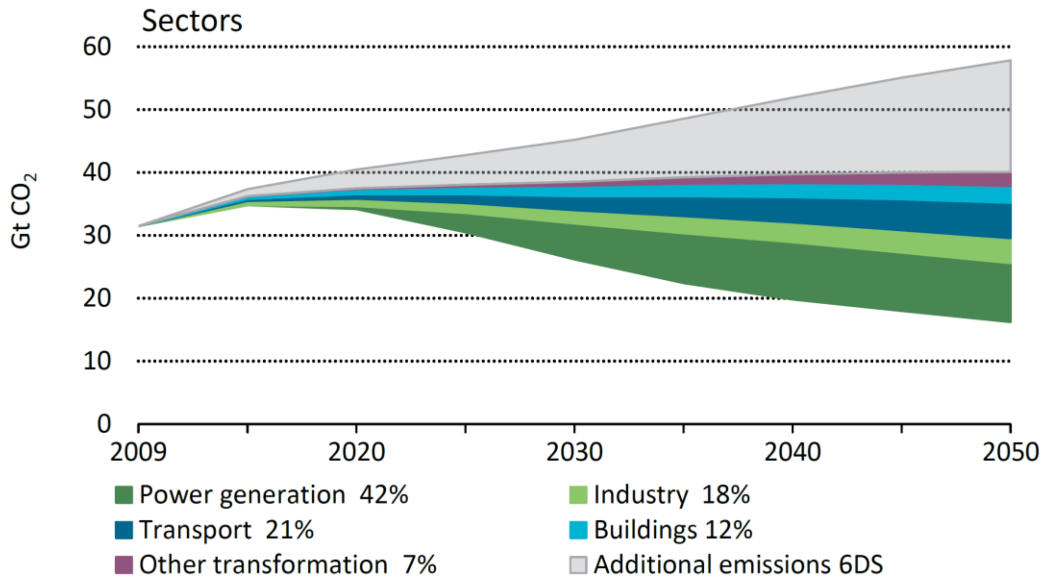

Figure 1: sectorial contribution to the decrease in carbon emissions. The superior line is the baseline scenario and the inferior line corresponds to the scenario in which the rise in temperature is limited to 2°C. Source: IEA (2012).

Distributed generation (DG) technologies–i.e. small and geographically dispersed generation units located close to consumer sites–, and especially DG technologies based on renewables, may certainly play an important role in this transition process. However, there exist various barriers of different natures to a large-scale penetration of DG technologies. This article focuses on the behavioral and psychological ones, emphasizing the roles that citizens have to play in the diffusion of these technologies. It was motivated by the growing literature concerned with the importance of more deliberative and inclusive participation of consumers in the energy production process. In this perspective, it explores a specific way of involving citizens in the diffusion of DG technologies, namely energy cooperatives. These are organizations that enable consumers themselves to own and invest in generation units. By doing so, they may enhance, it is said, the social acceptance of such model.

The structure of the paper is the following: section 2 provides a definition of DG technologies and briefly presents their effective and potential advantages, while section 3 explains why cooperative ownership is, in some situations, particularly well-suited to the development of such technologies. In this perspective, we present the two driving forces of the emergence of cooperative firms in the energy sector: rural electrification and environmental concerns. The rest of the paper is dedicated to the analysis of the latter question. Section 4 discusses the concept of social acceptance of DG technologies by emphasizing the crucial importance of the *active* dimension of such acceptance, beyond mere passive consent. Consistently, we argue that the concept of *consumer engagement* may be better suited to capture this active aspect of acceptance and we provide a precise description of the different elements that this notion refers to. Then we analyze the determinants of consumer engagement toward the diffusion of DG technologies, relying on insights from behavioral economics and social psychology. Finally, based on this analysis, we present the assets of the cooperative ownership structure to enhance consumer engagement toward the diffusion of DG technologies.

2. Distributed generation technologies

While many definitions of distributed generation technologies exist[2], distributed generation (DG) technologies are, according to the EU Electricity Directive (Communities, 2009), generations units connected to distribution systems. In addition to this criterion, the literature often emphasizes the following basic elements: they are small generation units, typically ranging from less than a kW to tens of MW, which are geographically dispersed and located close to load centers. In the context of the major environmental challenges linked with climate change and greenhouse gas emissions, it is increasingly recognized that they represent a more sustainable model of power supply, for several reasons (e.g. Goldemberg et al., 1988; Johansson et al., 1993). First of all, a large segment of the DG market is constituted by combined heat and power production (CHP) units. These units are expected to enhance energy conservation and, subsequently, to reduce CO_2 emissions, due to a higher overall

[2] See e.g. Ackermann et al. (2001) and Pepermans et al. (2005) for discussions.

efficiency through the simultaneous production of heat and electricity. It is worth mentioning that CHP units are at the moment mostly based on fossil fuels, but they have the potential to be fuelled by renewables in the future. Secondly, while the development of renewable energy sources, such as photovoltaic or wind, appears to be an essential tool in the fight against climate change, most renewables, except for large hydro, have a decentralized nature. Hence, "most government policies that aim to promote the use of renewables will also result in an increased impact of distributed generation technologies" (Pepermans et al., 2005: 790). Thirdly, aside from reductions in carbon emissions due to enhanced technological efficiency (in the case of CHP) and zero carbon emissions (in the case of renewables), empirical studies show that DG technologies may also induce a shift in consumption behaviors towards lower levels of energy consumption and through load shifting[3] by increasing consumers' awareness of their energy use and it impacts (Bahaj and James, 2007; Dobbyn and Thomas, 2005; Haas et al., 1999; Keirstead, 2007). Overall, "a system with a large amount of DG is considered an environmentally friendly alternative to the traditional power supply system" (Wolsink, 2012: 823).

3. The two drivers of the emergence of energy cooperatives

3.1.Rural electrification

Two main forces have been driving the development of cooperatively-owned distributed technologies. The first one lies in the electrification of rural areas, both in developed and developing countries. In general, rural electrification is characterized by high per capita and per kWh costs of distribution and maintenance derived from physical isolation, lower density of settlements and lower electricity loads. This is especially true for developing countries, "where residents may have fewer opportunities to purchase electrical goods due to poor transport infrastructure or issues of affordability" (Yadoo et al., 2011: 6400). Hence, profit-motivated investor-owned utilities have generally no interest in serving these areas. One solution to these market inadequacies has been the formation of local electric cooperatives that operate on a non-profit basis. "The cooperative is a consumer-owned autonomous organization that constructs, operates, and manages its own electricity distribution system in the area under its jurisdiction." (Rahman et al., 2013: 843)

[3] Load shifting designates the change in the time of energy consumption and, in particular, the transfer of demand from the peak hours to off-peak hours of the day.

