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Development finance innovations and conditioning factors: The case of the Brazilian Development Bank and sustainable industries

Inovações e condicionantes no financiamento do desenvolvimento: O caso do Banco Nacional de Desenvolvimento Econômico e Social e as indústrias sustentáveis

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RESUMO: Este artigo analisa a capacidade do Banco Nacional de Desenvolvimento Econômico e Social (BNDES) desenvolver e implementar inovações financeiras para fomentar a indústria eólica local e seus fornecedores, no Brasil, na década de 2010, quais fatores exógenos e endógenos condicionaram suas ações e quais resultados foram alcançados relacionados. O artigo demonstra que fatores associados ao progresso técnico, mercado e política constituíram janelas de oportunidades exógenas, enquanto, do ponto de vista interno, o BNDES mobilizou competências necessárias para implementar sucessivas inovações financeiras, resultando em desenvolvimentos significativos da indústria e seus fornecedores. Espera-se que este artigo possa contribuir para acadêmicos e *policy-makers* interessados em discutir inovações em políticas públicas.
PALAVRAS-CHAVE: Capacidade política; financiamento do desenvolvimento; inovação; indústrias sustentáveis.

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ABSTRACT: This article analyses the policy capacity of the Brazilian Development Bank, BNDES, to develop and implement finance innovations to foster the local wind industry and their suppliers in the 2010s and which exogenous and endogenous factors conditioned its actions and the related outcomes. It demonstrates that technology, market, and policy drivers constituted exogenous windows of opportunities while, from an endogenous perspective, BNDES timely mobilised internal competencies to implement successive finance innovations resulting in a significant development of such sustainable industry. It is hoped that this article may be a source of inspiration for those engaged in researching and promoting policy innovations.
KEYWORDS: Policy capacity; development finance; innovation; sustainable industries.
JEL Classification: O13; O16; O25; Q01; Q48.

1. INTRODUCTION

This article analyses how the Brazilian Development Bank (BNDES) introduced development finance innovations in the 2010s to foster the Brazilian wind energy and its supply industries, which factors conditioned its actions, and the related outcomes.

This analysis was inspired by the political economy, public management, economics of innovation literature debating the relevance of public institutions to innovate in the face of development challenges. It also draws on authors discussing development finance (Ferraz 2016; Griffith-Jones and Ocampo 2018). The article argues that the capacity of a public organisation to innovate is conditioned by specific external and internal factors. In this case study, the former is related to market and technology trends, the local economic scenario, and the existing political and policy frameworks. Endogenous factors are BNDES (i) history; (ii) balance sheet strength and portfolio of products; (iii) strategic priorities – and its alignment with policy directives-; (iv) organisational and process procedures and (v) abilities of employees to identify challenges and explore solutions to foster emerging economic activities.

The focus on green-related industries is purposeful due to its importance for sustainable, competitive, and inclusive development trajectories of nations. However, embedded in the emergence of these industries are uncertainties of different sorts – political and policy, technology and production and market, among others. As economic attractiveness is unknown, it is the mission of public institutions to foster and even shape markets (Mazzucato and Penna 2016). This is the case of Development Finance Institutions (DFIs) in the support of sustainable infrastructures. As Studart and Ramos (2016) demonstrate, worldwide, they are involved in fostering mitigation and adaptation to climate change; according to IDFC (2020) such support amounted to US$ 134 billion in 2018. However, research on specific institutions to face up the challenges of climate change and about development finance innovations towards sustainable industries, and their contributing or impeding factors, is still scarce (Hoschtetler 2021). With its emphasis on development finance

innovations to foster the wind industry in Brazil, it is the intention of this article to partially contribute to fill such void.

The article is organised as follows. The analytical framework comes next. The second section examines the exogenous conditions influencing BNDES during the 2010s. The third section introduces the bank's missions and financial capacities, priorities and organisational capabilities, and involvement in green financing. Section four analyses BNDES innovations to foster wind energy and its suppliers and the outcomes of such actions. Main findings are discussed in section five while the last one draws policy and research implications.

2. POLICY CAPACITY, FINANCE INNOVATIONS AND CONDITIONING FACTORS

2.1 Development banks and emerging industries

The capacity of State institutions to effectively accomplish their mandates is a relevant policy and intellectual subject matter. Skocpol (1985) suggests three main factors behind such accomplishment capacity: qualified professionals embedded with the mission of serving the public interest, adequate financial resources, and operational autonomy. Autonomy – not a synonym for insulation – is to be understood as the capacity to formulate and implement policies, having the collective interests – not particular ones – as the guiding reference, requiring, from institutions and their professionals, embeddedness in the economic, social and policy milieu (Evans 1995).

To fulfil mandates, any public institution must have the capacity to do so. Wu et al. (2015:166) define policy capacity as "the set of skills and resources – or competencies and capacities – necessary to perform policy functions" which, for Hochstetler (2021:12) should be aimed at achieving "broad public goods". Karo and Kattel (2018) suggest the importance of policy functions: agenda-setting, planning, adoption, implementation, evaluation, and revisions. The rolling out of such functions requires, as Wu et al. (2018) suggest, specific skills accumulated over time. In short, well-mobilised competencies are necessary conditions for the efficient execution of mandates. Even more so, they are essential for changing – in the sense of innovating – procedures, processes, and operational instruments.

National development banks are public financiers with potential strengths like (i) well-established procedures and instruments; (ii) trustworthiness; (iii) linkages with local and international sources of financing, and (iv) financing in local currencies (OECD 2017). Under political guidance and policy directives, they support the modelling and the financing of development projects. Given the proximity between policy formulation and execution, DFIs are also often involved in policy design.

