8. Renewable distributed generation evolution: perspectives and new trends for prosumers in Brazil and Italy

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8.1. Introduction

The current paradigm for electric power generation systems is still based on large plants located in areas where it is more convenient to build them, usually very far away from consumers. These systems are connected by transmission and distribution power grids to supply the main consumer centres (mainly cities and industrial hubs). Moreover, the construction and expansion of these large transmission infrastructures are complex to plan, expensive and time-consuming, and difficult to implement due to multiple land uses and legal restrictions, especially regarding property rights and environmental aspects. Furthermore, in the last two decades, advances in renewable technologies and batteries are opening up an expansion vector on the generation side, allowing the emergence of a new paradigm based on renewable distributed generation (RDG) implemented directly within the electrical distribution network. This evolution will also imply the need to improve and evolve the power grids. Around the world, users, supported by different incentive schemes, are adopting RDG, simultaneously becoming consumers and producers of electricity (prosumers). This can positively impact local production, increasing user autonomy and savings in terms of electricity costs. In addition, photovoltaic (PV) is the most used source of energy in the RDG modality in the energy transition process. According to International Renewable Energy Agency – IRENA (2022), in this last decade, the costs of

PV technology have fallen significantly, and there has been an improvement in its capacity factor, increasing its competitiveness and attractiveness in several countries. This cost reduction has boosted the expansion of PVDG and directly paved the way for the five main vectors of the energy transition (decarbonization, electrification, digitalization, decentralization and democratization) for consumers. In this context, end-users' role as prosumers presents a promising trend of greater interaction, connectivity, proactivity and reciprocity in terms of the provision of the electricity supply service with distribution companies, contributing to implementing energy efficiency measures and improving sustainability in the urban areas. Thus, this work proposes to comparatively study two countries, being a reference country in Latin America, Brazil, and a reference country in Europe, Italy, as a way to contribute to a better understanding of the subject in question.

8.2. Scope, specific objectives and methods

This work analyses the RDG evolution in Brazil and Italy through a comparative perspective from 2000 to 2021. It also discusses socio-political issues and the growth of the RDG model oriented by five main vectors of the energy transition, considering the role of the prosumers and their possible contribution to energy sustainability in cities.

The specific objectives are to (i) analyse the RDG evolution from a comparative perspective in Brazil and Italy; (ii) present scenarios about the trend in the prosumer's role and energy sustainability in cities; (iii) point out legal recommendations for improving the development of RDG.

The present work used multiple research methods (Sovacool et al., 2018), blending systematic literature review (Sorrell, 2007) for data collection and the functional method of comparative law (Michaels, 2006), discourse analysis (Antaki, 2008) and triangulation (Flick, 2004) for data analysis, performing thus qualitative, applied, descriptive and exploratory research. A comparative study was carried out on two cases of DG market in countries on different continents: Brazil (Latin America) and Italy (Europe).