As an emblematic example, the US electricity sector presents an old and well-established cooperative tradition. In the mid-1930s, nearly 80% of rural farms and homes were not electrified. As a result, President Roosevelt signed in 1935 a federal executive order to establish the Rural Electrification Administration (REA), and the Rural Electrification Act was passed in 1936. The goal of REA, which was reorganized by the U.S. Department of Agriculture into the Rural Utilities Service (RUS) in 1994, was to facilitate the investment of capital in order to extend electric infrastructure and service into rural regions by providing loans, loan guarantees and other support instruments. "Within four years following the close of the World War II, the number of rural electric systems in operation doubled, the number of consumers connected more than tripled and the miles of energized line grew more than five-fold. By 1953, more than 90 percent of U.S. farms had electricity" (NRECA, 2013). There are two types of electric cooperatives: distribution cooperatives and generation and transmission (G&T) cooperatives. Distribution electric cooperatives serve end-users, such as households and businesses, who make up their membership. Until the mid-1950s, they bought power from privately- and federally-owned providers. But as their supply needs grew, they decided to join their purchasing power for wholesale electricity by forming generation and transmission (G&T) cooperatives in order to ensure a reliable and cost-effective power supply. Hence, G&T cooperatives are cooperative federations that sell to their member co-ops wholesale power that they generate themselves or purchase and deliver from public- or investor-owned power plants. Today, there are 905 cooperatives, among which 840 distribution and 65 G&T cooperatives, which serve 42 million people in 47 states (NRECA, 2013).

By their very nature, rural electric cooperatives are organizations that are well-suited to the development of distributed generation. U.S. electric cooperatives are, for example, actively promoting DG technologies. As stated in a NRECA report on distributed generation, "In their continuing efforts to find ways to lower costs for rural electric consumers, electric cooperatives have been actively exploring DG technologies." (NRECA, 2007: 14). The report contains many examples of development activity of DG technologies led by electric co-ops.

Given its success and with the support of organizations such as the United States Agency for International Development (USAID), the World Bank and the National Rural Electric Cooperative Association (NRECA), the U.S. rural electrification program has been replicated in various nations around the world, like Bangladesh or Costa Rica (Maddigan et al., 1984).

The Bangladesh Rural Electrification program started in 1977, when only 10% of its total population was connected to a grid (Rahman et al., 2013). The country adopted the U.S. rural electric cooperative model. In order to implement it, the government created a central statutory agency called the Rural Electrification Board (REB), which was in charge of establishing local electric cooperatives (known as Palli Bidyut Samities, or PBSs) in partnership with rural communities. In 2007, there were 70 PBSs which employed around 16,000 people (GNESD, 2007). Distribution systems within PBS areas only suffer 13.99% system loss (REB, 2013), which is considerably lower than for the national utility (30-35%). Moreover, the PBSs' collection bill ratio is particularly high compared to other utilities, reaching 96%. Thanks to the 226,455 km of distribution lines installed by PBSs, 48,799 villages are now electrified (Ali et al., 2012).

In Costa Rica, the rural electrification program was implemented during the period 1965-1969, under the coordination of the Instituto Costariccense de Electricidad (ICE), the national electric power utility. It benefited from a financial support from USAID, while NRECA provided technical and administrative training to initial core staff. It consisted in the creation of four rural electric cooperatives, which were given the responsibility of the administration, maintenance and extension of the distribution systems in their jurisdiction. (Foley, 2007). As an illustration of the success of the program, by 1995, 93% of the total population had access to a reliable electricity supply and in 2006, the figure was over 97% (World Bank, 2006).

Other relatively successful cooperative experiences in the context of rural electrification have been conducted in Nepal (Yadoo and Cruickshank, 2010), Bolivia (NRECA, 2005), Tanzania (Ilskog et al., 2005) and the Philippines.

The cooperative structure offers several advantages compared to public sector management or profit-seeking utilities. First of all, it contributes to local economic development, by creating employment opportunities for the local workforce and helps increase local income. For example, according to a report on the economic impact of cooperatives in the U.S., electric cooperatives account for almost 130,000 jobs, $6.6 billion in wages paid and more than $11 billion in value-added income (Deller et al., 2009). Secondly, cooperatives are, in many situations, more cost-effective and efficient in providing services to local electricity consumers, since their direct accountability to their customer base makes them responsive to the concerns and needs of local communities and encourages a system of self-regulation. In line with this idea, they also help solve a number of market failures, such as asymmetric information and excessive market power, the latter being highly relevant since local electricity networks are natural monopolies. According to Hansmann (1996: 170), in spite of facing high capital costs per user, rural electric cooperatives can, "by aligning the firm's interests with those of its customers, […] avoid not only the costs of monopoly but also the costs of rate regulation". This transparency in the electrification process also tends to lower distribution losses, especially non-technical losses due to pilferage[4]. A third advantage of the cooperative form, especially in the context of developing countries is that it fosters poor rural people's empowerment by facilitating "the active involvement of local actors in development processes" (UNDP, 2009).

This does not mean that cooperatives are exempt from drawbacks. Cooperative ownership has been criticized, both on theoretical and empirical grounds (see Hansmann, 1996, 1999). The cooperative model may suffer from limited access to capital and slow decision-making. In addition, Cooper (2008) leveled various criticisms against U.S. electric co-ops. He pointed out, in particular, the failure, in some cases, to serve their customers' interests, agency problems arising between managers and members, and the tendency for large cooperatives to operate similarly to for-profit companies, a phenomenon known as "market isomorphism" (DiMaggio and Powell, 1983).

3.2.Environmental concerns

Various developed countries, particularly in Europe, have recently witnessed a new wave of development of energy cooperatives. The reasons for the emergence of these organizations and the context in which it has taken place are sensibly different from the ones underlying the different rural electrification programs described above. Indeed, these initiatives are primarily motivated by environmental concerns, in a context of electrification rates close to 100%. The Federation of groups and cooperatives of citizens for renewable energy in Europe, REScoop.eu, states that its main objective is "To speed up local renewable energy projects in order to achieve the European 20-20-20 energy goals by increasing the involvement of citizens. Specifically, REScoop 20-20-20 aims to increase the social acceptance of new renewable energy installations by sharing practical knowledge about setting up and running local, citizen controlled Renewable Energy Sources cooperatives (or REScoops) across Europe." (REScoop.eu, 2013).

