BRAZIL

MARKET OVERVIEW

Brazil installed 1077 MW of wind power in 2012 to reach a total installed capacity of 2 508 MW. The country has excellent wind resources in its north-east[4] and southern parts. Today Brazil has a project pipeline for more than 7 GW of wind power by 2016, with a market forecast to grow at over 2 GW annually. The Brazilian government's Decennial Energy Plan (PDE 2021) sets a goal of 16 GW of installed wind capacity to be reached by 2021, accounting for 9 % of national electricity consumption. This makes Brazil the fastest-growing market on the South American continent (Global Wind Energy Council (GWEC), 2013).

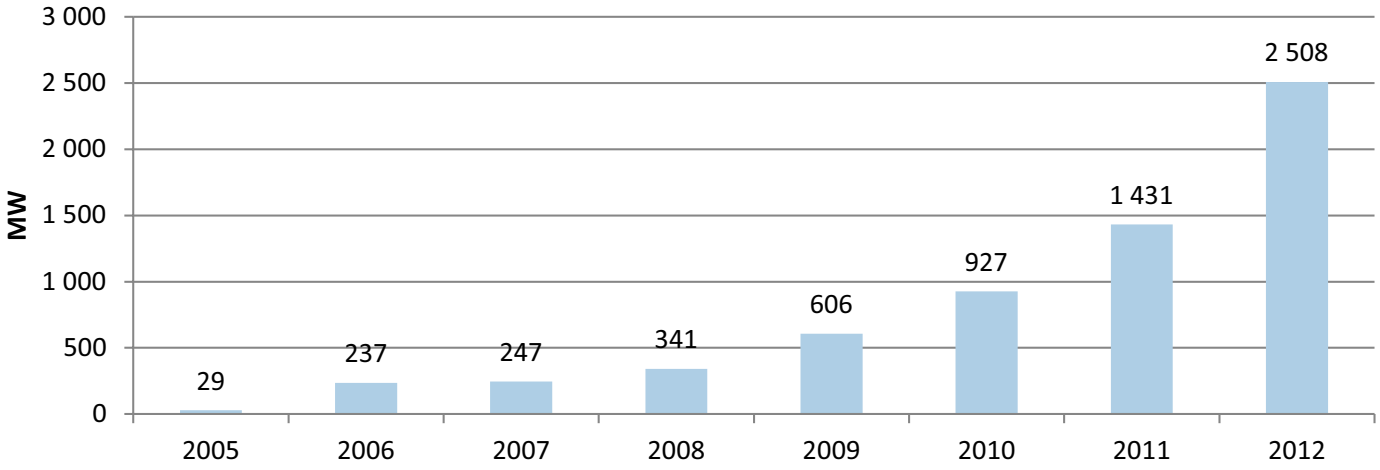

Figure 4: Cumulative Wind Installation (MW) of Brazil (GWEC, 2013)

HISTORY AND EVOLUTION OF POLICY AND REGULATORY FRAMEWORK FOR WIND ENERGY

Brazil has one of the cleanest energy matrices in the world with hydropower providing 67% of the total installed capacity (Aneel, 2011). In the 1990s, Brazil faced a period of rapid economic growth which led to a rapid increase in energy demand, particularly in the north-east of the country. Brazil faced a very serious energy crisis between 2000 and 2002[6], due to three key factors.

Firstly, in a country with over 80% historical dependency on hydroelectric generation capacity several years of below average rainfall forced over-tapping of its very large reservoirs. Secondly, even during this shortage the

[4] Especially across the states of Bahia, Rio Grande do Norte and Ceara. Furthermore, the high wind seasons coincide with low rainfall seasons, thereby providing a natural complementarity between the country's hydropower and wind resources.

[5] In 2001 when Brazil's first wind atlas was published, the country's wind power potential was estimated to be 143 GW at 50 meters.

[6] The Brazilian energy crisis prompted the former government of President Fernando Henrique Cardoso (1994-2002) to embark on a USD 5 billion countrywide "crash" construction programme that called for 55 gas-fired power plants totalling 22 GW (Ellsworth and Gibbs, 2004).

[7] In 1953, the energy sector was a monopoly operated by Petrobras. In 1975, the market was opened up to permit risk contracts with private sector operators. In 1997, Petrobras was partially privatised, and joint ventures with other companies were permitted (Mares, 2010).