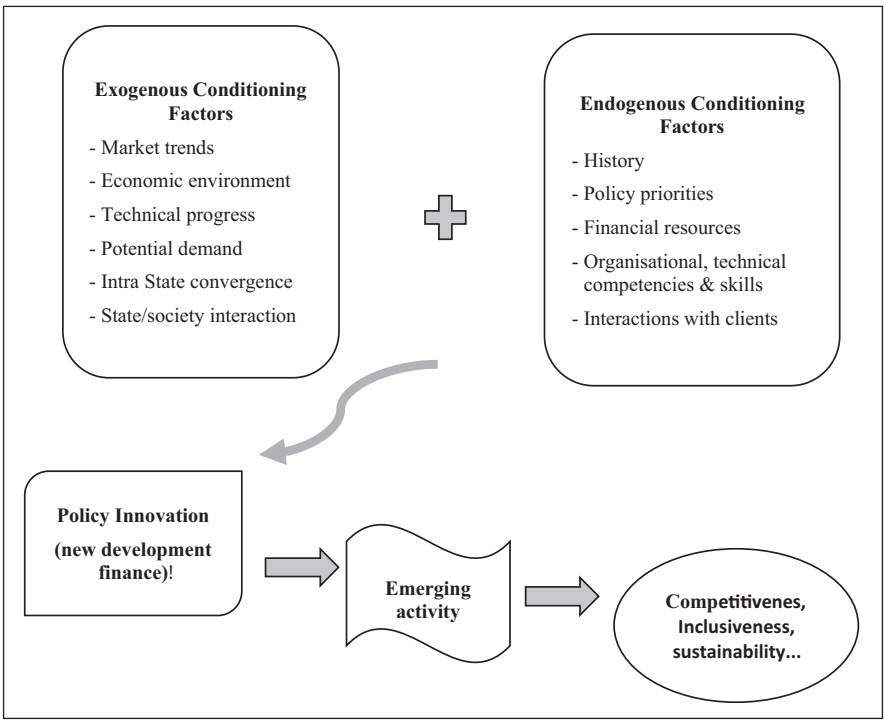
New activities require investment under uncertain conditions: projects have no track record of costs and returns, demand is not ensured, institutional framework may not be consolidated, and infant industry challenges may apply. As suggested by Coutinho, Ferraz, and Marques (2015:101), it "is in these sorts of contexts that

development banks can foster markets by making strategic public investments in radical innovations, infrastructure, climate change mitigation, and environmental protection." Provided with political guidance and policy directives, plus adequate resources, DFIs would be fit to take up development challenges by mobilising dynamic capabilities to implement innovative financing solutions (Kattel and Mazzucato 2018).

2.2 Finance innovations and conditioning factors

The framework for this article was designed around five interconnected dimensions (Figure 1). Exogenous and endogenous factors affect the nature and the extent to which policy innovations come about. With adequate financial support, new economic activities may emerge, generating goods and services. Eventually, a DFI effectiveness is revealed when beneficiaries turn investment projects into productive installations and efficiently deliver goods and services to society.

Figure 1: Development-oriented finance innovations and conditioning factors



Source: Authors'own elaboration.

Discerning boundaries between exogenous and endogenous factors is a difficult task (De Voogt and Patterson 2019). Events within each category may co-occur, and influence or reinforce each other. Also, there may be spill overs across these

domains (Howlett and Ramesh, 2002). Nevertheless, such logical separation can be useful to discern the relative importance of different framework conditions. Exogenous factors are associated with the political, technological, and economic environment under which a DFI operates. Endogenous factors are related to the extent to which capabilities exist to read internal and external ambiances, perceive opportunities, and introduce and implement changes over established practices[1].

The meaning of innovations in public institutions requires specification. According to Howlett (2014), policy innovations come in diverse forms and shapes. Auld et al. (2013) argue that they can be new designs to address a pre-existing challenge or alternative approaches to support an emerging challenge. Some may result in short-lived experiences (pilot projects that are never scaled up); others are not only relevant but long-lasting. Drawing from the Schumpeterian literature, in this article policy innovations are defined as changes in processes – including organisational procedures – and products a financing agency offers to society. For policy beneficiaries, these are product innovations, but, when taken up, they imply process changes in the recipient organisation. Moreover, policy innovations can be of radical or incremental nature depending on the extent of changes they imply in policy benefactors and beneficiaries. Nonetheless, and for any possible types of innovation, a necessary condition for their emergence and application is the mobilisation of capabilities.

3. WINDOWS OF OPPORTUNITIES

3.1 Market and technology trends

Internationally, the installed capacity of the wind industry was expanding at fast rates during the first decade of the new century – 121GW to 238GW between 2008 and 2011. Brazil firmly entered the industry when, momentarily, demand was receding elsewhere due to the financial crisis (Basso 2019). By then wind operators and suppliers were actively searching for new markets and it is around this time that the most prominent international turbine producers established operations in Brazil.

Technical progress provided a unique window of opportunity. In the last two decades, costs of turbines (representing around 80% of total investment) were decreasing and yields in the technical capacity of turbines were expanding, both at fast rates. According to the Global Wind Energy Council (2020), wind turbines' costs dropped by around 50% between 2008-2009 and 2018-2019. Meanwhile, in Brazil, the average power of wind turbines increased from 1.3 MW to 2.6 MW (EPE 2019).

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[1] The "space" for a collective of professionals to innovate naturally depends on the openness of leadership to new ideas. These leaders would fall under the category of "policy entrepreneurs", as proposed by Kingdon (1984). A review on this subject is found in Mintrom (2019).

