SHARED SOLAR COOPERATIVES IN BRAZIL: CONTEXT, OVERCOMING BARRIERS AND LESSONS TO BE DRAWN FROM PREVIOUS EUROPEAN COUNTRIES EXPERIENCES

Kathlen Schneider[1,2], Johanna Fink[3*], Camila Japp[3*], Paula Scheidt Manoel[4*], Marco Olívio Morato de Oliveira[5], Ricardo Rüther[1,2]
1 - Universidade Federal de Santa Catarina / Fotovoltaica-UFSC,
2 - Instituto para o Desenvolvimento de Energias Alternativas na América Latina – IDEAL,
3 - German Cooperative and Raiffeisen Confederation – DGRV
4 - Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH – GIZ,
5 - Organização das Cooperativas Brasileiras – OCB

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ABSTRACT: Then integration of rooftop solar photovoltaic (PV) systems to individual households has increased manifold in recent years. Mainly in urban areas, a good portion of the population rent their houses or live in multi-family households, where it is not economically feasible to invest in a rooftop solar PV system, or where roofs are not adequate for PV integration. In this context, community solar has the potential to overcome those barriers by providing a way for all energy consumers to access solar photovoltaics. In Brazil, community solar projects became possible in late 2015, when shared distributed generation (DG) was regulated by the National Energy Agency ANEEL. This paper is focused on the cooperative model of community solar and it aims to present the context of shared solar cooperatives in Brazil, as well as the barriers and experiences experienced in Europe. Since in Brazil shared DG cooperatives are a very recent possibility in the decentralized energy generation market, there is a lack of information and understanding about this model. We present the current national context in a review format intending to shed some light to what is happening in Brazil and to contribute with the international discussion on this topic.
Keywords: Solar Community, Solar Cooperatives, Renewable Energy Cooperatives, Distributed Generation

1 INRODUCTION

The renewable energy field has developed remarkably over the past decades, including wind, solar, small hydropower, biomass and geothermal energy sources. These sources have been increasingly promoted in the context of climate policies aiming at mitigating climate change by reducing the dependency on fossil fuel energy sources. In this context, solar photovoltaics (PV) is the fastest growing renewable energy field in the current decade [1].

Despite PV technology being today a reality to a growing number of worldwide citizens and becoming a cost-competitive source of renewable energy generation, there are still some barriers to the more widespread development of this technology. For example, mainly in urban areas, for individuals who do not own the house they live in, or for those who live in a condo, the option of installing an on site PV system is limited. In addition, even for those individuals who own their house, they may have a limited solar resource due to either trees or other buildings shadings on the roof, or even a sub-optimal roof orientation or tilt.

In this context, shared solar communities have the potential to overcome these barriers. In addition, they can also overcome possible cost issues by capturing economies of scale. Shared solar communities are the concept of multiple participants sharing both costs and benefits of a single and larger PV system rather than each individual pursuing scattered and individual PV systems on their rooftops. Chan et al. [2] have shown that shared projects provide opportunities at the community level to adopt renewable energy technology as part of a larger-scale energy transition revolution. According to Augustine and McGavisk [3] shared solar can also be attractive for the utilities by increasing customer satisfaction and engagement, and addressing customer demand for renewable and a more sustainable energy supply.

This work focuses on investigating the cooperatives modality of a community project. By its definition, a cooperative is an autonomous association of persons united voluntarily to meet their common economic, social and cultural needs and aspirations through a jointly owned and democratically controlled enterprise [4]. Therefore, cooperative businesses are run by and for their members, whether they are consumers, workers, residents, employees, farmers, the community, or any combination of those. What they have in common is that they are not about profit maximization, but about bonding for reaching their goals. Thus, in economic terms, cooperatives are a distinct form of business organization because they have a different model of ownership [5]. Another distinction is that decision-making in cooperatives follows the one-member-one-vote principle.