8.3. The electric power system and the challenges to enable the energy transition in Brazil and Italy

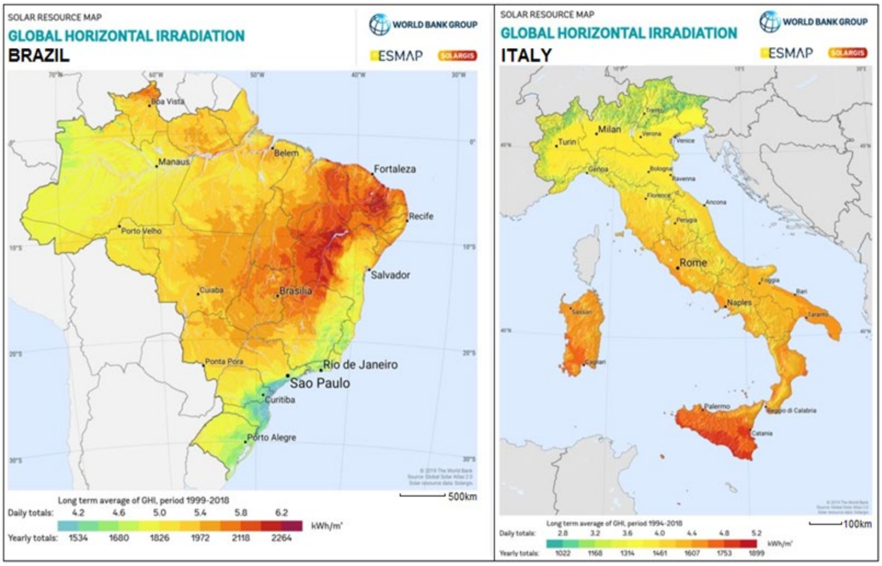
Nowadays, the five main expansion vectors of the energy transition identified in the literature are decarbonization, electrification, digitalization, decentralization and democratization (Dash, 2016; Ghezloun et al., 2017; Di Silvestre et al., 2018; Asif, 2020; Lampropoulos et al., 2020; Wagner and Götz, 2021; Mittelviefhaus et al., 2022). These five vectors can orient the RDG model development toward energy sustainability in cities in Brazil and Italy, the focus of this article.

The term "decarbonization" indicates the declining average carbon intensity of primary energy over time, thanks to the exploitation of new and clean energy sources. Decarbonization targets were set worldwide for the first time at the Conference of the Parties (COP21) in Paris in 2015. COP22 in Marrakech in 2016, called "the COP of the action", opened the way to the practical implementation of the Paris COP21 agreement (Ghezloun et al., 2017; Di Silvestre et al., 2018;). COP26, held in Glasgow in 2021, and the most recent reports from the Intergovernmental Panel on Climate Change (IPCC, 2022) reaffirm the urgent need to decarbonize the world energy sector to combat global warming and climate change. The war in Ukraine added another dynamic to global investments in energy and even more urgency to the processes of independence from fossil fuels.

Decentralization and electrification are particularly relevant in the urban environment (Lampropoulos et al., 2020; Mittelviefhaus et al., 2022). They have become two major intertwined decarbonization pathways due to the stark technological improvements (incl. digitalization) and growing political support for efficient, electricity-based mobility and stationary energy converters and storage, such as heat pumps and electric vehicles (Steinberg et al., 2017; Di Silvestre et al., 2018; IPCC, 2022). While classical non-renewable electricity generation units can predictably dispatch power on demand in that regard, they face challenges of relatively high emissions due to the commonly used fossil energy carriers. On the contrary, installing renewable energy technologies, such as PV, can reduce the supply's carbon footprint; however, it brings along with it challenges of seasonality, intermittency, and non-dispatchability. Energy storage systems may alleviate these concerns, adding costs, storage losses, complexity and embodied emissions to the energy system. Whether to implement such supply systems as decentralized energy systems, i.e. via small-scale converters and storage in proximity to the consumer, with relatively high specific investment cost and embodied emissions, or instead to invest in centralized technologies, which profit from economies of scale, but require costly and lossy transmission and distribution infrastructures to supply the end-users, increases the complexity of energy system planning (Mittelviefhaus et al., 2022).

However, the success of electrification is largely dependent on the geographical and temporal availability of affordable, reliable and environmentally-friendly electricity, which is not equally distributed across the globe, as indicated by the Energy Trilemma ranking (World Energy Council, 2020; Mittelviefhaus et al., 2022). Hence, to enable electrification, depending on the geographical location, the existing electricity supply must be upgraded by installing new electricity generation, distribution and storage technologies, and corresponding integration methods (Mittelviefhaus et al. 2022). In these regards, the two selected countries in this study are similar in that they have abundant solar resources located in geographical areas opposite regions of the most significant demand (northeast – southeast in Brazil and south-north in Italy) (Fig. 8.1).

Fig. 8.1 – Solar radiation comparing Brazil-Italy.