3.2 Investment-led policies

Between 2004 and 2019, the energy policy framework in Brazil was influenced by three factors: the heritage of an energy crisis, the mobilisation of infrastructure investment programs, and the implementation of explicit renewables related initiatives.

Around the turn of the century, a long period of drought lowered generation capacity from hydro plants – the relevant energy source in Brazil – opening the space for new sources. According to Hunt et al. (2018), during the 1990-2000 period, electricity consumption increased 52.3%, in contrast with a 41.2% growth in total generation capacity.

The opportunity to diversify the grid came about with the support of a redesigned legal framework, and new policy directives issued in 2004, with three objectives: expand and diversify the energy matrix, security of supply and widen the access to energy under affordable tariffs. An auction-based contracting process was inaugurated under which distribution utilities signed Power Purchase Agreements (PPAs) based on the lowest price offered by energy generators[2]. PPAs secured the sale of energy over a long period at a fixed price (adjusted annually to the inflation rate), thereby ensuring a steady income flow for energy projects (Fieldfisher 2016).

Institutional changes came along an investment-led economic cycle during which political priority was granted to infrastructure through three successive programmes: Investment Pilot Project (2005), Growth Acceleration Program (PAC) of 2007[3] and the Logistics Investment Program (PIL) of 2012. After President Dilma Rousseff's impeachment in 2016, subsequent infrastructure policies were announced but not much has been translated into project investments[4]. By then the economic cycle reversed and investments fell back[5].

Energy investments were supported by a well-established institutional framework, with the participation of policy-setting authorities, long-term planning organisations, regulatory agencies, financing institutions, and operational state-owned enterprises. Under such framework, in 2002, a programme for renewable energies, the Program for Alternative Sources of Energy (PROINFA, the Portuguese acronym), introduced cost advantages for renewables, vis a vis other energy sources, through a levy paid by energy customers (Araújo and Willcox 2017).

In 2004, the auction-based process was inaugurated, with two contracting modes[6]:

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[2] Auctions were organised under policy guidelines of the Ministry of Mines and Energy (MME). The regulatory agency, ANEEL (Portuguese acronym for National Agency for Electrical Energy), was responsible for setting up ceiling prices.

[3] For a critical appraisal of PAC see Frischtak (2016).

[4] The "Partnership and Investment Program" (PPI) of 2017, launched by Temer administration and the "Pro-Brasil" announced by the Bolsonaro government of 2020.

[5] Investment to GDP expanded from 16% in 2004 to 19% in 2014. In 2019 it reached 15%, the lowest ratio in 50 years.

[6] A trading chamber (CCEE, the Portuguese acronym) is responsible for processing all contracted energy.

- The regulated contracting mode (ACR, the Portuguese acronym)[7]. Energy was contracted through auctions having, as references, ceiling prices and volumes of energy to be acquired. Projects should start delivering electricity either in three or five years, long-term demand was ensured and lower tariff guided competition.
- The unregulated contracting mode (ACL, the Portuguese acronym). Price, delivery times, duration, and volumes of energy were contracted through bilateral agreements between generators and energy distributors, large or unrestricted consumers, importers, and exporters of energy.

3.3 Demand expansion (with decreasing investment unit costs)

Between 2000 and 2016, Brazil doubled its energy generation capacity to around 170 GW. Favoured by natural conditions, the expansion of "green" energy sources was expressive; wind energy was responsible for 18% of such additional capacity[8]. Total investments in wind energy, between 2006 and 2019, amounted to US$ 35 billion or 55% of all renewable investments in the period (ABEEólica 2020).

In 2019, total wind installed capacity reached 15.4 GW, a 15-fold increase from 2010, placing Brazil among the 10 largest producers in the world. Figure 2 shows the yearly evolution of capacity in regulated and unregulated markets. Until 2016 the regulated environment predominates; price-free contracting was relevant in an odd year (2014). More recently, price-free contracting takes a share of around 300MW while, in 2020, around 1GW of capacity was expected to come from such contracting mode. For many pundits, 2020 inaugurates a strong future trend[9].

Concurrently, unit investment costs fell, and efficiency increased. Between 2001 and 2018, investment costs per kW decreased from US$ 3,258 to US$ 1,823 (EPE 2019)[10]. While in 2007/8 the average length of time for setting up towers and wind turbines was 13 months, by 2018/9, such a period was reduced to around 4 months (EPE 2019).

Another agency, the National System Operator, calculates prices of reference and coordinates energy dispatch.

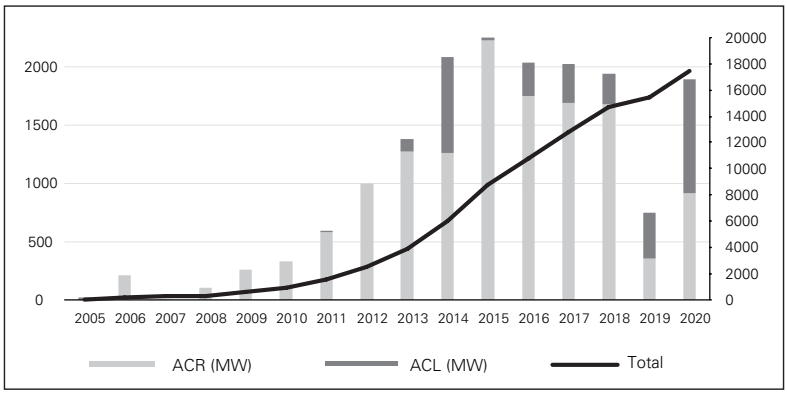
[7] In the regulated market ANEEL fixes electricity rates, with the public interest and the economic needs of agents as references. In the unregulated market, rates are negotiated between parties. All power purchase agreements must be registered with CCEE, but prices are not disclosed.