Since cooperatives are very flexible organizations, they have been proved as a good option of practice responding to current social and environmental challenges. These challenges include access to housing (e.g. grouped housing) and respect for the environment (organic farming and consumption, renewable energy, etc.). Renewable Energy Cooperatives (RECs) fit into the Distributed Generation (DG) context, where energy is generated in a decentralized manner near to the consumer units. Therefore, in many cases, energy cooperatives have the potential to provide an important boost for the decentralized energy transition [6]. Consequently, shared solar cooperatives provide the institutional framework to involve citizens with political, social and financial aspects of renewable energy deployment, thus “democratizing” the energy sector [7].

Shared solar cooperatives are a very new DG modality in Brazil, which were regulated in late 2015 and came into force in 2016. Thus, there is practically no literature available on this topic. On the other hand, there is a lot of interest to better understand this model in order to turn it into a reality in the country. Therefore, this paper aims to

present the current context of shared solar cooperatives in Brazil intending to shed some light on the development of this decentralized energy generation model and to contribute to the international discussion. To this end, regulation information and data about the existing shared solar cooperatives in Brazil are compiled and described in a review format. In addition, a brief literature review is carried out in order to present the renewable energy cooperatives reality into the European context to further illustrate the cooperative concept and across countries experiences.

2 SHARED SOLAR COOPERATIVES IN BRAZIL

2.1 Brazilian context

In Brazil, PV systems installed on rooftops (or on the ground) and connected to the utility's distribution grid only became a reality in early 2013, when the Brazilian Electricity Regulating Agency ANEEL issued REN 482/2012. REN 482/2012, which regulates DG in decentralized energy generation based primarily on small-scale (up to 5MW) rooftop/ground PV systems, was later revised by REN 687/2015. This regulatory framework allowed individuals and legal entities to generate their own energy at the consumer unit location through a one-to-one net-metering scheme (each one kWh exported to the grid generates a one kWh credit, and there is a further monthly and fixed connection fee to account for the distribution grid availability to the consumer unit). Currently this national regulation is under revision and its changes will be officially presented in 2020.

Up to August 2019, there are nearly 100 thousand DG units at the ANEEL registry, amounting to over 1.21 GW of power capacity installed, and growing has now reached an exponential rate. From these, solar PV source accounts with nearly 1.06 GW installed, representing nearly 90% of the total [8]. Following the Brazilian PV market increase, the prices of PV systems equipment and installation have dropped significantly [9,10]

In November 2015, shared solar projects became possible by the revision of REN 482/2012 through REN 687/2015, which regulated shared DG in the model of shared consortia and cooperatives. According to ANEEL [11], up to August 2019 there were 302 shared DG units registered, amounting some 25 MW installed, which represents only 2% of the total nominal power installed in DG projects across the country.

Shared solar cooperatives are a shared solar DG modality, which is characterized by individuals who wish to voluntarily gather in order to generate their own energy through a PV DG system. The energy generated is compensated at the consumer units of the cooperative members through the one-to-one net-metering scheme. Cooperatives are regulated by Brazilian Law No 5764, which states that a minimum number of 20 individuals must join to compose a cooperative. Exceptionally, according to Art. 29, §4°, legal entities with the same goals and economic values as the individual members, can also be admitted into the cooperative [12], as long as the minimum of 20 individuals has been reached. Also, to fit into the net-metering scheme regulated by REN 482/2012, the consumer units and the PV system must be located in the same concession area of the local distribution utility [13].

Up to August 2019, there were ten shared DG cooperatives registered at ANEEL [11]; seven are solar cooperatives using distributed PV generators, two use hydropower and one uses biomass. Shared solar cooperatives together sum 2.6 MW of nominal power installed, while shared hydropower cooperatives sum 6.5 MW and the only shared biomass cooperative has 4.9 MW installed. In terms of nominal power installed, shared DG cooperatives represent only 1.2% of the total amount of DG systems under operation in Brazil up to date.