Source: Elaborated by the authors, based on SOLARGIS (2022).

Brazilian PV generation potential is higher than that of Italy due to having more areas and higher solar irradiation levels. However, in both cases, restrictions on the transmission capacity of transferring generations' surpluses are already inhibiting the installations of new renewable energy (RE) centralized generation plants. Accordingly, when planning new complex energy systems, trade-off decisions between centralized and decentralized, renewable and non-renewable, and electrified and non-electrified assets are inevitable. They should ideally simultaneously ensure affordability, sustainability, and energy security (Mittelviefhaus et al., 2022).

Thanks to digitalization, the world is experiencing a fourth industrial revolution (Schwab, 2016; Di Silvestre et al., 2018). According to Gartner's (2022) definition, digitalization is "the use of digital technologies to change a business model and provide new revenue and value-producing opportunities; it is the process of moving to a digital business" (Di Silvestre et al., 2018; Gartner, 2022). The World Economic Forum (Schwab, 2016) and Di Silvestre et al. (2018) indicate three technologies as the most revolutionary in the field of digitalization: the cloud, the Internet of Things (IoT) and the mobile phone. Concerning power systems, decentralization involves generating and managing electricity close to the load centres by using distributed generators connected to the LV and the MV grids. The concept is closely linked to decarbonization and digitalization since most generation units are RES-based plants that must be coordinated to achieve security and efficiency (Di Silvestre et al., 2018). The democratization of the energy industry covers a vast field. This includes the possibility of many individuals becoming prosumers (Brown et al., 2020; Wagner and Götz, 2021) with the desire for social participation in energy issues (Yildiz et al., 2015; Wagner and Götz, 2021) and the fight against energy poverty. The founding of numerous public utilities, the re-municipalization of many electricity distribution networks (Wagner and Berlo, 2017; Wagner and Götz, 2021), the establishment of hundreds of energy cooperatives (Kahla et al., 2017; Wagner and Götz, 2021) and the great interest in bio-energy villages, energy-autonomous municipalities, etc. are an expression of a change in social awareness (Debor, 2014; Wagner and Götz, 2021). It is also an expression of a growing distrust of large energy supply companies and a system for providing services of general interest predominantly based on shareholder value (Wagner and Götz, 2021).

8.4. Brazil and Italy in a comparative perspective

The geographic and socioeconomic realities between Brazil and Italy are quite different, as shown in Table 8.1. Brazil is located in South America and covers an area of 8,515,767 km^2; it has a population density of 25/km^2 and a human development index (HDI) of 0.765 in 2019. Italy is located in Europe, with an area of 301,230 km2, a population density of 201.3/km^2 and an HDI of 0.892 in 2019. Brazil is part of the Global South, while Italy is part of the

South of Europe, with similar relative positions in the global and European contexts, respectively.

Tab. 8.1 – Comparison of some Brazil-Italy socioeconomic indicators.

N°	Indicators	Brazil	Italy
1	**Population in 2020**	212,559,409	59,729,081
2	**Life expectancy at birth in 2019**	75.9 years	83.2 years
3	**GDP total in 2020**	US$ 1,445 Trillions	US$ 1,889 Trillio
4	**GNI per capita in 2020**	US$ 7,850	US$ 32,290
5	**CO_2 emissions (metric tons per capita) in 2018**	2.042	5.376

Source: Elaborated by the authors, based on he World Bank (2022).

8.4.1. Renewable distributed generation evolution in Brazil and Italy: period 2000-2021

RDG, especially PV, in Brazil has attracted much attention and has become relevant since 2012 (Jannuzzi and Melo, 2013; EPE, 2014; Santos et al., 2021), as observed in Table 2. According to Energy National Electric Agency – ANEEL (2022) and Energy Research Company – EPE (2022), from normative resolution N. 482/2012 (ANEEL, 2012), the growth in the Brazilian DG has become exponential as the number of RDG systems connected to the electricity grid reached almost 830 thousand and installed capacity reached around 9.2 GW in 2021 (Table 8.2).