[8] Brazil average factor capacity (ratio between effective production of a plant and maximum total capacity) is 46% compared to a 36.3% world average. For Bradshaw (2018), wind is complementary and compatible with hydro-based electricity systems. In the Northeast – where most farms are –, wind conditions are better when hydroelectric plants operate at low capacity, during the dry season.

[9] See https://bit.ly/2Q1F9wE

[10] Reductions in total installed costs vary by country. China (1996-2018), India (1991-2018) and the United States (1984-2018) have experienced relevant declines in total installed costs, 56%, 66%, 66%, respectively.

Figure 2: Wind energy installed capacity
in Brazil (MW) by trading environment – 2005-2020



Source: ANEEL / ABEEólica (2020). * 2020 projections

4. BNDES MISSIONS, CAPABILITIES AND GREEN FINANCING

3.1 Missions and financial capacities

BNDES mission is to finance projects to support Brazilian development. Since its foundation (1952), it has followed political and policy directives, from different administrations, alongside the evolution of the economy. Currently BNDES is a diversified financial institution, providing loans directly or through commercial banks, grants (to social, cultural, and technological development), and equity (through investment funds or directly investing in state-owned or private firms)[11].

Since the late 1980s, its main sources of funding have been quasi-public funds provide by worker's insurance funds (PIS-PASEP and FAT, their Portuguese acronyms), from returns of outstanding loans and equity investments, as well as bond issuance, and borrowing from multilateral institutions. Yet, between 2009 and 2014, the National Treasury provided long-term, low-cost loans for BNDES totalling US$ 197 billion[12]. These loans allowed it to extend credit at low rates and cost differentials were expressive: for example, in 2016, BNDES average rate (TJLP, the Portuguese acronym) was 7.8%, compared to 11.5% rate for a 10-year Brazilian Treasury Bond (NTN-B) and 14% for the market rate (SELIC).

With such financing capacity, BNDES could support an on-going investment cycle and act contracyclically, during the financial crisis[13]. Between 2007 and 2015,

[11] BNDES is subject to regulations it must adhere to, like commercial banks (Basel indices, for example). Besides complying with regulations, BNDES has consistently shown the ability to avoid unsound projects as revealed by a low default rate (2.12 % in 2018).

[12] For an assessment of this operation see Ferraz and Coutinho (2019).

[13] Similar actions are to be found elsewhere, although the role each DFI played, their funding sources and policy priorities were country specific (Griffith-Jones 2016).

BNDES financing backed up around 20% of total Brazilian investments; infrastructure took up a fifth of loans (BNDES 2016). When the economic cycle reversed, from around 2014 onwards, and the political climate worsened (President Dilma Rousseff impeachment, 2016), economic policies shifted towards an austerity mode. Two policy directives (reduction of the bank's balance sheet by requesting the anticipation of payments of the Treasury loans and increases in the costs of loans) were implemented to decrease BNDES prominent role. As a result of the economic crisis and political and policy directives, in 2019 BNDES disbursed US$ 13.9 billion, compared to US$ 88.2 billion 6 years before[14].

4.2 Priorities, processes, and capabilities

Between 2007 and 2016, BNDES's aligned its corporate priorities with public policies. Infrastructure, capital goods acquisition, and firms of smaller size were privileged through (i) annual disbursements target goals; (ii) allocations of human and organisational resources, and (iii) financing conditions. Discrimination criteria also considered a project's potential contribution to positive externalities and social returns: sanitation projects enjoyed better financing conditions, for example, compared to highways; in turn, greenfield highway projects deserved more favourable conditions compared to brownfield ones.

Following closely policy directives, BNDES had, nonetheless, technical or operational autonomy to discriminate among "good" and "bad" projects. According to Colby (2013:238) "outside actors did not have the legal authority to influence particular hiring or loan-making decisions". Such technical autonomy is anchored in segregation, impersonal and collegiate decision-making processes and policy implementation following strict hierarchical instances, along four stages[15,16].

Firstly, two different teams examined a preliminary project proposal submitted by interested parties. At the Planning Area, its alignment with strategic priorities as well as its technical and financial coherence was assessed. In parallel and independently, the Credit Risk Assessment Area evaluated the creditworthiness of beneficiaries and priced its risk. These segregated assessments were then submitted to a Project and Credit Committee. Approximately one-third of projects did not pass this stage. After a project was approved in this first collegiate instance, during a second stage, the project was further developed by its proponent and screened by a team of legal, technical, and financial specialists of an Operational Area. Thirdly, once a project proposal was completed and certain milestones were explicitly defined, it was submitted for final decision to BNDES Executive Board. Lastly, during the implementation phase of a project, disbursements were made only after milestones

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[14] 2013: R$ 190.4 billion; average US$ 2.1576; 2019: R$ 13.9 billion, average US$ 3,9451 (IPEADATA).

[15] The described process was in place until 2018.