[8] United Kingdom and Argentina.

[9] Brazil's electricity sector went through two major reforms. The first reform took place between 1995 and 2003. The second reform started in 2004 with the introduction of a long-term market (Oliveira, *et al.*, 2005).

grid operators' preference to dispatch hydro-electricity led to the reservoirs shrinking to dangerously low levels (Oliveira, *et al.*, 2005).

Lastly, although substantial hydropower potential remains, it is difficult to develop, as much of it is located in the eastern part of the country far away from load centres. In addition to this difficult situation, the national privatisation process had delayed investments in new generation plants and transmission.

This crisis highlighted the urgent need to diversify Brazil's energy mix to ensure security[7] of domestic energy supplies, and created opportunities and incentives for renewable energy sources.

Phase 1:

PROINFA programme – learning by doing (2002-2009)

Until the mid-nineties the Brazilian electricity sector was predominantly run as a public sector monopoly. In 1996, inspired by concurrent reforms in other countries[8], the Brazilian government implemented reforms to the electricity sector[9] and transformed it from a monopoly into a competitive market (Wanderley, Cullen and Tsamenyi, 2011).

Power sector reform started with the privatisation of distribution, followed by generation and transmission. In 2002, the provisions for diversifying the electricity generation matrix were the first step towards opening up the Brazilian market for the global wind industry.

The Programme of Incentives for Alternative Electricity Sources (PROINFA[10]) was passed in April 2002[11]. It was divided into two phases, and its scope extended to small hydropower plants, biomass and wind power.

For the first phase, a total capacity of 3 300 MW was assigned under a feed-in tariff scheme, distributed equally between wind power, biomass and small hydropower. The programme was seen to be especially important for wind energy, given the long history of support for both biomass and hydropower in Brazil.

This first phase, which had to be implemented before December 2008, included provisions for a fixed tariff, guaranteed grid access for all electricity produced over a period of 20 years, and distributed equally across all participating sources.

The first phase of the programme was based on a guaranteed 20-year power purchase agreement with Eletrobras[12] (utility) at a price set by the government[13]. The target for wind was revised upwards to 1 429 MW (Fiestas, 2011).

For the second phase[14], the programme set a target for new renewable energy sources to provide 10% of the country's annual power consumption within 20 years. This phase was due to come into force after the target capacity of 3 300 MW of the first phase had been met, which is yet to be implemented.

During the implementation of the first phase of PROINFA, several practical issues undermined the development of some of the alternative energy projects, which led to a slower than expected start of operations. These problems included:

- Complex and highly bureaucratic permitting process and procedures to obtain or renew environmental licences.
- Problems and delays in obtaining the Declaration of Public Utility (DUP) for projects[15].
- Difficulty in connecting to the grid, particularly in the

[10] Law 10,438 of 2002 of 26April 2002, as amended by Laws 10,762/03, and Law 11,943 of 28March, 2009 authorised the creation of PROINFA.

[11] Law No. 10,438 of 26 April 2002 set out the targets and timescales for PROINFA, as well as the mechanisms for assigning projects and determining the prices at which electricity will be sold.

[12] As of 2010 Eletrobrás owned and operated 38% of Brazil's installed capacity as well as the majority of the country's high-voltage transmission system (Schwieger, *et al.* (eds.), 2009).

[13] With floors or minimum purchase prices of 50%, 70% and 90% (for small hydro, biomass and wind farms respectively), of the average retail power price in the final 12 months, and where participation in the programme is via an Independent Power Producer, and provided that the nationalisation index for equipment and services is at least 60% in the first stage (GWEC, 2011).

[14] The price for electricity in the second phase will be equal to the weighted average cost of the generation from new hydropower plants with capacities greater than 30 MW and natural gas power stations (GWEC, 2011). The acquisition will be again made under a 20-year Power Purchase Agreement (PPA) with ELECTROBRAS, through annually scheduled purchases from each producer. New renewable energy sources would achieve a minimum annual increase in power output of 15% to be supplied to the consumer market.

central-west region.

» For the first phase of PROINFA, local content requirements (also known as "nationalisation índices") were set to 60% for equipment (calculated by weight) (Backwell, 2011). For example, the high local content requirement created a high demand for locally produced wind turbine towers, thereby creating an upward price pressure on Brazilian steel. The steel industry was dominated by a single supplier[16] which led to significantly higher costs in comparison to the option of using imported steel (Azau, Rose and Aubrey, 2011).