[4] In Nepal, for instance, the amount of electricity theft in rural areas has decreased due to the creation of local cooperatives. In addition, the community-led process of grid extensions suffers less corruption, which ensures a higher rate of rural electrification (Yadoo and Cruickshank, 2010).

Denmark is certainly an eloquent example of this second cooperative trend, as this country presents the strongest cooperative energy sector in Europe. Denmark's energy policy goals since the mid-1970s have been a reduced dependence on imported energy–which accounted for more than 90% of all energy supply in 1973–and the pursuit of sustainable development. As a result, in 2011, Denmark was the only EU member state that was self-sufficient in energy, with a self-sufficiency rate of 110% (DEA, 2012). The historical context, marked by the oil crises and a growing anti-nuclear movement, was particularly conducive to the implementation of these policies. The result of the latter has been the development of a decentralized model of electricity generation, considerably shaped by cooperative firms, as we can see from the following figures for the different technologies (Mission, 2004):

- **Wind power**: in 2002, the share of the Danish total wind capacity owned by cooperatives amounted to 23% (600 MW), as shown by figure 2, which represents 100,000 members owning more than 3,200 wind turbines.
- **CHP/district heating**: In 2001, consumer cooperatives owned 300 of the 400 district heating networks. 85% of the 430 district-heating companies were co-operatives, accounting for 37% of the total heat sales.
- **Biomass fuel**: "farmer co-operatives manage the fuel supply chain and own the majority of the 120 straw and woodfuel district-heating plants" (Mission, 2004: 18).
- **Anaerobic digesters**: Farmer cooperatives own the majority of the 20 centralized digester plants that have been built across Denmark, which accounts for 80% of Denmark's biogas production.

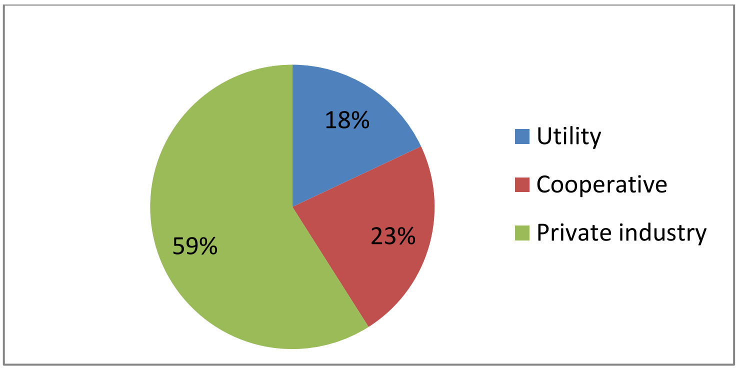

Figure 2: ownership of the total Danish wind capacity in 2002. Source: CEEO (2003).

With respect to wind power, the creation of cooperative firms benefited from institutional support, as the Danish legislator promulgated a series of laws that limit ownership of shares in windmill projects to residents' municipalities. Such ownership form considerably contributed to the high level of public support of wind turbine development among the Danish population at the national and local levels[5].

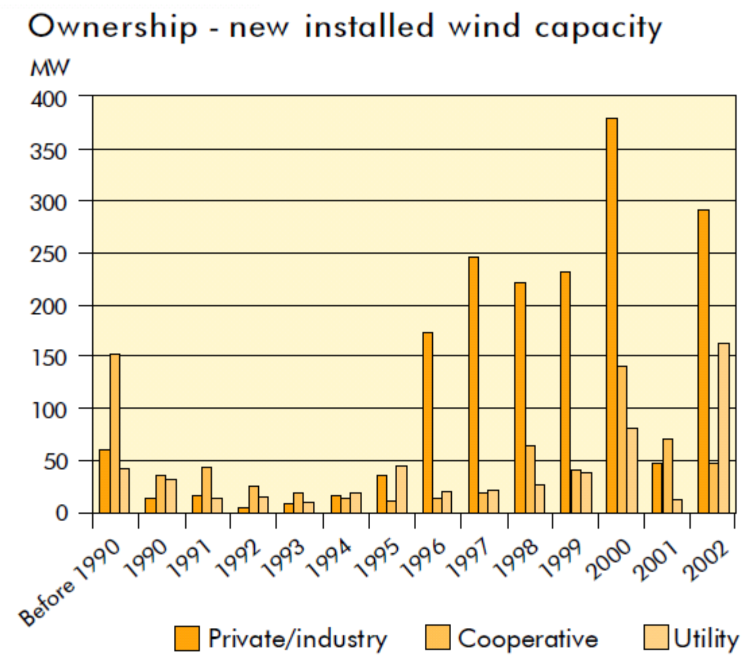

Figure 3: Ownership of the new installed wind capacity, 1990-2002. Source: CEEO (2003).

However, such decentralized and participatory model of wind development has been put under pressure in recent years, which resulted in a very limited expansion of wind power and in a decrease in the cooperative share of new built capacity from more than 50% between 1978 and 1994 to less than 20% between 1995 and 2001, as shown in figure 3 (Mission, 2004). One reason for these trends lies in a new wave of legislations from the early 1990s onwards that further hardened the restrictions for the building of new turbines. These regulatory measures were taken as wind turbines were growing in size and capacity due to technological improvements, increasing pressures on landscapes. These pressures, combined with the fact that large scale projects were increasingly led by private investors rather than cooperatives, generated an increasing public opposition against wind projects. Another factor was the abolishment in 2000 of the fixed feed-in tariff which guaranteed price certainty for energy producers. Today, the Danish government policy is oriented towards the development of large scale offshore projects (Möller, 2010).

[5] For instance, a survey on the Danish population's opinion on energy production in the future conducted in 2009 by the Danish Wind Industry Association revealed that 91% of the population think that Denmark should expand the use of wind power and 85% think that the expansion can take place in their local area (DWIA, 2013). See also Krohn and Damborg (1999) and Ladenburg (2008).