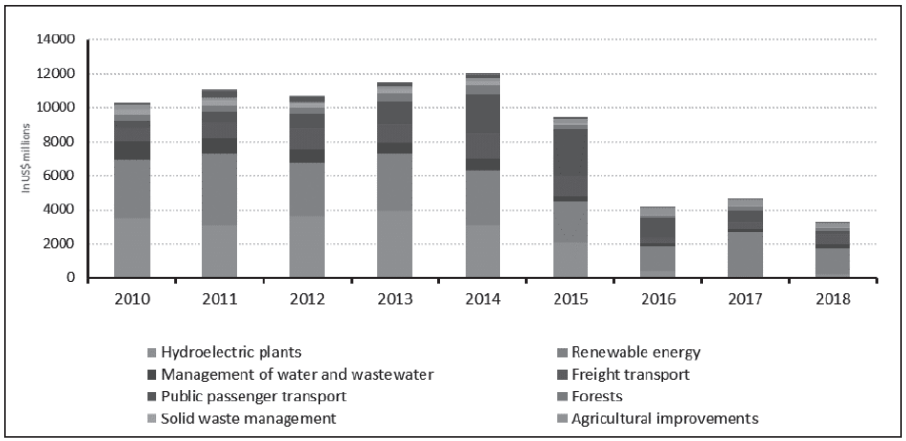
[16] The technical quality of BNDES staff is widely recognised. Entrance is based on competitive entrance processes and merit defines career evolution. These features reveal a typical Weberian institution.

were reached in order to avoid finance arbitrage. The granting of financing was parallel to the monitoring of physical and financial events associated with the project execution to provide feedback information for the bank's planning and operational learning processes.

4.3 Green financing

Between 2010 and 2014, green financing increased from US$10 to US$12 billion; between 2016 and 2018, concessions fell to around US$ 4 billion a year, on average, due to the retrenchment of investment and policy directives to reduce BNDES role in the economy (Figure 3). Over the years, new energy sources took an increasing share of green financing: hydroelectric plants' share decreased from 34.4% in 2010 to 7.3% in 2018. In contrast, wind, solar, biomass sources increased from 33.3% in 2010 to 46.3% in 2018. As a result, for the 2010-2018 accumulated period, renewable energies accounted for 32.6% of total green financing, followed by hydroelectric plants and public transport (26.4% and 12.6%, respectively).

Figure 3: BNDES financing for the "green economy", 2010-2018, US$ million



Source: BNDES.

Such performance finds resonance from an international perspective. During the 2004-2019 period, BNDES had the highest debt portfolio in clean energy in the world (US$ 31.3 billion), closely followed by Santander and MUFG. The portfolio of other entities such as the European Investment Bank, KfW, Mizuho Financial, Société Générale was between US$ 11 and US$ 19 billion (Bloomberg/NEF 2020).

In wind energy, BNDES participated with some level of financing in 80% of the 15.5GW projects implemented between 2006 and 2019. BNDES US$ 15.2 billion loans thus leveraged approximately US$ 28.5 billion of investments (Table 1).

Table 1: Wind energy in Brazil 2006-2019: capacity, investments, and BNDES financing

Wind energy 2006-19: capacity, investments, and BNDES participation	GW and US$ billion	Features
Installed capacity in Brazil	15.5 GW	Accumulated capacity from all auctions
Installed capacity with some level of BNDES support	12.4 GW	BNDES participated in the financing of about 80% of all wind park projects
Total investments in wind parks in Brazil	35.6 US$	Project development, land lease, towers, blades, wind turbines, assembling services
BNDES loans for wind parks	15.2 US$	BNDES financed 53% of total investments

Source: Authors'own elaboration based on BNDES information

Moreover, considering that the share of capital goods to total wind park investment is somewhere around 80%, it is possible to deduct from Table 1 that, between 2006 and 2019, the size of the Brazilian market for wind energy suppliers amounted to US$ 28.5 billion. Proportionally then, out of BNDES US$ 15.2 billion disbursements, it is reasonable to assume that loans of around US$ 12.7 billion were directed towards equipment acquisition during the 2006-2019 period. The following section will analyse how BNDES used such a prominent role to foster local wind energy suppliers.

5. DEVELOPMENT FINANCE INNOVATIONS

Historically BNDES has "pulled" investments in new capacity and "pushed" the emergence of a local capital goods supply industry through the combined use of financial instruments. The "pull" side comes in the form of BNDES terms of credit being adherent to the characteristics of different long-term investment. The "push" perspective comes through an inductive mechanism. To benefit from BNDES local currency financing, investors must follow a long-standing condition: equipment must be locally acquired. In turn, through an accreditation process, suppliers must comply with publicised rules of local content. This is a policy prevailing for more than 40 years[17] (Miguez 2020).

Wind energy is a good illustrative case but with one difference: to pull and push development, changes were required. For wind parks, BNDES had to adapt financing to the regulated and unregulated markets' inherent features. Concur-

[17] Such practices were carried out by the subsidiary FINAME – Special Industrial Financing Agency-.

rently, BNDES accreditation mechanisms had to change given the infant nature of the supply industry.

5.1 Innovations to support wind projects

Until 2016, most energy was traded in the regulated market (ACR). Auction winners signed long-term agreements to provide a specific energy volume within agreed prices. For them, BNDES offered loans of up to 70% of total investment, to be paid back in (up to) 16 years. Cost of loans was based on the TJLP rate (see section 3.1) plus a 0.9% spread (plus credit risk). The project and its long-term power purchasing agreement (PPA), constituted the basic collateral. By then, very few ACL (unregulated market) contracts existed.

In 2016, as the price per MW/h offered in the free market reached R$ 90.00, energy consumers became interested in settling contracts at such rate, even if under contracts of shorter duration. In 2019, more than 2 GW was sold in the ACL, compared with 1.13 GW in the regulated market.