These early experiences led to repeated postponements of the deadlines set out in the original programme of action. In late 2008 the administrative barriers and lack of a clear long-term policy signal to support further wind power generation were strongly undermining the investments.

The global and local industry took coordinated action to identify bottlenecks and barriers to wind power development. The wind industry worked closely with the regulators to raise awareness about the technology during that time. In late 2009 the government launched the first specific electricity auction for wind power generation which resulted in over 1 800 MW being allocated.

This was the first in a series of auctions in which wind power was awarded large capacity allocations. These auctions spurred the development of the projects granted under the first phase. The rate of installations increased during the last two year of the PROINFA programme and led to the creation of a local supply chain.

Phase 2:

Introduction of auction systems (2009-2012)

Under this phase a reverse price auction (competitive bidding system) was introduced which constituted a marked change from the PROINFA programme. While PROINFA was implemented with the aim of diversifying the electricity mix, the auction model was aimed at efficiently and cost-effectively increasing energy security.

The first "wind only" auction was organised by the Brazilian Ministry of Mines and Energy (MME) in December 2009 (LER-2009[17]). The auction had a very positive impact on the development of wind power. Wind installations saw their fastest growth that year, attracting more than three times the investment they did in 2008[18]. The auction commercialised 1.8 GW of new projects[19] which are due to come online by the end of 2012 (UNEP, 2010).

In August 2010, the MME held further sets of auctions (LER-2010 and LFA 2010) in which wind power developers were allowed to participate and compete with a variety of energy sources, including conventional sources. The pressure to compete on costs with conventional sources might explain the high concentration of projects in the north-western region of Brazil where almost 80% of the awarded projects are located.

Under these auctions, specific measures were introduced for all power generation technologies. For wind, the 2009 auction prohibited the import of wind turbines with nominal capacity below 1.5 MW. The tenders held in 2010 (LFA-2010 and LER-2010) did not include such provisions, and no local content requirement was necessary to take part in the tender process.

The nationalisation index remains a stipulation to access funding from the Brazilian National Development Bank (BNDES), which comes at a lower cost. This funding requires additional conditions to be fulfilled, including meeting deadlines for implementation, and has resulted in a rapid expansion of the local supply chain. However, not all wind power projects in Brazil are financed by BNDES.

According to UNEP, investment in the wind sector took off in 2009, more than trebling to USD 2.2 billion. Brazil is increasingly financing projects in other developing

[15] This is a qualification that facilitates negotiations to use the assets and rights affected by the projects, in particular the land, which in many cases is affected by complicated terms of use and occupation, and disputes between owners and landholders that make it difficult to identify the property for the wind farm developer (GWEC, 2011).

[16] Belo Horizonte-based Usiminas, a former state-owned company privatised in the 1990s.

[17] With the exception of the first wind-only auction in 2009, the framework of regulated contractual arrangements for power generation capacity addresses a variety of technologies without distinction.

[18] Asset finance provided the majority of financial investment in Brazil at USD 7 billion (89% of the total), followed by venture capital and private equity. There was only a very small role for public market finance in 2009.

[19] First-time wind developers in Brazil under-priced natural gas-fired power projects. The average price for wind was USD 62/MWh while it was USD 65/MWhfor natural gas. These are the lowest tariffs being offered to wind generators on a market-wide basis globally, and below wholesale electricity prices in Latin American markets. However, the wind developers are required to supply energy at

countries, with USD 5 billion of government-subsidised debt pledged by BNDES to renewable energy projects in developing countries (UNEP, 2010).

The wind power industry and its supply chain have been firmly established, and offered a varied additional production capacity of over 1 000 MW per annum by 2010. Rising industrial investment will significantly increase this capacity, and the sector aims to implement a manufacturing base capable of producing between 2 GW and 2.5 GW of wind power equipment per year. As a result of its local content requirement Brazil saw an increasing number of manufacturers entering the wind power equipment supply chain. The Brazilian market also has excellent potential to become a manufacturing base for most of Latin America (GWEC, 2011).

