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Sugar-Cane Bioelectricity in Brazil: Reinforcing the Meta-Discourses of Bioeconomy and Energy Transition

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8.1 Introduction

In Brazil, more than 80% of the electrical matrix is composed of renewable sources. Sugar-cane bioelectricity from residues occupies third place behind hydroelectric and natural gas power plants if its use to power sugar factories is taken into consideration. However, it comes in fourth place, slightly behind wind, in terms of supplies to the national grid (EPE[1] 2019). The expected decrease in the supply of hydroelectric energy, which accounts for over 60% of the energy mix (MME[2] 2019a), and the rapid increase in the supply of natural gas for power generation (ANP[3] 2018) mean that additional power generation from renewable

[1]Empresa de Pesquisa Energética: Energy Research Office

[2]Ministério de Minas e Energia: Ministry of Mines and Energy.

[3]Agência Nacional do Petróleo Gás Natural e Biocombustíveis: National Agency of Petroleum, Natural Gas and Biofuels.

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sources is a critical factor in the clean energy transition in Brazil. Global consensus around the need for an energy transition can provide powerful stimuli for institutional changes in favour of bioenergy promotion. This chapter analyses how meta-discourses regarding energy transitions and the bioeconomy influence the expansion of sugar-cane bioelectricity in Brazil.

Brazil has already become a key reference in global energy geopolitics through its sugar-cane ethanol fuel programme (Wilkinson and Herrera 2010). Bioelectricity, produced from bagasse and straw resulting from the harvesting and treatment of sugar-cane, has now become the third most important by-product of the sugar-cane industry, with 46% of producers using it to power their factories and 54% supplying energy to the national grid (UNICA[4] 2019). The emergence of actors from new energy combinations, including natural gas and new renewable energies (namely wind and solar), is having an impact on the governance of sugar-cane bioelectricity. As both a substitute for petrol and a food commodity, sugar-cane production in Brazil has to negotiate a complex institutional and market environment covering fuel, food and agriculture (Kuzemko et al. 2016). Bioelectricity now adds a new component to this complexity as it involves a competitive market environment that includes both fossil fuel (coal, diesel and natural gas) and alternative renewables (biomass, hydraulic, wind and solar).

The energy transition is generally understood as a fundamental structural change in the energy sector of a particular country that involves the phasing out of fossil energy sources (Hauff et al. 2014) and their replacement with renewables. The bioeconomy is based on the idea of applying biological principles and processes to all sectors of the economy together with the increasing replacement of fossil-based raw materials in the economy with bio-based resources and principles (Dietz et al. 2018). Moreover, it also involves the promotion of bioenergy as a renewable energy source. To replace fossil energies in the electric sector, sugar-cane bioelectricity must not only become competitive in terms of costs, but must also face up to competition from other renewable sources, especially wind and solar, in the formulation of policy-promoting instruments.

[4]União da Indústria de Cana-de-Açúar: Brazilian Sugarcane Industry Association.

The following sections present the analytical framework of the arguments put forward in this chapter, which rely on the notion of socio-technical transitions as viewed from a multi-level (macro/landscape, meso/regime and micro/niche) perspective. Sugar-cane bioelectricity is then situated within the macro-context of the energy transition and the regulatory and market forces governing the sugar-cane sector. The chapter then explores the potential of sugar-cane bioelectricity to establish itself as a dynamic niche within the overall energy transition.

8.2 The Analytical Framework

In the "multilevel perspective on transitions", transitions are considered nonlinear processes that result from the interaction between three levels of development: the landscape (macro-level), the regime (meso-level) and niches (micro-level) (Geels and Schot 2007). The notion of the socio-technical regime refers to the predominant set of routines or practices that actors and institutions adopt and that create and reinforce a given technological system (Rip and Kemp 1998). Although specific definitions of "regime" may differ, an essential characterization refers to its dominant position and its reproduction of dominant structures in a particular social system. As such, a regime is, by definition, associated with "power", "dominance" and "vested interests" (Avelino and Wittmayer 2016). The landscape (the convergence around meta-discourses), in contrast, is the macro-level that can influence the dynamics of both the regime and niche levels (Rip and Kemp 1998) and that actors cannot influence in the short term (Grin et al. 2010).