Of course, both drivers–the electrification of rural areas and sustainable development–are increasingly combined and interconnected on the field and in policies. Indeed, many initiatives whose original objective was rural electrification are now based on renewables and integrate environmental concerns. In the US, for instance, although most G&T cooperatives were originally based on coal, they began to diversify their technology portfolio, so that today cooperatives own and purchase a total of nearly 5.3 GW of renewable capacity all over the country. About 11 % of the electricity distributed by co-ops is based on green energy (approximately 9 % from hydropower and 2 % from other renewable energy sources such as wind, solar, and geothermal). This allows 94 percent of the nation's co-ops (793 out of 841 distribution utilities) to offer renewable energy options to 40 million Americans (NRECA, 2013). The Danish cooperative movement was also originally rooted in rural areas (van der Vleuten and Raven, 2006). In developing countries, but also in some regions of developed countries, locally generated renewable energy is becoming central in policies aiming at electrifying rural areas, due to the high environmental and economic costs related to the use of hydrocarbon fuels (Javadi et al., 2013).

4. From social acceptance to consumer engagement

4.1.The notion of social acceptance

We have already mentioned that cooperative initiatives in Europe aim at increasing social support for renewable energy installations. Indeed, the development of DG technologies and, in particular, the ones based on renewables, depends on the willingness to accept the key aspects of the innovation that they imply among society and its different actors (consumers, producers, authorities, etc). The traditional notion in the literature to refer to this fact has been the one of "social acceptance". Wüstenhagen et al. (2007) identify three dimensions of social acceptance as far as renewable energy innovations are concerned: socio-political, community and market. Socio-political acceptance concerns the broad societal consensus (or lack thereof) that renewables have positive consequences, what Ek (2005) has called public attitudes towards energy technologies. In turn, community and market acceptances relate to "decisions about the integration of renewable power generation at a particular location and in a community" (Wolsink, 2012: 827). In this article, we concentrate on so-called community acceptance, which is more directly concerned with private attitudes towards energy technologies and, therefore, reflect individuals' personal well-being. The notion of social acceptance has been applied so far to a large number of case studies (Breukers and Wolsink, 2007; Gross, 2007; Hall et al., 2013; Pepermans and Loots, 2013). In this section, we discuss the concept of social acceptance, by first highlighting the importance of its active dimension and then by explaining why the concept of *consumer engagement* may be more relevant.

4.2.The active dimension of social acceptance

An important distinction has to be made between *passive* and *active* acceptance (Schweizer-Ries, 2008). While the construction of large technology projects and infrastructures like central power plants usually necessitates a rather passive consent by local communities and by the public in general, DG technologies, in turn, require a more active approval by individuals, in terms of willingness to provide space for the installations of these technologies, capital investments and behavioral changes. In other words, DG technologies require "households' acceptance in terms of both positive public and private attitudes to achieve market up-take of these technologies" (Sauter and Watson, 2007: 2772).

Consequently, the installation of DG technologies potentially implies new roles for consumers, who may be actively involved in the energy production and, therefore, become "prosumers" or "co-providers" of energy services (Chappells et al., 2000; van Vliet and Chappells, 1999). In that respect, it becomes apparent that the acceptance of DG technologies depends on the *institutional arrangements of ownership and control of the production units*. As Sauter and Watson (2007: 2771) remarkably summarized, "A new role for consumers—as energy suppliers in their own right—is one particular aspect of this potential step change. A pre-condition for this change is the diffusion of [distributed] generation technologies into the market which will depend on consumers' acceptance of [distributed] generation technologies. The need for acceptance will in turn depend on the extent to which consumers are actively involved in the [distributed] generation deployment". In this perspective, a growing number of scholars have emphasized the need for more deliberative and inclusive participation of consumers in the energy production process (Breukers and Wolsink, 2007; Devine-Wright and Devine-Wright, 2004; Schweizer-Ries, 2008; Warren and McFadyen, 2010).

4.3.Is social acceptance really the right concept?

Given the importance of this active dimension of approval, Batel et al. (2013) ask the question whether the very concept of "acceptance" is really well-suited to study the social reactions to the installation of renewable energy technologies. Indeed, according to them, the notion of acceptance entails the idea of non-agency, i.e. "the reaction to something that is proposed externally" (Batel et al., 2013: 2). In this perspective, they argue further that the use of "acceptance", beyond a simple lexical question, may serve to enforce and legitimize the top-down approach to peoples' relations with energy infrastructure currently prevailing in policy-making contexts. It could also impede researchers to take into account other types of reactions, such as support, uncertainty, resistance and so on. They suggest the use of "social support", instead of acceptance, to refer to people's active approval of renewable energy technologies and provide empirical findings that account for the relevancy of the distinction between the two notions.

In line with this analysis, we consider that the notion of "acceptance" does not appropriately reflect the active dimension of approval: "if people's active engagement with RET and support of them is what is desirable, arguably we should be trying to better understand public support for those energy infrastructures, and not just acceptance" (Batel et al., 2013: 2). What is more, while Batel et al. (2013) focus on large-scale infrastructures and not on DG technologies, it makes the current discussion even more relevant for the latter, given the new roles consumers have to play in their diffusion that we described above. However, contrary to the authors, we suggest the term of "consumer engagement", rather than "social support", to replace the notion of "social acceptance".

4.4.Consumer engagement and the different types of technologies

The determinants of consumer engagement depend on the type of technology involved and, in particular, on the scale at which this technology is deployed. As Devine-Wright (2007) puts it, "Since each scale of technology will present different impacts on the local economy, community and environment, public attitudes towards, and engagement with, renewable energy technologies implemented at different scales is likely to vary considerably." He distinguishes three scales of implementation of renewable energy technology:

- **micro** (at single building or household level);
- **meso** (at the local, community or town level)
- **macro** (at large scale 'power station' level).

Since the focus of this article is DG technologies, we are primarily concerned with the two first scales of implementation, i.e. *micro* and *meso*. However, there is an important difference between the two scales, since the meso scale generally involves "behavioral responses to situations where the public is faced with the placement of a technological object in or close to one's home, which is decided about, managed or owned by others", while the micro scale "reflects the public's behavioral responses to the availability of technological innovations, that is, the purchase and use of such products" (Huijts et al., 2012: 526). This distinction is relevant for the analysis of the factors that foster consumer engagement, as we will see below.