In Italy, RDG, also mostly PV, has attracted consumers' attention and has become increasingly relevant from 2005 on (Table 2) with a Feed-in Tariff incentive called *Conto Energia* that finished in 2013 after five years. According to Gestore Servizi Energetici – GSE (2021) and TERNA (2021) (Table 2), between the third and fifth year, the growth in Italian RDG was exponential and became almost flat in the following years. In 2021, the number of RDG systems connected to the electricity grid exceeded 1 million and installed capacity reached 25.5 GW.

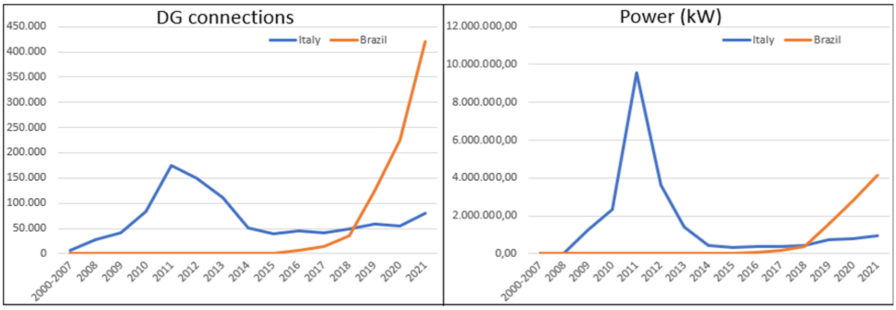
When comparing the evolution of RDG in Brazil and Italy from 2000-2021 (Fig. 8.2), the differences in the growth curves are noticeable. Brazil has an exponential growth curve, while Italy has an elevation curve until 2011 and then there is a reduction in the pace of implementation of new DG systems. A discreet surge in annual growth was observed in recent years.

Tab. 8.2 – Distributed generation development in Brazil and Italy: 2000-2021.

BRAZIL	Year	2000-2007	2008	2009	2010	2011	2012	2013	2014
	DG connections	0	1	2	6	7	6	58	305
	Power (kW)	0	25.00	23.00	40.02	101.00	467.22	1,493.46	2,795.68
	Year	2015	2016	2017	2018	2019	2020	2021	TOTAL
	DG connections	1,458	6,717	13,945	35,958	124,076	224,140	420,780	**827,074**
	Power (kW)	17,032.60	65,467.97	162,382.54	401,547.43	1,581,620.14	2,828,945.32	4,152,058.04	**9,213,999.42**
ITALY	Year	2000/2007	2008	2009	2010	2011	2012	2013	2014
	DG connections	7.647,00	27.158,00	41.788,00	84.343,00	174.422,00	150.048,00	110.949,00	51.841,00
	Power (kW)	87	344,00	1.263.569,00	2.328.000,00	9.539.000,00	3.654.000,00	1.400.000,00	409.000,00
	Year	2015	2016	2017	2018	2019	2020	2021	TOTAL
	DG connections	39.563,00	44.294,00	41.961,00	48.287,00	57.789,00	55.748,00	79.401,00	**1.015.239,00**
	Power (kW)	307.000,00	382.000,00	399.000,00	426.000,00	757.000,00	785.000,00	937.000,00	**22.587.000,00**

Source: Elaborated by the authors based on ANEEL (2022), TernA (2021), GSe (2021).

Fig. 8.2 – Comparison of DG development Brazil-Italy: growth by year from 2000 to 2021.



Source: Elaborated by the authors.

8.4.2. Legal structure of electricity markets in EU/Italy and Brazil

The structure of the electricity market has been widely discussed in recent years at the European level (Europe Commission Communication, 2018, EU, 2022). This sector has increased the share of renewable energy generation up to 37.48% in 2020 (Eurostat, 2022).