Fig.1 shows the location of each of the seven shared solar cooperatives in Brazil currently under operation, and Table I presents some of their characteristics. Cooperatives 1-4 were founded exclusively with the purpose to generate solar energy to their members. Cooperative 3 also offers energy efficiency strategies with a consultant available to assist in reducing energy consumption. Cooperatives 5, 6 and 7 are existing cooperatives in other sectors (Credit and Agricultural), which adopted shared PV DG systems to offer solar energy to their members. All of these three existing cooperatives models are in a prototype scope. Cooperative 5 installed a 36 kWp PV system and shared the credits with three consumer units owned by the cooperative and with other three consumer units from members in order to test the shared DG model.

Cooperative 6, in particular, is the only one that still does not share the credits with their members. This cooperative is testing the shared DG model sharing the credits generated by a 1 MWp PV plant with 28 consumer units owned by the cooperative, and which are spread across the state of São Paulo. The cooperative plan is to test the shared DG model and elaborate a business model to offer solar energy to its members in the near future. Cooperative 7, based on the experience from cooperative 5, is now generating energy through a 1 MWp PV system to 75 members and to 95 consumer units owned by the cooperative that are spread across the Espírito Santo state.

Figure 1: Existing shared solar cooperatives operating in Brazil.

2.2 Overcoming Barriers

Shared solar cooperatives face some barriers to become more popular in Brazil. Since it is a very new DG modality in the country, it is noted that there is a lack of knowledge and understanding about the model itself. This stems from both the cooperative as well as from the utilities side. From the cooperative side, there is a lack of

Table I: Characteristcs of the existing shared solar cooperatives in Brazil

#	Cooperative Name	Location	Sector	Grid Connection Year	Nominal Power
1	Coober	Paragominas-PA	Shared DG	2016	75 kWp
2a	Cooper Sustentável	São José-SC	Shared DG	2017	1 kWp
2b		Arcos-MG		2017	0.25 kWp
3	Enercred	Pedralva-MG	Shared DG	2017	90 kWp
4	Compartsol	Araçoiaba da Serra-SP	Shared DG	2017	400 kWp
5	Sicoob Centro-Serrano ES	Santa Maria de Jetibá-ES	Credit + Shared DG	2017	36 kWp
6	Coopercitrus	Bebedouro-SP	Agricultural + Shared DG	2019	1000 kWp
7	Sistema Sicoob ES	Ibiraçu-ES	Credit + Shared DG	2019	1000 kWp

both technical knowledge about the technology and about the shared DG model through the net-metering scheme, as well as of understanding about the cooperative model and its principals itself. From the utility side, it is noted a lack of experience on how to operate the DG model and properly compensate the energy generated by a shared PV system at the consumer units of a cooperative.

Another barrier found is that, for newly shared solar cooperatives to be founded, the net-metering scheme is not very attractive because it imposes the need of scale in order to achieve a better economic viability. In this scenario, newly founded cooperatives have a great barrier in order to reach scale since gathering initial capital is a major difficulty and one of the reasons for that is the fact that there are currently no financing options suitable for the modality. In addition to this, there is also the need of paying the contracted power demand for PV systems above 75 kWp (classified as minigenerators by REN 482/2012). In informal conversations with people interested in establishing new shared solar cooperatives in Brazil, they have expressed this concern as a major barrier for forming minigeneration cooperatives (with nominal power between 75kWp and 5MWp) since this fee could jeopardize the shared solar cooperative economic viability.

There are also regulation barriers to be addressed. In April 2015, the National Finance Policy Council CONFAZ published the goods and services tax (ICMS) agreement 16/2015, which allows individual States to exempt ICMS taxes from DG net-metering operations. The issue here is that the ICMS agreement 16/2015 was established during REN 482/2012 period of validity and, therefore, does not automatically apply to REN 687/2015 updates. For example, ICMS tax exemptions are only possible for distributed generation projects up to 1MW (which is the original maximum installed power for microgenerators that was increased to 5MW by REN 687/2015) and are not possible for shared DG modalities.

The State of Minas Gerais (MG), is the only State across the country that does not follow that rule. This is because the State enacted Law No 22549/2017, adding Article 8-C to the Law No. 6763/1975, which consolidates the tax legislation. Through this Law, in the State of MG, the ICMS is exempt for distributed solar generation up to 5MW and for shared solar distributed generation as well.