4.5.The dimensions of engagement

Following Sauter and Watson (2007), we define consumer engagement in DG technologies as composed of three main elements: *attitudes towards such technologies*, *induced changes in energy consumption patterns* and *investments in DG technologies*. It is worth describing further these three elements.

4.5.1. Attitudes

We have already mentioned that, beyond passive consent measured by public attitudes, DG technologies are more concerned with people's individual utility. Indeed, since a distributed generation model implies the development of generation units close to consumer sites or even in people's own homes, the willingness to provide space for their installation depends on their private attitudes towards technologies. Wind turbines have been the technology most subject to contention to date (Devine-Wright, 2007). Wind power development has provoked considerable opposition in many places, whose motivations are primarily the impacts on natural landscapes, which can, in turn, affect tourism, the generation of noise pollution and the negative consequences for property prices and local fauna and flora (Warren and McFadyen, 2010).

4.5.2. Consumption

It is recognized that DG technologies, by creating "opportunities for consumers to become more aware of their energy use and its impacts" (Keirstead, 2007: 4129), may encourage behavioural changes in households' consumption patterns towards load shifting and lower consumption levels. Various empirical studies have supported this statement for technologies at the micro level (Bahaj and James, 2007; Dobbyn and Thomas, 2005; Haas et al., 1999; Keirstead, 2007). The possibility of such effect on consumption behaviours is less obvious for technologies developed at a meso scale, such as onshore wind turbines. Indeed, most wind projects are still led by external developers with no direct implications of consumers, and conventional investor-owned utilities typically have the incentive to increase instead of decrease their customers' energy consumption. However, cooperatives seem "to clearly include in their missions to help their members reduce their consumption, as this is in line with the interests of the consumers who are controlling the organization" (Huybrechts and

Mertens, Forthcoming). For instance, Ecopower, a cooperative based in the Flemish part of Belgium, observed a spontaneous 25% decrease in their customers' average electricity consumption within three years, from 4000 kWh/year to less than 3000 kWh/year (Huybrechts and Mertens, Forthcoming). In this sense, cooperatives can be an interesting demand-side management measure and contribute to more generate more active consumer responses.

4.5.3. Investments

In order to ensure the market up-take of these technologies, consumers need to invest in the latter. Such investments involve *up-front costs* that are balanced by annual savings in form of reduced energy consumption, which determine the *payback time*. The former is influenced by grants and subsidies and can be fully predicted at the time of the purchase. On the other hand, payback time is influenced by tariffs for generation or export and is more difficult to predict accurately, since it depends on use and actual performance of the system, as well as future energy prices (Bergman and Eyre, 2011). In the case of cooperatives, investments are made by buying shares of the organization, which give right to a dividend that are paid on a regularly basis.

5. The determinants of consumer engagement: insights from behavioral economics and social psychology

This section intends to identify, based on the literature, the economic and socio-psychological mechanisms through which the cooperative ownership structure may enhance consumer engagement toward the diffusion of DG technologies. This will be done in two steps: first, we review the different factors that typically influence households' energy practices in general, relying on insights from behavioral economics and social psychology. Then, on the basis of this general review, we focus on the cooperative model strictly speaking and try to identify its assets as regards the enhancement of consumer engagement.

5.1. The conventional view: an emphasis on monetary incentives

Most of the time, behavioral aspects are totally absent from traditional economic models of energy analysis (Maréchal, 2007). In effect, the latter generally assume representative energy consumption and investment behaviors, rooted in rational economic calculations and precise cost-benefits analyses (e.g. U.S. Energy Information Administration. 2012). As a result, these models tend to overestimate the impacts of energy prices, financial incentives and technological solutions, while overlooking the importance of human behavior and psychological factors (Lutzenhiser, 1993).

In this perspective, economists and policy-makers' traditional analysis of energy demand conceive relative prices as the primary force that drives energy demand. Consistently, the classical instruments used to take into account environmental externalities are Pigouvian taxes, emission trading schemes and subsidies for energy-efficient assets (Allcott, 2011). In addition to feasibility problems due to purely economic reasons, these price-based approaches raise questions that are more directly related to the neglecting of psychological factors. On the one hand, there is the so-called crowding-out effect: motivations and feelings of collective responsibility may be crowded out by financial incentives (Baddeley, 2011; Gowdy, 2008). On the other hand, economists and policy-makers typically overlook the multidimensionality of monetary incentives.

Let us explore this last point more carefully. Financial incentives certainly have an important influence on energy choices. However, the inadequate appreciation of behavioral aspects and the multidimensionality of money mitigate their effectiveness. Stern (1992: 1228) observes that "Economists compare different kinds of money (e.g., fuel costs with capital costs) or evaluate different kinds of incentives, such as rebates, price cuts, grants, and loan subsidies, by applying a standard "net present value" formula to them. But although costs or incentives with the same net present value may be interchangeable for accounting purposes, psychologists question the assumption that they are equivalent for consumers, assuming instead that costs or incentives that take different forms may be perceived and responded to differently". Beyond the amount, several other dimensions are important in the analysis of financial incentives: immediacy of consequences, effects on cash-flows, requirement to assume debt, effort and formalities required to use them, eligibility requirement, etc. For instance, in a comparison of the effects of reduced-interest loans, interest-free loans, and grant or rebates incentives, Stern et al. (1986) found that different subgroups of households were attracted by different types of incentives – e.g. low-income households tend to prefer grants, due to their aversion to indebtedness. Another finding is that grant and rebate programs seem to induce the highest rate of retrofit activity[6], whereas reduced-interest loans are associated with the lowest rate, interest-free loans lying in between. This analysis suggests that

[6] Retrofit activity consists in the improvement of existing buildings with energy-efficient equipment.

interventions should take non-price-based factors into account, in order to “nudge” consumers to make better choices.