In the multilevel perspective, changes in the socio-technical regime develop out of selection pressures arising from the landscape and technological niches, as well as from within the regime itself (Geels and Schot 2007; Smith et al. 2005). Among the pressures from the landscape on a global scale, meta-discourses correspond to the emergence of new beliefs or political challenges. Regime transition is promoted when the selection pressures resulting from meta-discourses reinforce each other and when resources such as investments, capacities and knowledge are coordinated with these selection pressures (Hall 2010).

Actors with different powers and interests within the regime play critical roles in shaping the discourse, setting the policy agenda and framing, supporting or suppressing niches, or simply lobbying to obstruct or promote legislation (Andrews-Speed 2016). Thus, the established energy system and the associated institutional structure often prevent the adoption of potentially superior alternatives (Foxon and Pearson 2007). From this perspective, meta-discourses can be harnessed by sugar-cane bioelectricity producers to exert pressure on the established regime in order to bring about institutional changes that are favourable to the expansion of bioelectricity. The extent to which this is the case in Brazil is the focus of this chapter.

8.3 The Landscape: The Meta-Discourses of Bioeconomy and Energy Transition

The "landscape" represents the broader political, social and cultural values and institutions that form the deep structural relationships of a society and change slowly (Foxon et al. 2010). Pülzl et al. (2014) view discourses—a set of concepts that become transformed into a particular set of practices (Hajer 1995)—as generally very stable and rarely changing overnight. The concepts of energy transition and bioeconomy are treated in this chapter as two global meta-discourses that have recently emerged from previous debates and that will have an impact on global policies in the coming decades.

Beginning as far back as the 1970s, a global convention has become consolidated around the need to move towards an energy mix based on renewable energies. This is called the clean energy transition by the European Union (EU 2019). This convention gained force with the United Nations Conference on Environment and Development held in Rio de Janeiro in 1992, as well as with the 2015 Millennium Development Goals (MDGs) and the 2030 Sustainable Development Goals (SDGs). The discourses of energy transition and bioeconomy are thus rooted in the notion of sustainability and its three components (economic, social and environmental) that are aimed at facing up to global energy challenges (Dubash and Florini 2011; Goldthau 2013).

In Brazil, meta-discourses on climate change and sustainable development have been translated into policies such as the National Policy on Climate Change (implemented in 2009) with commitments until 2020 (Law 12,187/2009). In 2016, Brazil ratified the SDGs and the Paris Agreement, linking its commitments to energy and the bioeconomy. In addition to reducing greenhouse gas emissions, Brazil committed to increasing the share of renewable energies (wind, biomass and solar in addition to hydropower) in its supply of electricity to at least 23% by 2030, and the share of sustainable bioenergy in the energy mix to 18% (MRE[5] 2015). Consistent with these environmental commitments, but also for reasons of energy security and industrial development, the National Biofuels Policy (RenovaBio—Law 13,576) was launched in 2017 to expand Brazil's bioenergy production capacity and was supported by an environmental certification system, the Biofuel Decarbonization Credit or CBIO. This institutional change provided new impetus to the sugar-cane industry.

In the case of Brazilian biofuels, a historical perspective shows that the influence of international discourses and the prospects of demand were decisive and that these translated into new policies based on the promotion of sustainable practices (e.g. zoning law and mechanization of the harvest) and bio-diplomacy (Wilkinson 2014). In terms of the market, the meta-discourses of energy transition and bioeconomy influenced the adoption of sustainability certifications by the biofuels sector to embrace the possibility of exports, as in the case of the European voluntary schemes. By using the approaches proposed by van Dam et al. (2008) for biomass sustainability certifications, Herrera (2014) argues that, while the private sector and civil society have the power to act directly on the private certifications criteria, states participate through governmental networks (Slaughter 2005) on the definition of national regulations and global principles.