The mismatch between the long maturation of a wind park project and the shorter-term contracts of the unregulated market posed financing challenges. To face challenges BNDES designed simulations for prices and guarantees for periods longer than those prevailing in the energy contracts and proposed a new model covering periods of potentially noncontracted energy. For that, BNDES introduced a price parameter (Difference Liquidation Price or PLD in the Portuguese acronym) for its financial modelling to restrain project leverage[18]. Considering the long-life span of a wind park, BNDES initially assumed, as a pilot proposal for its terms of credit, an energy price threshold of R$ 90/MWh, the 2016 lowest ever contracted energy price. Such reference price was applied to any amount of noncontracted energy during the operational horizon of a wind park (up to 30 years), allowing for the long-term estimation of the project cash flow and, consequently, the sizing of credit with compatible payment terms[19]. Under such modelling investors were benefited, and loans could be taken up. In contrast, BNDES assumed a riskier position (relative to ACR) but it maintained the commitments to support the industry thus fulfilling its development missions.

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[18] PLD is the reference price for the settlement of possible differences in contracted and consumed volumes of energy. PLD is calculated and disclosed by the National System Operator with a weekly periodicity for the Electricity Trading Chamber (CCEE). It is not a market price (as bilateral prices are contract confidential) but an estimated price based on operational marginal costs with energy costs optimisation and security of supply as references.

[19] One year later, BNDES an incremental change was introduced, to update its reference of value to values between R$ 130 to R$ 110 per MWh (Price Support Mechanism). Such incremental change was launched in November 2019, and until July 2020, BNDES had disbursed US$ 73 million under such a new scheme.

5.2 Innovations to foster wind energy suppliers

BNDES accreditation procedures affecting wind energy suppliers went through four successive changes. The first and the last procedures were valid for capital goods of all investment projects financed by the institution. The second and third modes of accreditation were explicitly designed for wind energy suppliers. These policies were oriented to increase the density of production and innovation capabilities required from equipment producers and their suppliers.

The first corresponds to a 40-year procedure up to 2009. Accreditation was based on a composed ratio of components costs and weight of equipment to its sale price – "Cost and Weight to Sales Accreditation", CWSA. By the early 2000s, CWSA was set at 60%, regardless the type and complexity of equipment. The remaining 40% could be sourced from abroad. By then, BNDES financed only a limited number of components for wind parks, such as steel based towers.

As the demand for wind energy increased (2009-2012), a new instrument (to the wind industry) was designed, the "Firm Level Progressive Accreditation" – FPA-, a bilateral agreement between BNDES and a given supplier, with specific goals to increase local production gradually. Such innovation resulted in the entering in the country of 11 turbine producers[20]. For BNDES, this was a learning process by getting acquainted with international practices, technical and cost features of products, and Brazilian value chains' conditions.

When wind energy investments were expanding at high rates (2012-2018), a new mode of accreditation was implemented: the "Sectoral Progressive Accreditation", SPA. This is an evolution over FPA in two senses. Firstly, a sectoral-based accreditation process is firstly introduced in BNDES, ending the one-to-one accreditation mode. Secondly, the reference for localisation shifted away from a cost and weight to sales-based ratio towards parameters related to the progressiveness of sophistication level of devices, considering minimum efficient scales of production and potential backward linkages:

- For simple components with well-established facilities (steel-based towers), a ramp-up over existing technical levels was defined. For turbine manufacturers, the focus was on localising metal-mechanical parts.
- For middle-range components, it aimed at increasing assembly capabilities and, gradually, widening the acquisition of locally produced components, with higher sophistication levels (chemical components for blades).
- For high technology devices, without a standing industrial base, but with potential competencies, lower levels of internalisation were accepted against slow and gradual increases in local content (electromechanical energy conversion package components).

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[20] Wobben, Gamesa, GE, Vestas, Impsa, WEG, Alstom, Siemens, Acciona, Suzlon and Führlander. The only locally owned company was WEG, an electrical engineering corporation first entering the wind energy sector. Subsequently, some of these manufacturers were disqualified for not meeting the established milestones.

- For segments with extremely high technological density and without potential local capacity (or minimum efficient scale), imports were allowed (digital-based controls).

Such sectoral approach in wind energy was instrumental for the learning process which resulted in the introduction, in 2018, of a new accreditation policy and instruments, to be implemented for all capital goods producers (but taking into account the inherent features of different segments): the Cost and Qualifier Based Accreditation – CQB-. CQBA is based in two components: a local to total cost ratio (LTCR) and a set of capability related qualifiers (TCQ). Local costs include costs of inputs and components, services, and labour directly allocated to production. In the denominator, a relevant change was introduced: the indicator for "sales" (valid for the long standing CWSA accreditation procedure), was substituted by an of total input costs which excluded profit margins.

The capability-related qualifiers (TCQ) brought about new referential parameters in terms of the technical complexity of the equipment and capabilities of firms. These qualifiers are not mandatory for accreditation, but if fulfilled, they may add to the CQBA. Five qualifiers are specified, each with objective thresholds: (i) technological complexity of equipment; (ii) investments in innovation; (iii) export propensity of companies; (iv) technical qualification of labour force and (v) value-added. A CQBA of at least 50% is required for an equipment to be accredited by BNDES. Such proportion can be reached in two ways. The first alternative is simply to have at least 50% of local to total cost. The second alternative is to have a LTCR between 30 to 49% with the difference to reach 50% is composed by the technology and capabilities qualifiers, TCQ.

Such mode of accreditation was the result of BNDES evaluation of the pros and cons of its 40-year standing practice, the learning from previous experiences in doing things differently, including and especially the sectoral accreditation enforced for wind energy suppliers and of a lengthy interaction process with the private sector.