3 RENEWABLE ENERGY COOPERATIVES (RECs) IN EUROPE

In order to investigate the European context on shared solar cooperatives, we carried out a brief literature review about this topic. However, little was found specifically about shared solar cooperatives themselves. On the other hand, renewable energy cooperatives (RECs) are well documented in the literature. The development of RECs in the European context is thus a fundamental topic in this research.

3.1 European context

The cooperative movement became stronger in Europe over the course of the Industrial Revolution in mid-19th century as being the answer proposed by the working class to the rise of unemployment and poor wages offered by the European companies. Cooperatives were also created as a tool to resist to monopolies and, therefore, besides its economic functions, cooperatives were also a broader movement with political aims of transforming society [14].

RECs play an important role towards energy transition in Europe and their emergence can be explained by consumers dissatisfaction, desire to better control the origin of their energy and its price. Indeed, RECs are the only model represented by a federation, the Federation of Groups and Cooperatives of Citizens for Renewable Energy in Europe, known as REScoop.eu. REScoop.eu was founded in 2011 and since then it has been playing a very important role as an international network, creating support and contributing to the success of such initiatives across Europe [15].

In terms of energy origin, own and local production by RECs led to more transparency to the consumer. On prices, transparency was also a major attractiveness besides simpler pricing mechanisms that were observed in many RECs [14]. Aspects such as active participation, democracy and the desire to influence local energy policy decisions were defined as the main motivation for individuals joining a REC according to empirical data from Germany compiled by [16]. Wierling et al. [17] also noted this pattern at the pioneers' renewable energy cooperatives in Europe, which are often built by societal groups that intend to demonstrate alternatives to established socio-political structures.

However, the influence of RECs varies across Europe, being well established in some countries while remaining

marginal in others. Germany and Denmark are the countries where RECs are the strongest and well established [7,14,15,17,18]. According to Bauwens et al. [18], this strong development is due to the support mechanism schemes promoted in these two countries.

United Kindom (UK), Netherlands and Belgium present a lower degree of development if compared to Germany and Denmark; yet those are also relevant countries [17,18]. In the UK, most of the RECs were founded in the period between 2010-2015, which coincides with the introduction of a feed-in-tariff (FiT) scheme in 2010. In 2015, the number of newly founded energy cooperatives dropped drastically, coming down from 80 in 2015 to 20 in 2016. This fact can be explained by changes in the FiT polices [17]. In Belgium, electricity generation is mainly dominated by Electrabel, the former state monopoly. Since the liberalization of the energy market, new players were able to enter the market. Only offshore wind power and hydropower are regulated. There are other support mechanisms for other renewable energy resources, such as the mechanism of green certificates. Still, these certificates do not benefit the foundation of new RECs [18]. Bauwens et al. [18] noted that wind cooperatives in Belgium are more likely to be a 'top-down' model, while 'bottom-up' emergences are an exception. Yet, Belgium has one of the greatest pioneers in the bottom-up REC model, Ecopower, which is the largest cooperative in Europe in terms of membership [19].

On the other hand, the developmet of RECs in southern Europe has been much slower [7,14,15]. In the case of Spain, a study of Heras-Saizarbitoria et al. [15] identifies the Spanish legal framework as the main restriction for the expansion of energy cooperatives in the country. According to these same authors, there is a great lack of research on the development of renewable energy cooperatives in southern Europe. Therefore, the participation of these community actors in energy generation is more developed than what is presented in the literature currently.