However, signs of discontinuity in climate policy, the Brazilian government's weakening of policies implemented in 2019 to prevent and combat deforestation and the expansion of electricity generation from non-renewable sources threaten to divert the country's path to fulfilling

[5]Ministério das Relações Exteriores: Ministry of Foreign Affairs (Itamaraty).

its climate change mitigation commitments (CMA[6] 2019). The efficacy of established meta-discourses is currently being challenged by the Bolsonaro Government in Brazil, and this is part of a broader tendency that is challenging notions of sustainability and that will illuminate the leeway that national policies have to flout the global practices that arise from conventions based on these meta-discourses.

Until the emergence of global meta-discourses on sustainability and climate change, bioenergy governance in Brazil was characterized by national policy and the strength of the sugar-cane agro-industry lobby. The consolidation of these meta-discourses has led Brazilian bioenergy governance to become open to decisions taken at the international level and to new actors interested in the market opportunities that arise from them. As Bernstein and Cashore (2012) argue, it is not only about the "compliance" or the "effectiveness" of the meta-discourses in Brazil, but also about their "influence", since the latter includes "the combined effects of the international and transnational efforts on domestic or firm policies and practices". Both the sugar and the oil and gas markets in Brazil are already part of a global governance. Although there is only an incipient market for ethanol in the USA and Europe despite its lower emission of greenhouse gases (Herrera 2014; NovaCana 2020), the influence of global governance is evident in the sustainability claims put forward to defend in Brazil's sugar-cane ethanol (Wilkinson 2014).

Through the lens of the energy transition and bioeconomy meta-discourses, sugar-cane bioelectricity implies, on the one hand, the substitution of fossil energy sources. However, it also involves other renewable and sustainable energy actors that have complementary interests in the promotion of alternative sources, but which can also be competitors in the promotion and design of political instruments, especially wind and solar, both of which are undergoing significant growth in Brazil. Faced with the rigidities of established interests and pathways associated with fossil energies and ethanol, the meta-discourses have also stimulated other technological options to compose the new energy mix, which poses a direct challenge to sugar-cane bioelectricity.

[6]Comissão de Meio Ambiente: Brazilian Environment Commission.

8.4 An Emerging Renewable Electricity Regime

Brazil's energy sector presents a complex architecture of actors that splits responsibilities for energy regulation into the electrical power and the oil and gas sectors, all of which are subordinated to the Ministry of Mines and Energy but are separated from the environmental sector. Streeck and Thelen (2005) and Nunes (1997) argue that the development of Brazil's state bureaucracies has been extremely unequal and heterogeneous. The institutional changes adopted along the national development path (Colomer and Queiroz 2019) have resulted in an energy sector that is not regulated holistically and that is strongly affected by other national political issues (Hauff et al. 2014). During its previous transitions, Brazil has focused its priority on the national security of energy supply and demand and on economic development. From a historical perspective, bioethanol expansion is congruent with an energy policy based on self-sufficiency and local industrialization (Rodríguez-Morales 2018). Moreover, the Brazilian state has played the role of market maker, regulator and motivator for the ethanol market and for biodiesel (Herrera 2014).

With the adoption of ethanol as fuel, the interaction of the energy and food markets accelerated the institutionalization of the sugar-cane industry as part of the socio-technical system of road transport (Rodríguez-Morales 2018). By developing the bioelectricity market, the sugar-cane industry is also institutionalized as part of the socio-technical system of the electricity sector. The Brazilian electricity sector has historically been structured around the planning of the country's hydroelectric resources. As of the 1970s, the state fostered rapid industrialization and economic development through hydroelectric energy (de Oliveira 2007). In the 1990s, privatization and restructuring transformed the energy sector and state-owned companies, introducing competition and attracting more foreign investors (Bradshaw and de Martino Jannuzzi 2019). Since 2003, the electricity sector has favoured the commercialization of wind and solar energy, and has done so as part of a strategic plan based on distributed electricity generation, the implementation of smart grids and the diversification of energy sources (Garcez 2017). In the past, fossil fuel-based thermoelectric plants were built to compensate for the lack of hydroelectricity during periods of low rainfall. Whereas hydraulic energy faced progressively greater costs and environmental constraints, e.g. in the fragile ecosystem of the Amazon, natural gas availability increased by 85% between 2010 and 2017 (ANP 2018).