However, the EU also suffers from a rise in emissions, high levels of unscheduled and reverse flows and an increase in redispatch costs, which are partly due to the suboptimal geographical zone configuration of the electricity market and distribution of the RE resources available (Europe Commission Communication, 2018; Koirala et al., 2018).

This is a situation currently worsened by the global impacts of the Covid pandemic and the Russia -Ukraine war. Despite the commitments announced and the intention to become the first carbon-neutral continent, the EU is still one of the most prominent greenhouse gas (GHG) emitters, and its commitments are not yet aligned with the goals of the Paris Agreement (CAT, 2022a; 2022b).

Furthermore, the increasing penetration of variable RE generation will increase the challenges of balancing and controlling energy flows. To pursue energy transition in Europe, the most recent plan released by the European Commission is the REPowerEU: *affordable, secure and sustainable energy for Europe*. This plan defines a Clean Energy Package (CEP) that aims to make Europe independent from Russian fossil fuels well before 2030, in light of Russia's invasion of Ukraine.

Nevertheless, in the CEP, by 2030, the share of solar and wind-generated electricity in the total renewable electricity estimated percentage in the grid will be of: 21% at 41% in the reference scenario and at 29% at 50% of the total in the high ambition scenario (REmap scenario), as mentioned by Couture et al. (2019). Thus, the energy transition challenge will be even greater now. In fact, the variable characteristic of generation from modern renewable energy sources and the less-than-optimal integration and coordination of the European electric system (policy, market and geographic aspects) together are becoming limiting factors for the efficiency of the integration process of the electricity market (Europe Commission Communication, 2018; Pérez-Arriaga et al., 2019; Lilliestam et al., 2019; Barroco Fontes Cunha et al., 2021), problems that Europe is trying to solve with successive legal reforms.

In December 2021, six months after the original deadline, Italy promulgated the national law for the transposition of the Renewable Energy Directive with the Legislative Decree 199/2021 (EU, 2021a) and with more than a year's delay, the Directive on the Internal Electricity Market was transposed with the Legislative Decree 210/2021 (EU, 2021b). Both Directives belong to the CEP. The laws, when fully applicable (only after September 30, 2022, with the normative acts from the ARERA), should unblock investment in RE to accomplish the objectives established in the Italian Integrated National Energy and Climate Plan (PNIEC), which foresees a total of 51 GW of PV generation by 2030 due to a 30 GW capacity increase in this next decade (Ministry of Economic Development et al., 2019). This target should be updated to follow the REPowerEU package, leapfrogging the Fit for 55% package approved in 2021 (EU, 2022b).

To date, several aspects regarding RDG foreseen in the new laws, especially involving collective self-consumption and renewable energy communities, are dealt with in Law n. 8/2020, which implemented an experimental phase design to collect data and valuable elements for the final implementation of the Directives.

The main way in which to incentivize the RDG established by the CEP is implemented by four different concepts of collective energy self-consumption, namely: renewable energy communities (RECs), citizen energy communities (CECs), renewables self-consumers and active consumers (EU, 2018; EU, 2019). CEP introduced the concept of shared energy within the scheme members, which is equal to the minimum between the electricity produced by the community generation facility and the electricity withdrawn by all the associated members. The energy is considered shared by the members for instantaneous self-consumption also if stored through storage systems (Gazzetta Ufficiale, 2020; ARERA, 2020).

These new schemes bring a paradigm shift to the energy markets by promoting new ways of engaging citizens and the private sector in the production and consumption of RDGs by giving them the possibility to play an active role in energy markets.

It is worth noticing that before CEP, the incentives to the private sector to participate in the generation of RE around the world could be classified into two central schemes: the *feed-in tariff* (FIT) or the compensation by *net metering*.

In both cases, little attention is required for active consumption, since it was implemented in the passive logic of "feed and forget" (Kubli et al., 2018; Dubois et al., 2019; Barroco Fontes Cunha et al., 2021).