Huybrechts and Mertens [14] identified two main barriers that seem to explain why RECs face an unequal and sometimes difficult development across Europe. They defined these barriers as barriers to entry (access to capital to invest and access to location for a renewable energy project); and, more generally, cognitive barriers related to poor knowledge and understanding of the cooperative model. According to the authors, access to capital and the lack of access to location for the development of the projects, especially in the start-up phase, are serious obstacles to the emergence and development of RECs. In addition, low knowledge and understanding of the cooperative model among politicians, bankers, potential partners, and the general public, are also important barriers. Furthermore, in some countries, especially in Eastern Europe, the issue was not so much cognitive but moral legitimacy, with the association of this model with 'old-fashioned' and 'socialist' images. Bauwens et al. [18] also pointed support mechanisms for renewable and societal norms including attitudes toward the cooperative model and culture of energy local activism as some other factors to explain such disparity

The solar technology has been proving to be a very attractive option for renewable energy cooperatives. Photovoltaics are particularly attractive because of their modularity, simplicity, high reliability and low maintenance. In addition, another benefit from photovoltaic systems for renewable energy cooperatives is the possibility of mounting them on roofs – such as public buildings, including nurseries or schools, which are not used by individuals [6], thus avoiding the issue of land area and the associated costs. In the UK, solar PV has also been proving itself as a more straightforward option for cooperatives - Green Energy Nayland's project took seven months from start to finish, whereas Valley Wind took over five years struggling to find a suitable site [20]. Germany follows the same path for choosing solar before other renewable energy sources when forming an energy cooperative. [16,17,21].

As mentioned, Germany and Denmark have a well established development in RECs summing some decades of experience. Therefore, in the next subsections we present their context in more detail intending to contextualize their experiences with the newborn Brazilian renewable energy cooperative context.

3.1 Germany

In Germany the history of cooperatives dates around 170 years back. The beginning of the cooperative movement was guided by Friedrich Wilhelm Raiffeisen and Hermann Schulze-Delitzsch and coincides with the beginning of the industrialization. Cooperatives functioned during this time as a measure to counter economic and social problems and to achieve a reduction of poverty in the long run. This led to the formation of the first credit and trade cooperatives [6]. Today, closely to two centuries later, the cooperative movement is very strong and solid in Germany.

The German Cooperative and Raiffeisen Confederation (Deutscher Genossenschafts- und Raiffeisenverband e.V., short: DGRV) is the confederation that organizes, promotes and develops the cooperative system in the country. According to DGRV [6] the cooperative organization is the largest business organization in Germany in terms of membership, accounting with 19.4 million individuals members of cooperative under the roof of DGRV. This number means that nearly one in each four citizens in Germany is member of a cooperative.

In the energy sector, the first boom in the development of energy cooperatives occurred between 1895 and 1932, when at least 6,000 energy cooperatives were established [22]. During this period energy cooperatives were primarily founded in rural areas to provide electricity to smaller communities. Most of these cooperatives were later dissolved through the many regime changes that Germany experienced.

Since the end of World War II, energy cooperatives were typically founded at times of energy crisis (notably in the field of renewable energy), for example, during the first oil crisis in 1973 and in the aftermath of the nuclear incidents in Chernobyl and Fukushima. According to a DGRV survey [21], in 2018 there were 869 renewable energy cooperatives in Germany accounting with 183,000 members registered at DGRV. Fig. 2 presents the foundation of new energy cooperatives from 2006 to 2018. This survey also found that 75% of these energy cooperatives finance their renewable projects in cooperation with one the Germany's 1047 cooperative banks. Other findings are that the membership structure is comprised of 95% of private individuals, followed by 2% of companies and banks, 2% of farmers and 1% of local authorities/public institutions/churches. Furthermore, 78% of these cooperatives operate solar PV systems [21].

As shown in Fig. 2, there was a "boom" of newly founded energy cooperatives, which experienced a sharp increase up to 2014. This growth was mainly due to Germany's FiT scheme enacted in 2000 by the Renewable Sources Act (known in German as Erneuerbare-Energien-Gesetz, EEG) which granted feed-in-tariffs and priority feed-in-tariffs for electricity originated by renewables [17,22]. Other reason for this growth, highlighted by Wierling et al. [17], refers to the decision to phase out nuclear power by 2022 after the Fukushima nuclear disaster associated with the movement to accelerate the low carbon energy transition, known as "Energiewende".