On the one hand, the meta-discourse of sustainability, climate and the energy transition stimulates wind and solar energy because they are alternatives to fossil fuel, but they are also supported by interests linked to natural gas. The generation of energy using natural gas has attracted more attention as it has lower specific CO_2 emissions and greater operational flexibility than energy produced by coal and oil (Khallaghi et al. 2020). At the same time, it is also independent of climate variations, which brings reliability gains to the system (TCU[7] 2018). The switch from coal and oil to natural gas could contribute to a cleaner energy production. However, gas is not a clean source of energy since it results from oil exploration, a global energy system, and Brazil has created expectations of exporting gas on global markets (IEA—International Energy Agency 2019). However, it could also improve the viability of intermittent renewable energy sources, such as wind and solar energy sources, (ANP 2018) until an energy storage technology were to be made available at a competitive price, and, therefore, provide for national energy security. Renewable energy sources and natural gas are predicted to account for 85% of energy growth, representing 15 and 26% of the primary energy consumption in 2040, respectively—oil being in first place with 27% (BP 2019). This transition, however, responds to the market appeal of low-cost supplies of both and an increasing global availability of gas, aided by the growing supplies of liquefied natural gas (ibid.). The discovery of offshore fields (*Pré-Sal*) in 2006 confirmed Brazil as having one of the largest oil and gas reserves in the world (Goldemberg et al. 2014). The "new gas market" (MME 2019b), implemented in June 2019 in the context of a liberalization of energy markets for foreign companies, represents a key component in the new energy transition in Brazil, combined with wind and solar sources.

[7]Tribunal de Contas da União: Federal Audit Court.

Although there are other potential by-products, bioelectricity has emerged as the third major co-product from sugar and ethanol milling, and it is produced from the bagasse and straw that results from the harvesting and treatment of sugar-cane. Each tonne of sugar-cane processed in the mill produces around 270 kg of bagasse and 155 kg of straw—these figures are expected to increase with the introduction of the new variety of energy-cane (EPE 2018), in addition to 72 kWh of bioelectricity (EPE 2017). Bioelectricity generation and its efficiency, however, depend on technological choices (de Souza and de Azevedo 2006). The history of sugar-cane has already shown the importance of government financial support from Brazil's National Development Bank (BNDES) (Wilkinson 2015). Political support alone does not necessarily provide sugar-cane with greater access to energy markets, as this also depends on the government's interest in expanding bioenergy and its application of regulations and incentives for technological improvement.

The commercialization of sugar-cane bioelectricity has been stimulated ab initio through public policies based on energy security concerns, as is the case of the market for ethanol. The "Programa Nacional do Álcool – *Proálcool*" or National Alcohol Plan was created in 1975 and characterized by a high level of market intervention. Suddenly, bagasse was no longer a nuisance that had to be burned but a marketable good that was progressively adopted by the industries close to the distilleries. A prolonged drought in 2001 resulted in a national energy crisis and this provided the first major political impetus for the development of non-hydroelectric renewable energy sources. In this context, the first institutional change in favour of bioelectricity came in 2002 in the form of Proinfa—the Programme to Stimulate Alternative Sources. Its objective was to increase the proportion of alternative renewable sources used to produce electricity (small hydroelectric plants, wind power plants and biomass thermoelectric projects—solar energy was not included at this time) compared to the large hydraulic reservoirs. In 2003, the national wind industry began to receive financing from the BNDES and since then it has become competitive and focused on an industrial policy that advocates the local components production. Between 2003 and 2009, ethanol production increased annually by some 13%, thanks to national and global investments that poured into the sector in addition to the huge support provided by the BNDES. The boom in resources contracted from the BNDES for cogeneration in 2018 highlights the importance of the RenovaBio policy for bioelectricity. Meanwhile, the first BNDES financing of solar energy was only approved in 2017 and the solar sector still depends on imports of materials (Costa 2020).