However, the collective models proposed by CEP established the need to match energy production and consumption, thus requiring more user awareness in relation to the production process and even more regarding their own consumption profile. Domotics, smart mobility and energy efficiency also play a significant role due to increasing digitalization and electrification of final uses.

These aspects are implemented aiming to stimulate virtuous behaviours, promote flexibility in consumption and to favour a more significant insertion of variable renewable sources, mainly solar and wind (Kubli et al., 2018; Dubois et al., 2019; Barroco Fontes Cunha et al., 2021).

In Brazil, electricity sector regulation is fragmented in several normative documents, and the current legal framework for RDG is the result of the last reform implemented by Law N. 14.300/2022 (DG New Legal Framework) (Government of Brazil, 2022). This law perpetuated the compensation system (Net Metering) original implemented by the normative resolution 482/2012 (ANEEL, 2012).

It defines the electric energy compensation system, the concept of shared generation and enterprise with multiple consumer units, among other measures. Under the current regulation, individual properties, condominiums, cooperatives and consortia can be included in micro and mini modalities, participating in the energy market through the net metering scheme (Luna et al., 2020; Barroco Fontes Cunha et al., 2020).

In the Ten-Year Energy Plan 2029 (PDE 2029), Brazilian EPE estimates that Brazil will have 1.3 million micro and mini-energy facilities distributed by 2029, equivalent to 11.4 GW of installed capacity (MME and Energy Research Company, 2020). There is, however, no official concern or incentive that focuses specifically on ECs in Brazil. EPE (2014) estimates that by 2050 only 13% of total residential demand will be supplied via distributed generation.

This hampers RDG because large-centralized ventures enjoy many benefits, such as special financing conditions (funding provided by public development bank with long-term repayment and low-interest rates) and long-term energy sales contracts with Distribution System Operators (DSO), in addition to gains of scale, creating utility-scale lock-in technology for PV in the country (Lacchini and Rüther, 2015; Silva et al., 2016; Vazquez and Hallack, 2018).

The official estimate of RDG growth in Brazil by 2050, prepared by EPE (2014), is relatively modest given the growth potential of PVDG in the national market. This might be due to a previous concern about the impact that robust growth of RDG would entail on the income of DSOs and energy trading companies and tax revenues from electricity.

The Federal and State Governments will probably collect less tax. However, the impact of lower electricity costs could be compensated for with part of the savings going to more consumption in the economy, more competitive prices for industrial production and more significant business investment in production, starting a growth cycle in the economy (Lacchini and Rüther, 2015; Cunha et al., 2020).

8.5. Perspectives and trends for prosumers in the energy markets in Brazil and Italy

Good policies provide a strong foundation for action on energy efficiency and RDGs growth, which can improve electrification, replace fossil fuels with renewable energy, boost energy savings and participation towards climate goals. Enabling a smooth switch from fossil fuels to renewables is necessary to build the energy transition pathway by lowering the carbon content of electricity (g/kWh) and emissions on a timescale with objectives and goals across the next decade.

Considering the current Russia-Ukraine war, it is also a good investment to consider now for energy security and independence. However, much work remains to be done to modernize traditional utility business models to encourage energy efficiency. These include revenue decoupling and implementing performance incentive mechanisms to limit the carbon content of electricity (g/kWh) and GHGs emissions.

The Brazilian Electric Sector (BES) is a world reference regarding low carbon intensity and the possibility of storing energy in reservoirs of hydropower plants. According to the National Energy Balance 2022 (Energy Research Company, 2022), carbon emissions from Brazilian electricity generation were 118.5 Kg CO_2-eq/MWh in 2021 and 104.1 Kg CO_2-eq/MWh in 2019, while in the EU, they were 285.0 Kg CO_2-eq/MWh in 2019. Nevertheless, Brazil runs the risk of increasing the amount of CO_2 due to the operation of very old thermal plants and the implementation of new thermal plants.