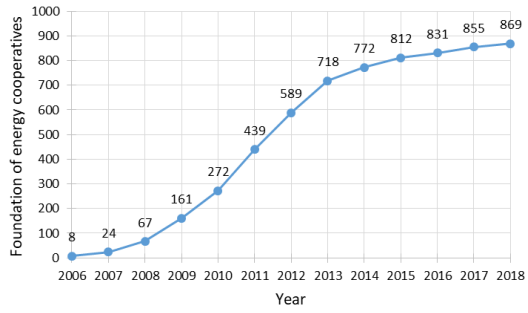

Figure 2: Accumulated growth of newly founded RECs in Germany from 2006-2018. Adapted from DGRV survey data [21].

Fig. 2 also makes it clear that the number of newly founded energy cooperatives is declining since 2014. This decline is related to the recent revisions in the EEG [17,22]. In 2014 the FiT was gradually replace by a tendering system, and in 2015 an auction system was enacted. These recent changes in policy brought more difficulties to small players to enter the electricity market and therefore made the previous renewable energy cooperatives business model unprofitable. As a strategic option for RECs to grow under the recent German policy changes, Herbes et al. [23] suggest that merging with other potentially larger RECs could be a good way. This movement is already a reality for some RECs in Germany as presented by Wierling et al. [17].

According to Herbes et al. [23], the shift for a tendering system may meet other policy goals, but on the other hand it can threaten the progress made in decentralizing and democratizing the energy system. These authors also point that in order to renewable energy cooperatives continue to play an important role in Germany, policy makers should consider measures to continue their continued growth.

3.2 Denmark

Denmark was the pioneer in establishing renewable energy cooperatives in Europe. However, a sharp decline on the number RECs in Denmark can be observed from around 2000 onward [17].

The oil crises from 1973 was an important factor on Denmark's shift from fossil fuel to renewable energy. The Danish government applied support mechanisms such as investment grants and tax exemptions, and from the mid-1980s, fixed FiT including guaranteed grid connection, purchase obligations and priority transmission for wind power producers [18]. Due to the country's geography, wind is an abundant resource and by 2017, 49% for the electricity produced in Denmark originated from wind based energy. Before the oil crises, Denmark energy needs relied nearly 80% on imported petroleum. These numbers make clear how significant energy cooperatives initiatives were important for the Danish energy transition [17].

According to Wierling et al. [17], Denmark had more than 650 energy cooperatives in 2014, down from 931 in 1999. The rapid decline in the number of cooperatives since 2002 can be explained by the abolishment of FiT by the center-right government that argued that wind energy technologies were mature enough to not need government support anymore, pushing for market liberalization [17,18]. The end of FiT was revised in 2009 intending to facilitate a further expansion of local ownership again. However, today the government support system benefits primarily large-scale projects since the government attempts to optimize wind energy generation on a national level [18]. Therefore, wind cooperatives have lost space in Denmark and many of them simply disappeared from the market while others merged attempting to survive to the market into a larger scale format [17].

4 CONCLUSIONS

This paper addresses the development of shared solar cooperatives in Brazil and it also presents some of the European context for further understanding of the history and development of the cooperatives concept. We acknowledge that comparisons from one country to another are tricky due to all the differences in culture, society, political framework, economic context, geography and so on. Yet, exploring other countries experiences can contribute to the international discussion around the important function renewable energy cooperatives can play in the energy transition movement.

Cooperatives are a very traditional business model in Europe and elsewhere. This traditional model summed with consumers' dissatisfaction and the desire to better control the origin of their energy and its price, are together the main players in the development of renewable energy in Europe. In Brazil, the cooperative culture is not as strong and well-known a movement among the population as it is in Europe. Therefore, the lack of knowledge and understanding about the cooperative model is a considerable barrier this model faces in Brazil.

In addition to this, shared solar projects only became possible in Brazil in late 2015, when shared DG projects were regulated by the National Energy Agency ANEEL. Thus, it is also noted that there is a lack of knowledge and understanding among the population about the possiblility of sharing in net-metering scheme itself. People are still not aware of the possibility of gathering to generate their own energy and compensate it in their energy bill.