In addition to direct incentives (mainly from the BNDES and tax exemptions for wind energy), the main public policy instrument to regulate the energy sector has been the organization of auctions based on a new model that was established between 2003 and 2004 for long-term planned contracts. This mechanism is based on competition between wind, biomass, hydro and centralized solar (non-distributed) sources, but also with natural gas and coal-based thermoelectric and hydropower plants. However, given the lack of efficiency improvements in existing plants (via retrofit) and investments in new greenfield plants, sugar-cane bioelectricity is still uncompetitive and the highest energy prices (ANEEL[8] 2019). In addition to a lack of differentiation within the biomass category, the auction rules do not take into account the externalities and characteristics of each sugar-cane bioelectricity project (retrofit, greenfield, use of straw and bagasse, biogas production, etc.).

8.5 Is There a Niche for Sugar-Cane Bioelectricity?

Within a regime, niches are the "spaces" where sustainability innovation can take place, and they are influenced by the broader "landscape" and the dynamic of the respective "regime" (Geels 2011). As explained above, sugar-cane bioelectricity is not an innovative practice—and market—per se, but a "niche", since its promotion can stem from meta-discourses.

In the near future, the lack of hydroelectricity is likely to be aggravated by the greater vulnerability associated with extreme events directly related to climate change such as droughts and floods (PBMC[9] 2014). The promotion of sugar-cane bioelectricity, in addition to wind and solar

[8]Agência Nacional de Energia Elétrica: Brazilian Electricity Regulatory Agency.

[9]Painel Brasileiro de Mudanças Climáticas: Brazilian Panel on Climate Change.

sources, in principle, would benefit the government and be perfectly in line with meta-discourses on energy transitions.

The first positive feature of bioelectricity is that it has the lowest levels of emissions (in grams of carbon equivalent per kWh) of all forms of renewable energy. It is particularly better than solar or wind energy, which, in addition to being intermittent sources, are currently dependent on natural gas (CTBE[10] 2017). The second positive feature of sugar-cane bioelectricity is its seasonality and complementarity with hydropower, as it is available during the period with the lowest water supply, just as much as it is available during the rainy season. In contrast to wind and photovoltaic sources, which are used for distributed energy generation and are intermittent instead of being dispatchable, biomass provides an uninterrupted production of (bio)electricity (CTBE 2017). Thirdly, the greater insertion of bioelectricity in the electrical system provides a strategic option with which to expand the national grid thanks to the distributed generation of bioelectricity close to the main consumption centres (in the southeast with expansion towards the centre). The inclusion of bioelectricity on a scale commensurate with its potential would reduce the need for investment in strengthening and expanding the electrical grid and would reinforce transmission efficiency by reducing technical losses. Fourthly, the sugar-cane industry can be related to other energy sources such as bioelectricity from straw and tips; biogas mainly from vinasse, which can be used to generate bioelectricity or biomethane, a substitute for natural gas and diesel; and second-generation ethanol from bagasse, straw and tips.

Periods of drought coincide with the months with the highest intensities of wind and therefore peak wind power generation takes placing during these periods (SEBRAE[11] 2017). But they equally coincide with the sugar-cane harvest and thus the possibility of producing bioelectricity (CCEE[12] 2019). In 2019, the supply of sugar-cane bioelectricity to the

[10] Laboratório Nacional de Ciência e Tecnologia do Bioetanol: Brazilian Bioethanol Science and Technology National Laboratory.

[11] Serviço Brasileiro de Apoio às Micro e Pequenas Empresas: Brazilian Micro and Small Enterprise Support Service.

[12] Câmara de Comercialização de Energia Elétrica: Chamber of Commercialization of Electric Energy.

grid (21.5 terawatt-hours—TWh) represented a saving of 15% of the total energy stored in the reservoirs of south-eastern/mid-western hydroelectric plants (UNICA 2019). Thanks to the extensive electrical grid that crosses the country, selection pressures should lead to institutional changes promoting the complementarity of the different renewable sources, both regionally, in the form of distributed electricity generation, and nationally, thanks to the advantages of sugar-cane bioelectricity from the point of view of energy security and sustainability.