Even being more complex than previous accreditation procedures, the Cost and Qualifier Based Accreditation, when fully implemented, can induce a resilient and innovative local capital goods industry. Its implementation, however, will require efforts and perspicacity from the industry and BNDES. On the one hand, significant steps will be required to adapt systems and generate the required increase in the amount and quality of information needed for an accountable accreditation process. On the other hand, as currently the demand for capital goods is very slack, BNDES is implementing the new policy in a phased mode lasting up to 3 years, considering, jointly, competency levels and effective and potential demand in different segments.

5.3 The industry that came about

By the end of 2019, 620 wind farms (mostly private concerns), operating over 7,500 turbines generating above 15GW equivalent to around 9% of total energy

capacity were installed in the country. Over the years, energy imports declined[21]: between 1990 and 2010, import dependence went from 25% to less than 10% of the total supply (Newborne and Welham 2014). By 2016, 150 thousand people were directly employed in the industry, an equivalent of 15 jobs per MW. Due to its very favourable wind conditions, most wind farms are in the (poorer) Northeast region, benefiting around 4,000 families (ABDI 2018). The expansion of wind energy also contributed to avoid CO_2 emissions. Between 2012 and 2019, around 78.5 million tons of carbon pollution were avoided because of wind energy generation (ABEEólica 2020).

In parallel, a large and complex wind energy supply industry emerged (Table 2).

Table 2: The Brazilian wind energy supplier industry: some structural features

Supply Chain	More than 100 companies in the supply chain.
	Six wind turbines production facilities, one, locally owned.
	Mechanical engineering firms entered the wind energy segment.
	Relocation of industrial capacity from the southeast to the northeast.
Jobs (2016)	15 jobs per MW (around 150,000).
Production Costs	Declining costs with growth in the volume of production.
	Exports and cost competitiveness of some components.
Technology and quality levels	Like best practices.
Wind turbine average power	Above 2MW and growing. Below Germany and Denmark. Superior to China, India, EUA.
Capabilities	Production and testing of new (international) models.
Installation period	From two to less than one year.
Cost to investors	Still higher than the international average.

Source: Adapted from Araújo and Willcox (2017) and ABDI (2018).

Such industry is the outcome of 15 years of continuous improvement and competition dynamics. Wind turbines producers, mostly subsidiaries of foreign firms, adopted different localisation strategies. Some companies verticalized the production phases of the electromechanical energy conversion devices. Other firms qualified local suppliers or attracted international partners for the same devices. Some wind turbine manufacturers withdrew permanently or left and re-entered the market. Others merged globally and reached a relevant share of the national market al.though the State of São Paulo has remained the primary hub of the metal-mechanical base,

[21] Energy imports came from Paraguay, the Brazilian partner in the Itaipú hydropower plant.

companies producing large equipment or components (blades and towers) were relocated in the Northeast and South regions, to areas close to wind farms.

According to Ferreira (2017), Brazilian suppliers of wind turbines and their components are competitive in quality and delivery time, and turbines incorporate the best available technologies. Yet, the costs of national equipment are still relatively higher when compared with the international average. Local efforts have been directed to adapt equipment to local production and value chain conditions, in parallel with ensuring delivery times. These efforts led to incremental innovations that are economically significant, as most wind turbines have shown technical operational efficiency. Given the prevailing high energy factor, Brazil has become a testing ground for new products by locally and foreign-owned firms. However, along the wind energy supply industry value chain, innovation capabilities – the ability to design and produce new devices nationally, at least equivalent to the international reference – are still limited. Podcameni (2014) showed that international subsidiaries concentrate their innovative effort at R&D centres at their headquarters. One exception is the locally owned producer, WEG, engaged in developing new turbines, with the support of its North American-based subsidiary.

Such a stage of development reflects the orientation of corporations to focus on the immediate needs of local demand. It is also the by-product of a policy framework with a primary concern with expanding energy capacity and the operationalisation of installations. Along the years, BNDES' modes of development finance were realistic to prevailing demand and supply and policy circumstances but also changed in time with a focus of strengthening local production and technical capabilities but always with an attention to the economic needs of the wind anergy producers. Substantial development was achieved but, so far, investments in innovation capabilities are still modest. And, when a new set of localisation guidelines – oriented towards fostering innovation efforts – were technically sound and mature and negotiated and accepted by capital goods producers, the external environment became hostile to investment expansion. BNDES then took measures to postpone the implementation of its new accreditation mode.

6. DISCUSSION

This article provided evidence about how development banks can support emerging sustainable related activities through innovative finance. The main messages are development-oriented finance innovations are a necessary condition for the emergence and consolidation of sustainable industries and, to be effective, innovations depend on the alignment of a complex web of exogenous and endogenous intervening factors conditioning the actions of a potentially innovative public agency.

For the Brazilian wind energy industries, and BNDES, these exogenous factors were associated with temporary windows of opportunities that opened up opportunities for the development of the industry while requiring innovations on development finance: the availability of international operators of wind parks and manu-

facturers; cost and technical improvements trends of turbines; an economic climate inductive of energy demand; the coherence of policy directives and, the convergence of actions by relevant executive agencies.

On one hand, without such framework conditions, Brazil's wind energy most probably would not take-off, even if a development-oriented finance institution were present: it is very unlikely that its isolated actions would find strong resonance in the real economy. On the other hand, without proper development-oriented finance conditions, favourable exogenous factors per se would not constitute sufficient conditions to ensure the emergence and consolidation of the wind industry and its local suppliers.

This article demonstrated the strategic role of a mission-oriented financial institution to temporarily lower the investment costs of projects (and, later, provide market-oriented solutions) and shape the emergence and consolidation of a local supply industry. For that, dynamic capabilities were essential; that is, the mobilisation of resources to introduce different and successive financial innovations, ensuring BNDES' historical mission of "pulling" investment projects and "pushing" local industrial development.