5.2.Awareness/information

Information is certainly an important factor as far as consumer engagement is concerned. Based on a representative survey applied to UK households, Oxera (2005) concludes that lack of information and knowledge represents one major barrier to energy efficiency investment. The role of information in consumption behaviors has also been emphasized for the case of the UK (Dobbyn and Thomas, 2005; Keirstead, 2007). What is more, standard assumptions of rational and cost-conscious behaviors have been challenged by a substantial body of empirical psychological research that indicates low levels of public awareness, interest and understanding as to energy issues. It has been suggested, for example, that there exists limited public awareness as regards energy prices and costs (Kempton and Montgomery, 1982) or the functioning of technology (Kempton, 1986). These findings seem to support the “information deficit model”, based on the idea that providing information about the consequences of certain actions will lead people to positively change their attitudes and behaviors towards the environment (Burgess et al., 1998). In this view, people are seen as having too little or incorrect knowledge about energy issues, which could be solved by educating them or simply to overrule them (Freudenburg and Pastor, 1992). However, the solution implied by this model, i.e. simply giving more information to people, has been discredited by a vast literature (e.g. McKenzie-Mohr, 2000; Petts, 1997; Wynne, 1996). In reality, the amount does not appear to be the most important element and the multidimensionality that characterizes financial motives also concerns information. In fact, psychological research suggests that what matters most is not the amount of information made available, but the way it is communicated (Stern, 1992). In particular, information is more likely to induce behavioral changes when it is specific, vivid, personalized and direct. The effectiveness of information is also enhanced by the delivery of energy-use feedback. While the latter does not provide any additional information compared to utility meters, it delivers information quickly after any change in consumption patterns in a vivid and effortlessly understandable way. The information provided by feedback is also perceived as very credible, in contrast to expert advice. Consistently, Lutzenhiser (1993) asserts that feedback is considerably more effective than so-called “antecedent strategy”, i.e. information provided to users prior to the act. More recent studies confirm this statement, stressing the impact of real-time feedback in terms of behavioral changes (Dobbyn and Thomas, 2005; Keirstead, 2007).

The source of information and, more precisely, its trustworthiness, can also greatly affects its effectiveness, which certainly contributes to explain why people often follow non-expert friends' advice as far as daily energy-related decisions are concerned. Moreover, the source of a message tends to have an impact on householders' responses to information whose objective is to influence technology choices. In support of this statement, Stern et al. (1986) describe an energy-audit program in Minnesota during the late 1970s in which free or low-cost expert recommendations about investment in energy-efficiency equipment were delivered in three different ways: by utilities themselves, by subcontracting with private energy companies and by subcontracting community groups. The latter received significantly better results, in terms of audit cost, quality as judged by state inspectors and response rate (15% of eligible homes compared to 4% and 6% for utility companies and private subcontractors respectively). These findings lead the authors to suggest that "the use of community-based, nonprofit contractors has been particularly effective in a number of conservation/incentive programs" (Lutzenhiser, 1993: 256). This is confirmed by a more recent study on the impact of price incentives on behavioral changes, whose authors assert that "local and well-known mediators and communicators are more likely to attract attention and obtain behavioural changes of households energy use through well-adapted programs, as opposed to general information and distant policies" (Næsje et al., 2005: 1262).

5.3.Social influences

5.3.1. Social norms

In a nutshell, "'Norms refers to behaviours that we engage in because we perceive others doing so" (McNamara and Grubb, 2011: 21). Life in society necessarily implies constraints, which often lead individuals to modify their discourse or their behaviors to conform to social pressures to which they are subject.

Social psychologists distinguish between two types of norms: injunctive norms and descriptive norms. The former involve perceptions of which behaviors are typically approved or disapproved by other people and provide points of comparison, e.g. to others consumption, while the latter involve perceptions of how other people are actually behaving, whether or not these are approved. An illustration of the influence of these two types of norms is given by a non-price energy conservation program led by an energy efficiency and smart grid software company called OPOWER. OPOWER, in partnership with utilities in Northern and Southern

California, mailed consumers Home Energy Report letters (HERs) with two components: an Action Steps Module providing energy conservation tips and a Social Comparison Module that compared households' energy use to that of similar neighbors (descriptive norm). The programme yielded an 1.9-2.0% decrease in energy consumption over the course of a year (Schultz et al., 2007).

Many models predict, however, that the "descriptive norm" component of the HER treatment would generate a "boomerang effect", that is, the fact that households that previously used less than the norm decrease their efficiency score to come closer in line with a consumption described as "normal". To avoid this, Schultz et al. (2007) employed an "injunctive norm" by including in the HER report either a "smiley face" or a "frowning face" depending on whether households performed well or bad respectively. This second treatment further increased average energy savings to 4% per household (Schultz et al., 2007).

5.3.2. Community identification

Stürmer and Kampmeier (2003) highlighted the importance of group identification as a determinant of community volunteerism and local participation: "The perception of a shared collective identity fosters group members' willingness to engage in mutual social influence and thus facilitates the development of collective decisions and collective norms guiding collective behaviors" (Stürmer and Kampmeier, 2003: 107). This variable is also relevant for the analysis of community-led energy projects.

5.4.Personal values and beliefs

Personal values and beliefs imply that individuals may act on a sense of personal obligation and invest in what they believe in. Various scholars assert that pro-environmental attitudes and behaviors in general are influenced by underlying general values and beliefs (Steg et al., 2005; Stern et al., 1995). This is also the case for attitudes towards wind energy developments in particular (Ek, 2005; Szarka, 2004; Warren and Birnie, 2009). Bidwell (2013: 10) provides empirical support to this statement, by showing that "Altruistic values have a buoying effect on wind energy attitudes, while values of traditionalism diminish wind energy support".

5.5.Emotions linked to the perceived context: trust, fairness and place attachment

In addition to these factors, it is apparent that emotions play a potentially significant role in a number of respects (Cass and Walker 2009, Schweizer-Ries 2008). For instance, regarding pro-environmental behaviors in general, Delacolette et al. (2011) found that moral emotions such as *vicarious guilt* (i.e. guilt experienced when one observes behavior of someone connected to them) induce pro-ecological intentions and/or actions.

Moreover, the literature concerned with the acceptance of wind farm projects highlights the importance of feelings such as *place attachment* and *fairness*. The concept of place attachment goes beyond aesthetics considerations and is meant to highlight the symbolic value that people may attach to the local landscape (Devine-Wright 2009, Cass and Walker 2009).

Feelings of fairness refer to perceptions of what psychologists call procedural and distributional justice (Schweizer-Ries 2008, Gross 2007). Distributional justice involves the subjective individual estimation of the way benefits and costs – which may not be merely material – are distributed within a group. Benefits can be monetary, like the earnings from the electricity produced or the creation of new jobs, as well as non-monetary, e.g. landscape-balancing actions in the region. Costs could be associated to change of the local landscape and noise pollution, real estate depreciation, etc. Procedural justice concerns the subjectively perceived fairness of the process through which DG technologies are implemented and relate to aspects such as zoning and licensing processes, the possibilities for participation, time and amount of information, etc.