Based on the regional potential of each source, an expansion of wind and solar energy is expected in the north-eastern and mid-western regions, and sugar-cane bioelectricity is predicted to increase in the southeast, with very little expansion in the south (EPE 2020). However, the technological synergy between gas and biogas (Bradshaw and de Martino Jannuzzi 2019) and short term economic concerns have pushed policymakers in the state of São Paulo (in the southeast), which is responsible for 52% of the sugar-cane bioelectricity generated in Brazil (NovaCana 2020) and home to the largest gas pipeline network in the country, to bet on the development of natural gas and the introduction of a state-sponsored biomass programme. The Brazilian sugar-cane industry can generate 56 million m^3 of biomethane per day, which corresponds to 10,565 megawatt (MW), or 75% of the capacity of the Itaipu hydroelectric plant (NovaCana 2019).

Data from the National Energy Balance (EPE 2017) show that at the end of the 1980s, all of the bioelectricity generated at the time (3.5 TWh in 1987) was destined for self-consumption in the mills. Since 2013, the sugar-energy sector has produced more bioelectricity for the national grid than the volume needed to meet its own electricity demand. Even so, in 2018, only 54% (200 of 369) of the mills in operation commercialized surplus electricity production on the national electricity market; this represents just 15% (21.5 TWh) of the potential provided by sugar-cane bioelectricity (142 TWh) (UNICA 2019). Encouraged by the RenovaBio programme, the number of sugar-cane mills could rise to 390, providing almost 60% more electricity between 2018 and 2030 (ibid.).

Through its dependence on biomass production from the sugar and ethanol markets, bioelectricity has been at the mercy of the swings in the sugar-cane sector that were accentuated after the worldwide crisis in

2008. In terms of the annual evolution of installed capacity, 2010 was a record year for biomass, with 1,750 MW (equivalent to 12.5% of an Itaipu Plant), as the result of investment decisions before 2008, when the expansion of the sugar-energy sector was being promoted (UNICA 2018). Between 2010 and 2011, ethanol production stagnated, investments in new capacity dried up, and the global market proved to be much more modest. The decrease in BNDES disbursements for sugar-cane bioelectricity until the recent RenovaBio programme (NovaCana 2020) can be explained by the retraction of investment in the sugar-cane sector itself, but also by the loss of competitiveness in the regulated auctions promoted by the Brazilian federal government since 2009 (ibid.) (Fig. 8.1).

Although sugar-cane bioelectricity is not an innovative practice or market in itself, it could become a key niche in the energy matrix if the relevant socio-technical transformations that depend on public policies are put in place. In turn, this depends on the degree to which key regime actors are influenced by the global meta-discourses and the way in which they shape global markets and regulation.

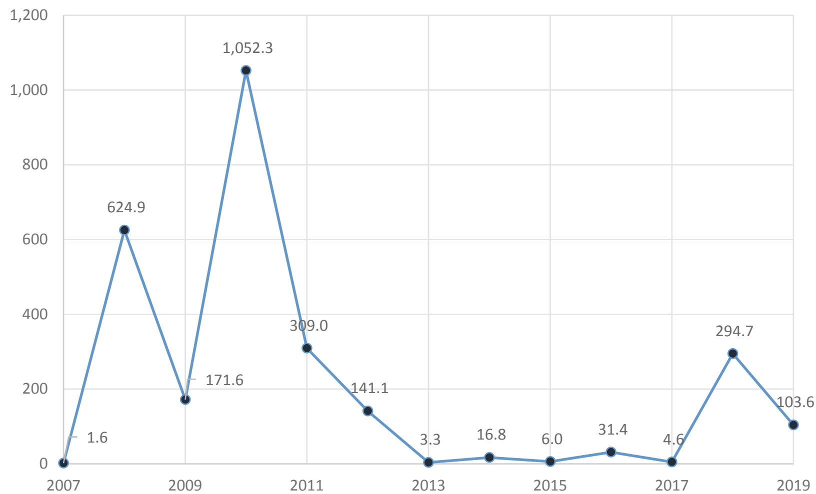

Fig. 8.1 Total BNDES funds contracted by the biomass industry between 2007 and 2019, in million R$ (*Source* NovaCana [2020]. Authors' illustration)