The insertion of REs (wind, solar PV, biomass, etc.) will help to maintain and increase the decarbonization of the BES. In this context, PVDG is particularly relevant. According to Balance Energy National 2022 (Energy Research Company, 2022), the Brazilian Electricity Sector emitted 118.5 kg CO_2-eq/MWh in 2021. In terms of decarbonization, Italy reduced its GHG emissions by 19% between 1990 and 2020.

Nevertheless, in 2020, 57% of Italian electricity was still generated by fossil fuels and 50% by gas (European Environment Agency, 2022). In 2020 average emissions were 342 Kg CO_2-eq/MWh for Italy (NowTricity, 2022). Both countries have shown progress in terms of decarbonization and the expansion of modern sources of RE (solar and wind).

However, the Brazilian energy scenario is in a better situation than the Italian one. The former's load base is provided by hydropower (in many cases with several reservoirs in a basin), which can provide more flexible, cheap and emission-free generation and better storage. Italy's load base, on the other hand, is based on gas, electrochemical or power-to-gas storage options. Brazil still has electrification deficits in its more isolated regions (i.e. in the Amazon region) but in cities, electrification is universal. Nevertheless, the poor population in Brazil usually live on the outskirts of cities or in slums (*favelas*), with lower quality or even precarious and illegal access to electricity (Pilo', 2021). In many cases, the inhabitants of the Brazilian favelas resort to power theft (popularly known as "gatos").

Important initiatives to change this situation has been a programme called Luz para Todos (Lights for everyone) and community projects to alleviate energy poverty, albeit incipient (Barroco Fontes Cunha et al., 2021). In terms of electrification, access in Italy is provided to virtually the entire population. Both countries have progress yet to make in terms of electrification. However, the Italian situation is better than the Brazilian one because the latter does not have areas without electrification. It is worth noting that electricity tariffs have increased significantly in recent years in both countries, and the less favoured layers of the population are suffering to pay their bills. Additionally, future increases in demand from electric vehicles and smart cities will add to this in both countries and this will require the adapting of electric distribution grids. Italy already 99% of users fitted with smart metering devices of the second generation.

Conversely, Brazil has less than 5% of consumers with two-way meters for net metering (first generation of prosumers). The number of electric vehicles in Brazil is still insignificant compared to all vehicles and there are only pilot projects for smart cities.

BES as a whole (Generation, Transmission, Distribution and Commercialization) is still relatively little digitized (Junior, 2020), despite the centralized system, coordinated by the Brazilian Electricity System Operator (ONS, 2022), having a robust operation to command and control of the main generations and consumption units in the country. In generation, companies currently implement infrastructures with a high degree of digitalization (automation, control and telecommunication) but the transmission and distribution sectors are much less digitized.

The Brazilian Electricity System Operator (ONS) and the Italian National Electricity System Operator (TERNA) concentrates on the activities of digitalized supervision and coordination of electricity transmission. As a rule, no IoT and Blockchain are still not full available to the final consumer. DG has helped in the digitalization process of the distribution network due to the need to implement bidirectional meters (first smart metering generation). However, only prosumers (less than 4% of consumers) have bidirectional meters. The Italian situation is better than Brazilian since almost 98% of the meters are bidirectional and digital, even from the first generation. In both countries, the electrical network needs significant investments to expand to cope with the new RE centralized generation and to absorb new technologies such as sensors and automatic controls, improving its digitalized tools. The Brazilian and Italian Electricity Sectors are still relatively centralized with large generating plants predominating and probably continuing like this for many decades.

However, the wave of RDG expansion gained traction in Brazil and is turning back in Italy, since the growth in the installed capacity of RDG should increase in the next period. Both countries have progress yet to make in terms of decentralization. Nevertheless, Italy is implementing an incentive system based upon matching local production and consumption with the collective energy schemes. The definitive legal framework is not yet totally clear and operative in 2022 (GECO, 2022). Brazil, on the other hand, has renewed the net metering system, implemented in 2012, in the RDG through federal law 14,300/2022 (Government of Brazil, 2022).