Departing from the implausible hypothesis of purely self-interested economic agents, several attempts have been made by economists to incorporate fairness into individual utility functions. For instance, Fehr and Schmidt (1999) developed a game-theoretical model in which people make decisions so as to minimize inequity in outcomes. Inequity aversion is consistent with observations of behavior in standard economics experiments, such as the dictator game, the ultimatum game and the trust game.

If we use the classification of the different types of technologies described above, these issues related to the perceived context are important, above all, for *meso technologies*, since "decisions are made by others and citizens living near to the location of the implementation and use of the technology feel affected by the way the technology is implemented and used (e.g., the location, the rate of use of the technology)" (Huijts et al., 2012: 529). If local communities feel that external interests are monopolizing most of the benefits from the electricity produced or that they are not involved in the development process, they may feel unjustly treated and, in turn, take part in oppositional activism. On the contrary, fairness issues have little influence on consumer engagement towards *micro technologies*.

6. Assets of cooperative ownership to increase consumer engagement

In line with the arguments developed in last section, we now argue that the cooperative ownership structure is particularly adequate for enhancing consumer engagement toward DG technologies. To do so, we rely on the theory of ownership rights developed by scholars like Hansmann (1996) or Gui (1991). These authors explore the reasons for and the implications of the presence, in the economic sphere, of enterprises that exhibit ownership forms different from the investor-owned corporation, involving, among other stakeholders, employees, customers or donors. Gui (1991)'s analysis is particularly useful to our concern. Following the traditional theory of the firm (Grossman and Hart, 1986; Hart and Moore, 1990; Williamson, 1975), he defines the ownership structure of an organization by the allocation of two formal rights: the rights on residual decision-making power and the rights on residual surplus. The beneficiaries of these two rights are respectively called the *dominant category* and the *beneficiary category*. These criteria make it possible to derive one crucial distinction between Third Sector organizations and traditional for-profit firms: contrary to the latter, the dominant and beneficiary categories of Third Sector organizations are distinct from investors. In the case of cooperative firms, the dominant and beneficiary categories are constituted by their users. In addition, their ownership rights take a very specific configuration. On the one hand, net earnings are usually divided pro rata among the members according to the volume of transactions they have realized with the firm. Moreover, this distribution is constrained in various ways, the limitation of profit redistribution being, indeed, one of the cooperative firm's principles (Levi, 2005). On the other hand, they present a democratic governance, implying equal individual voting rights and the absence of barriers to entry for new members. As to renewable energy cooperatives, they are "consumer" cooperatives. This means that energy users, i.e. regular citizens, constitute the dominant and beneficiary categories.

We argue that cooperatives have two types of effects on consumer engagement: direct and indirect effects. These effects, which are graphically reproduced in figure 4, are likely to mutually reinforce each other.

This is not to say that cooperatives only present advantages. As we mentioned earlier, cooperatives are confronted with a number of economic and management issues. We refer to

Hansmann (1996, 1999) for a review of the weaknesses and the limitations of the cooperative model.

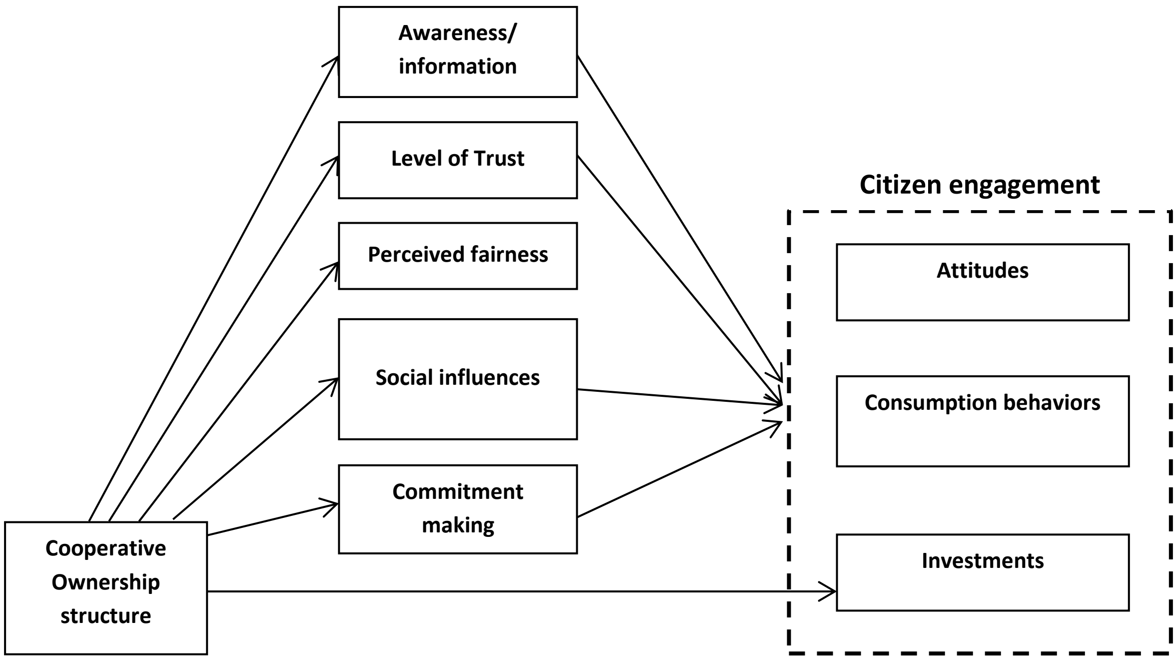

Figure 4: influence of cooperative ownership on consumer engagement. Source: created by author.

6.1.Direct effect on consumer engagement: financial incentives to invest

The direct effect is obvious: cooperatives offer consumers financial incentives to invest in DG technologies. By raising funds from citizens, cooperatives can tackle the problem of high up-front capital costs, which is known to be a barrier to the large-scale penetration of these technologies. They also give the opportunity of taking part to green energy projects to individuals who desire to invest in sustainable technologies, but cannot due to financial reasons. Since consumers are the beneficiary category, cooperative ownership of means of production creates local income, through returns on investment, the sale of produced electricity or heat, or the generation of local jobs (Walker, 2008). While wind farms are certainly the form of renewable energy that yields the highest returns (Bolinger, 2001), biomass-fuelled systems have also be proven to create local revenues, either through sales of heat energy or by serving as an outlet for local wood and agricultural residues (Madlener, 2007).