For the support of the wind park investments, PPAs' long duration and foreseeable prices constituted demand related windows of opportunities. They provided a solid project portfolio for relatively low-risk investment finance and BNDES existing credit instruments were quickly adapted to foster the wind energy ramp-up. By then only incremental innovations over existing practices were necessary.

As market dynamics changed and energy prices fell, the attractiveness of unregulated contracts increased. BNDES had to incorporate market price references into its financial modelling and credit risk evaluation parameters to avoid a potential mismatch between investment maturity and contract duration. Thus, new product and process innovations in the form of a market-oriented financial instrument substantially change the market-regulated (PPA) instruments. BNDES is taking up riskier positions but, as market-oriented agreements are likely to increase in the years to come, the institution may remain relevant and well-positioned to support sustainable-related investment projects.

To foster local suppliers, the long-standing policy orientation has remained in place: to benefit from BNDES' terms of credit, investment projects must be sourced from accredited local suppliers. However, the modes of accreditation changed substantially. While in the wind industry's initial years, the 40-year conventional policy was enforced, benefiting a limited number of local producers, the following strong wind energy investment drive provided sufficient demand for further development actions. Gradual changes were introduced up to the point when a new sectoral approach in accreditation procedures was designed and implemented with the capabilities of firms as the reference for localisation of production. Such experience was the spearhead to guide BNDES towards developing an advanced accreditation method to foster the dynamic capabilities of firms by considering specific sectoral competitive and innovation features. Nevertheless, an uncertain economic environment in which investments fell drastically have postponed the

bank to fully implement what would be an accreditation method in which the fostering of innovation would play a pivotal role. Even so, if and when the economic cycke reverses, BNDES already has the blueprint and the means to continue to foster the Brazilian wind industry and its suppliers to a new level of development, centred in the innovation capabilities of firms.

The opening-up of the innovation capacity box of a public mission-oriented institution provided insights to disentangle the intricacies associated with the concept of policy capacity. This case study showed that development-oriented finance innovations were a result of (i) strategic priorities aligned with policy directives; (ii) a balance sheet capable of absorbing liabilities and the availability of finance on a scale sufficient to attend a growing demand; (iii) organisational procedures based on the principle of segregation between credit and project evaluation; (iv) the capacity to design and implement terms of credit and accreditation procedures alongside the industry's evolution; and (v) the existence of a reliable and trustworthy network with relevant actors (public and private). Such endogenous determinant factors were backed up by impersonal collective decision-making processes and a qualified team of professionals, with the knowledge and network connections to learn and duly explore and evaluate economic, financial, market, and technology opportunities to foster development.

These components of the policy innovation capacity box are very much aligned with the propositions of embedded autonomy (Evans 1995), the relevance of adequate resources (Skocpol 1985), policy capacity and the specific nature innovations take in public institutions and how policy capabilities to innovate are put in motion (Wu et al. 2015; Howlett 2014; Karo and Kattel 2018). Moreover, it is a small contribution to the much-needed reflection about the role of the State in research in tackling the challenges posed by climate change through the understanding of how bottom-up processes of networked or interacting interventions – state-led and society-led at multiple scales – might prove effective for the facing of climate change challenges (Hoffmann 2011, Hoschtetler 2021).

7. IMPLICATIONS

This article analysed the capabilities of a public agency to introduce innovations in development finance to shape and foster the Brazilian wind energy and the supplier industry in the 2010s, what factors conditioned its actions, and the outcomes of such development actions. To address these questions, an analytical framework was developed, and an empirical exercise was carried out. Three main implications must be put forward in this final section.

Firstly, implications for public policies, on two directions. For BNDES, the wind energy sector could become a pilot for guiding BNDES navigation amidst the dire straits of low economic growth. It can also pave the path for a future development strategy in which socio-environmental sustainability is the main guiding beacon. For that, BNDES will have to follow on strengthening its development finance

innovation capabilities. For other public agencies, the opening of the innovation box may provide inspirations for their strategic positioning, especially the vital importance of investing in capabilities and ensuring the embedded autonomy of these agencies. Also, the case study has shown how important it is to be aware, perceive and explore external windows of opportunity.

Secondly, the approach in this article may provide lessons for research with similar purposes. The inquiry on how to approach the issue of policy innovations – in this case, new modes of development finance –, and the exploration of what are their constituting relevant explanatory elements demanded a specific approach to its realisation. Investigative flexibility, anchored in solid analytical concepts, coming from various sources of inspiration was especially important. Alongside its elaboration, research queries were finetuned *pari passu* with the need for further empirical investigation; as they were addressed to and new information gathered, questions were sharpened up and new responses drawn into the exercise.

Lastly, further conceptual and empirical research on policy innovation and their conditioning factors are still much needed. Valuable experiences must exist worldwide, deserving proper investigation; much evidence-based research is required in order to understand and come to a more definite assertive on how public institutions are to become or remain relevant if explicitly investing in innovative capabilities to serve their missions better. From a conceptual perspective, the research agenda on public innovation capabilities must be extended. Which concepts from the innovation theory are useful and can be further adapted to understand policy innovations? Which are not? What motivates public institutions to innovate when designing and/or implementing policies? How to investigate the nature and the determinants of policy capabilities to innovate? How to systematically organise the inter and intra flow of causal relations among political decisions, policy directives, capabilities, innovations, and socioeconomic consequences? It is hoped that this article may have raised inspirations for further work to address these and/or new research questions.

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