The net metering system made RDG gain prominence in the last decade because it proved to be economically and environmentally advantageous for prosumers.

However, in the medium and long term, distribution companies will need to invest in improvements to their power distribution networks to support the increase in DG systems with the necessary energy quality. In terms of democratization of the energy supply, even with both small and large consumers adopting DG in the analysed countries, both still have much to develop in terms of RDG since this still represents an adhesion of less than 5% of the total population (Energy Research Company, 2022; ANEEL, 2022). In addition, the RDG systems are concentrated in the most favoured regions and social classes. They are therefore failing to reduce energy poverty or promote social sustainability in urban areas and generate a burden on the grid at critical times, such as sunny holiday periods, extreme weather events or Covid lockdowns. Some suggestions for RDG evolution promotion schemes common to Italy and Brazil are:

- ensuring access to relevant information and data, which are indispensable for the planning and constitution of RDG, especially regarding collective energy coordination and sharing;
- integrating existing generation systems and storage (also from electric mobility) in the energy market schemes
- a more significant consideration to the provision of flexibility and ancillary services, incentivizing storage deployment and aggregated and coordinated use;
- promoting awareness by the inclusion of mandatory customized feedback to users on energy savings and energy retrofits to promote carbon intensity reduction;
- enabling users to respond to price signals, promoting behavioural changes, building retrofits and helping to increase the resilience of the electricity grid in the near future.

Local coordination is key to our shared energy future, even if energy markets present a greater degree of complexity and bid data and AI will be disrupted when effectively implemented in the digitalization trend.

Community energy is also a key to citizenship action on the climate crisis. These initiatives are also essential to empower people, boost local economies and reinvigorate communities, holistically creating greener and more positive energy districts.

8.6. Conclusions

The information and results point to the trend of RDG growing in Brazil and Italy as relevant and likely to be leveraged through adequate regulations. In both countries, recent legislative processes aim to change the legal landscape regarding the RDG, even if much of the work to reform the energy market in a broader perspective to allow the energy transition is still to happen. Implementing collective schemes by regulators, especially in Italy, remains lacking, causing legal insecurity and preventing investments in new systems.

In Brazil, the Law 14.300/2022 created satisfactory legal security for the RDG. Furthermore, Brazil and Italy are still very new to digitization, decentralization and democratization, in particular, in their respective national electricity sectors.

In both cases, the expansion of RDG helps to advance these three aspects because: (i) it requires the use of bidirectional digital meters and improvements in the command and control of the electrical network, especially at the distribution level; (ii) it enables greater autonomy of consumers to centralized generation, especially if there is associated storage; (iii) with the reduction in costs and the popularization of the RDG, more and more consumers will adhere to its use and, if there are public policies for the poor population, its expansion will be even greater. In Brazil, net metering compensation, confirmed for 2022-2035 in the current legal framework, benefits the wealthier share of the Brazilian population, taking up resources from the sector that could be destined for the most fragile and vulnerable layers of society or reducing energy bills.

In Italy, CEP still needs to be fully authorized and complied with by the sector authorities, and other energy packages are coming fast, such as REPowerEU plan. In terms of electrification, Italy has a higher level of electrification than Brazil, especially in its rural areas.

The differences in HDI and territorial dimensions strongly influence this aspect. Finally, while having an electrical matrix with a large share of renewable energies (hydro, wind, biomass and solar), Brazil is currently decarbonized, but can further expand the use of RE through the RDG.

Italy is still very dependent on fossil fuels in its electricity matrix, and RDG is an interesting opportunity to reduce this dependence and help decarbonise. Thus, in general, RDG can contribute significantly to the 5 main vectors (decarbonization, electrification, digitalization, decentralization and democratization) in the electricity sectors in both countries for energy security and to reduce current energy prices.

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