6.2.Indirect effects

Indirect effects refer to the fact that cooperatives may indirectly induce changes in attitudes, energy consumption and investment behaviors that are conducive to the development of DG technologies through mediating factors such as awareness raising or social influences.

6.2.1. Awareness/information

Cooperatives enhance citizens' awareness. Indeed, their two organizational features enable them to pursue other objectives than mere profit maximization, such as the decrease in their customers' energy consumption, as mentioned above. Let us illustrate this with the case of a cooperative in a rural area of the German-speaking community of Belgium. The cooperative owns 40% of a wind farm composed of 5 wind turbines. As a financial compensatory measure benefitting the municipality for the installation of the windmills, the cooperative is currently developing a solar energy project with an explicit consciousness-raising objective: solar panels are installed on the rooftops of all schools of the municipality to cover 80% of their energy consumption. In turn, the schools have to decrease their consumption by 20%, through energy-efficient investments made by the municipality and through energy savings realized by the stakeholders of the school – teachers, pupils and maintenance staff. The project, hence, meets three goals: the installation of solar panels and the production of renewable energy, a financial compensation for the municipality through the provision of energy for the schools, and the raise of children's and other actors' environmental awareness.

6.2.2. Level of trust

A second asset of cooperatives is their high level of *trust*. In effect, these are supposed to be less likely than their for-profit counterparts to exploit opportunistic behaviors stemming from the asymmetric distribution of information between agents, due to their constraint on the distribution of benefits. This gives them a competitive advantage for the production of goods and services characterized by a high degree of trust and unobservable quality. The democratic structure further contributes to the trust capital of cooperatives, since this gives the guarantee to non-controlling stakeholders that the firm is managed by people who share their interest.

Now, trust appears to be a crucial element as far as engagement toward DG technologies is concerned, mostly at the meso level, as we mentioned earlier. "When people know little about a technology, acceptance may mostly depend on trust in actors that are responsible for the technology, as a heuristic or alternative ground to base one's opinion on" (Huijts et al., 2012). We also have seen how the trustworthiness of the sources of information can affect the effectiveness of a message. More generally, "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. Working as and for the community through civic engagement can enhance trust between people and organisations, an outcome which both builds local capacity for future and further collective action, and [..] wider societal trust in renewable energy technologies from the bottom up" (Walker et al., 2010: 2657).

6.2.3. Perceived distributive and procedural fairness

The two sides of ownership mentioned above, i.e. the beneficiary and the dominant categories, refer to a different notion of justice: while the beneficiary category is more concerned with distributive justice, the dominant category relates to procedural justice, i.e. participation in decision-making processes. If energy users are the residual claimants on the organization's surplus and decision-making power, they are likely to feel more fairly treated and would accept the outcome more easily. As for distributive justice, the point is that they do not only generate real economic impacts locally, but also increase the *subjectively perceived distributive fairness*. Following Earle and Siegrist (2008) and Huijts et al. (2012), we assume that trust and procedural fairness are positively correlated.

6.2.4. Social influences

The cooperative, as an organization gathering consumers who may share similar objectives, is likely to exert some kinds of social influences, such as feelings of community identification or the activation of group norms. This, in turn, can have an impact on consumers' degree of consumer engagement.

6.2.5. Commitment making

So-called commitment-consistency theory has been extensively studied by social psychologists, in particular in environmental settings. The general idea behind it is that "when people commit to a certain behavior, they adhere to their commitment, and this produces long-term behavior change" (Lokhorst et al., 2013: 3), so that "persuading people to comply with a small and seemingly harmless request greatly increases their likelihood of complying with a subsequent, larger request". In this perspective, an interesting way for inducing compliance is the "foot-in-the-door" technique (Burger, 1999; Seligman et al., 1976; Snyder and Cunningham, 1975; Uranowitz, 1975). This compliance tactic is based on the fact that once a person commits to a modest request, it becomes more likely that she/he will comply with a larger related request.

A great deal of evidence has been found for commitment making as an effective way to promote pro-ecological actions. For instance, Lokhorst et al. (2013) conclude from their meta-analysis of environmental studies containing a commitment manipulation that commitment yields sustained behavioral change, especially when it is combined with another intervention. In particular, combining commitment with social norms appears to be particularly relevant (Wang and Katzev, 1990). Indeed, activating group commitment can be very successful, especially in groups with strong cohesiveness. This is consistent with the findings of Terry et al. (1999), who show that group norms are more likely to change behavior for people who strongly identify with the group.

Applied to the case of energy cooperatives, buying shares in a cooperative could be seen as a commitment process and, thus, could potentially lead to sustained behavior changes.

7. Conclusions and policy implications

The presence of the cooperative model in the energy sector is not a new phenomenon. As we have seen, cooperatives were the key actors of many rural electrification programs in various places of the world, with a pioneering role played by the U.S. What is new, however, is the revival of the cooperative structure in a sensibly different context: the objective is no longer the electrification of isolated areas, but rather the facilitation of the diffusion of energy-efficient and low carbon technologies. Indeed, they are said to enhance social acceptance of such technologies. In our discussion of this concept, we emphasized the crucial importance of the active dimension of acceptance and argued that the notion of consumer engagement was better suited to capture it. After defining the dimensions of this notion, we looked into the determinants of consumer engagement in the diffusion of distributed generation technologies, relying on behavioral economics and social psychology, and we proposed a model of the assets of cooperative ownership to foster this engagement. As far as the attempts to overcome the psychological and behavioral barriers to a further diffusion of DG technologies, the policy implications that we derive from this analysis are twofold. First, policy-makers should take non-price-based factors seriously, alongside standard approaches relying on monetary incentives and better information. Behavioral interventions based on social influences, consumption feedbacks, commitment making and other mechanisms have proved to be very cost-effective (Allcott and Mullainathan, 2010) and can favorably influence the outcomes of other policy tools. Secondly, further consumer involvement in the energy production process should be encouraged in order to induce desirable attitudes as well as consumption and investment behaviors. We believe that energy cooperatives, by including consumers in the ownership of generation units and by ensuring transparency and responsiveness to local needs, can be a useful and complementary tool, alongside other demand-side management measures, to achieve these two tasks. An empirical investigation of the theoretical analysis developed in the present article will constitute the author's future research agenda.

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