ApexBrasil (Brazilian Trade and Investment Promotion Agency) and UNICA, which represents more than 50% of Brazilian sugar-cane production, joined efforts to promote a "global agenda" of "alternatives to fossil fuels" (Biofuture site). This led the Brazilian government to launch the Biofuture Platform in 2016, a multi-stakeholder initiative with 20 countries, "to accelerate the transition to an advanced, low carbon, global bioeconomy". By using expressions such as "sustainable bioeconomy", "low carbon transport fuels", "renewable energy", "taking advantage of new, sustainable technologies already in place", the platform employs the meta-discourses of energy transition and bioeconomy to foster a global ethanol market, and, thus, the Brazilian sugar-cane industry, as a whole.

The top five bioelectricity generation companies and recipients of BNDES financing in recent years have mainly been Brazilian (NovaCana 2020). First place is occupied by Raízen (the joint venture between the Anglo-Dutch Shell corporation and the Brazilian corporation Cosan). Raízen is one of the promoters of the Brazilian Association of Sustainable Industrial Biotechnology (ABBI), which officially supports the Parliamentary Front of Innovation in Bioeconomy (launched in June 2019), and the Biofuture Platform. This context is favourable to the legitimation of meta-discourses in the negotiation between the actors involved who support institutional changes that encourage the commercialization of sugar-cane bioelectricity.

A series of technical, financial and public policy measures would be necessary to achieve a sugar-cane bioelectricity capacity of 6.7 gigawatt by 2029 (EPE 2020). At the technical level, and in the case of existing plants, new investment is needed to increase the efficiency of energy generation. Furthermore, special credit lines are needed to finance both the new equipment and the costs of connecting to the national grid, which remains the responsibility of bioelectricity producers and is only viable in very favourable locations. At the same time, the political design of the auction system is crucial to the promotion of renewables and, within this category, of bioelectricity. Finally, a long-term and stimulating sector policy for bioelectricity is important, with clear guidelines and continuity with the aim of guaranteeing the full efficient use of this renewable energy resource in the country's energy system.

8.6 Conclusions

The concepts of energy transition and bioeconomy represent meta-discourses (the landscape) that aim to incorporate sustainability concerns into bioenergy governance (the regime), and to incite institutional changes for a new bioenergy market (bioelectricity niche). At present, the complex interactions between the different levels highlights a transition towards an energy mix characterized by natural gas and new renewable energy sources, particularly wind but also sugar-cane bioelectricity and solar. Justifications based on multiple energy security considerations and environmental concerns represent supplementary factors that enhance and legitimize political support for the sugar-cane industry, which, however, still requires a major programme of investments and reformed auction regulations.

The promotion of sugar-cane bioelectricity, in addition to wind and solar sources, makes sense in terms of the energy mix. Thanks to the extensive electrical grid that criss-crosses the country, the sugar-cane industry can reinforce distributed electricity generation, provide bioelectricity to the southeast and south, with wind and solar energies concentrated in the northeast and mid-west, and biogas connected to the largest gas pipeline network in the southeast. Political support for sugar-cane bioelectricity would be in line with energy security, industrial development and sustainability concerns.

Finally, meta-discourses clearly influence the promotion of institutional changes through the development of a global network (Biofuture Platform), new national regulations (RenovaBio), and a new model of electric generation (distributed thanks to wind and solar sources). Both the Platform and the RenovaBio programme illustrate the convergence of interests between areas of the government that are favourable to the international ethanol market and concerned with undertaking action to comply with the Paris Agreement and promoting the transnationalized sugar-cane industry with its interests in expanding its market. However, given the technological obsolescence of bioelectricity production and the critical financial state of the sugar-cane industry in addition to the current priorities of the electricity marketing model, sugar-cane bioelectricity remains uncompetitive and its future uncertain.

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