In Europe, on the other hand, shared renewable energy projects into the decentralized energy market are not such a new possibility. However, their development varies significantly from one country to another. In Germany and in Denmark, RECs are well established and played an important role to the increase of share of renewable energy into these countries' energy market. In UK, Belgium and Netherlands they also have a significant participation. On the other hand, in Southern and Eastern Europe RECs development are much slower.

It is well documented that the rise of RECs in many European countries, mainly in the ones where the movement is stronger, is related to people action in times of energy crises. This is the case of Denmark and

Germany. In Denmark, the oil crises in 1973 was the main player for the shifting from fossil fuel to renewable energies. In Germany, this movement had boomed mainly after Fukushima nuclear disaster in 2011.

Another important finding is that the history of RECs development matches with the implementation of supportive mechanisms in most countries presented in the literature reviewed. In particular, the FiT scheme demonstrated to be the most effective. This was clearly the trend in Denmark, Germany and UK. In these three countries, it was also noted a similar pattern when the removal of the supportive schemes occurred: the founding of new RECs remarkably slowed down. For the existing RECs, many are merging in order to survive to the changes into the schemes framework.

In Brazil, the net-metering DG scheme introduced in 2012 by the REN 482/2012 boosted the decentralized energy generation market, with particular highlight to the solar source representing currently 88% of the 1.21 GW of DG systems under operation. However, in 2012 shared DG projects were not yet allowed. In late 2015, ANEEL reviewed the REN 482/2012 and allowed shared DG projects through cooperatives or consortia. Since then up to date, there are 10 shared DG cooperatives were established and are under operation. Together they sum 1.2% of the total power capacity installed in DG projects. From these, seven are from solar PV source, two are hydro and one is from biomass source.

Therefore, the net-metering scheme did not have the same impact in developing shared DG cooperatives in Brazil as FiT scheme had in countries like Denmark, Germany and UK. One of the major reasons for that is the fact that the net-metering scheme is not very attractive for newly founded cooperatives, because it imposes the need of scale in order to achieve a better economic viability. In this scenario, newly founded cooperatives have a great barrier in order to reach scale once gathering initial capital is a major difficulty and one of the reasons for that is the fact that there are no financing options suitable for the modality, discouraging many possible initiatives.

In the Germany case, 75% of the RECs under the DGRV umbrella in 2018 had financed their projects with credit cooperatives. This finding can shed some light on how to foster the development of new shared DG/solar cooperatives in Brazil: through fostering the partnership of credit cooperatives with shared DG cooperatives through financing options for shared renewable energy projects into the cooperativism scope.

Another important finding observing the Brazilian context, is the trend of existing cooperatives from different sectors to embrace the share energy generation service and adapt it to their cooperative business model, offering energy to their members through the net-metering scheme. For these cooperatives, barriers like the lack of understanding about the cooperatives model and high initial capital needed are not considerable (if not inexistent) as they are for newly founded cooperatives. In their case, the main barrier is the lack of technical knowledge and understanding about the share DG regulation.

To overcome this barrier, existing cooperatives are beginning small in size and testing the shared DG model internally through compensating the energy generated in few consumer units that are mainly only consumer units owned from the cooperative itself (which is the case from cooperatives 5 and 6 in Fig. 2). Once they understand the model and how the relation with the utility works for compensating the credits, they can then design their business model to offer energy to their members. This is the case from cooperative 7 (Fig 2.), which from the learnings taken from cooperative 5, built a bigger scale PV power plant and is now offering solar energy to 75 of its members (besides 95 consumer units owned by the cooperative itself). Cooperative 7 is planning to build many other PV plants spread at Espirito Santo state in order to reach as much of their members they can (about 300,000 members in Espirito Santo). Therefore, existing cooperatives in different sectors in Brazil might find a fertile soil to spread the shared solar energy access to people through decentralized energy generation into the cooperative model.

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