The downward pressure on wind prices was maintained at the last A-5 auction[20] held in December 2011. The National Electric Energy Agency (ANEEL) contracted 42 new power plants worth 1 211 MW, including 39 wind projects totalling more than 976 MW or 80% of the total sales. In contrast to previous auctions, including those that took place in August 2011, this auction permitted project developers five years before they must connect to the grid. In this auction wind projects competed with hydroelectric and even large-scale thermoelectric projects (Spatuzza, 2012).

Brazil met the first phase target of the PROINFA programme of 1 429 MW of wind power in 2011. Over 94% of the current installed wind generation capacity was achieved through PROINFA projects, although the balance of the remaining 7 GW pipeline came from the auction process.

Unlike the PROINFA programme, the structure of the auction system set the eligibility criteria at such a level, that only serious players were able to compete for the tenders. The rigorousness of this system has given the industry confidence to move ahead, even with the very low prices of the winning bids.

CURRENT CHALLENGES

Some of the main challenges facing the wind industry in Brazil in the short term are directly related to the projected growth of the market. This growth phase will involve:

- Mobilising and securing greater financial resources for the project pipeline.
- Increasing the production capacity of the wind turbine industry, and adapting the technology to local wind regimes.
- Improving the energy infrastructure through technological innovation.
- Adapting certification standards to Brazilian conditions.
- Training more local manpower for wind farm development, operations and project management.

Currently, the potential for wind power development is limited to the wind capacity allocated through the auctions. The low prices accepted in recent tenders[21] and the lack of specific long-term policy support (e.g., through 2020 or 2030 targets for wind) could potentially slow down the pace of development.

Even though Brazil has dispensed with the local content requirement it still has a high import tariff on foreign wind turbines. This has encouraged companies to open local manufacturing operations in the country, which has to some extent helped to reduce the project development costs.

However, the taxes and procedures for environmental impact assessments are causing delays for new projects. While the latest projects reflect significant downward price pressure, they remain to be financed and built. There is uncertainty about the ability of bid-winners to operate wind farms under such low-priced contracts.

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lower costs that would allow their investors to earn the necessary returns. To achieve those returns, nearly half of these new projects will have to operate at considerably higher efficiencies or lower cost than has been seen in other parts of the world. For most of these projects to become viable by current standards, turbine costs would have to fall by 15% in Brazil to USD 1.2/W, or 10% below the 2011 global average (Oliveira, 2011).

[20] This auction was significant as it was the first time the government allowed wind projects to participate in a tender – known as the A-5 – which was previously designed for bigger projects that need longer construction periods, compared to the 18-month-average for wind farms. Wind projects competed with hydroelectric and even large-scale thermoelectric projects. This A-5 energy auction saw average wind prices of BRL 105/MWh (approximately USD 62.9/MWh) up 5.5% from the record lows of the previous auction (in August 2011).

[21] Wind power was the largest contributor of new power capacity contracted at Brazil's two power auctions in mid-August 2011. Out of a total of 3.9 GW of contracted projects, 1 928.8 MW were allocated to wind energy projects in the A-3 and Reserve auctions. The overall prices achieved at the auctions were considerably lower than in previous processes in 2009 and 2010, at BRL 99.8/MWh (approx USD 59.8/MWh). The new contracts increased the pipeline of wind energy projects under construction to 5 175 MW in addition to the 1 120 MW in operation in 55 wind farms (Fiestas, 2011).

Grid access is a challenge for wind power in Brazil. Additional investments in the transmission grid would allow wind farms to be effectively connected to the power grid and to transport the electricity generated to the demand centres[22].

Under price pressure, the developments focus on the most economically feasible sites. The average capacity factor seen from the reserve energy tender (LER 2010) is as high as 50%, which is twice the average capacity factor for wind projects in Europe. This has led to a high concentration of the projects in a limited number of locations, increasing challenges for both the technology and grid integration.

Since wind energy is a relatively recent technology in the country, there is limited awareness about the industry. According to industry representatives, the project developers need to play an educational role towards ensuring buy-in from local communities[23].

Today, Brazil has a robust pipeline of wind energy projects, which is attracting large investments to the sector. The annual wind market could reach 2 000 MW per year. In addition there is an oversupply of wind turbines on the international wind market, which has contributed to lower costs for the projects.

CONCLUSION

Brazil has a long history of promoting indigenous sources of energy (initially bio-ethanol and hydropower). When a prolonged drought brought on the country's energy crisis of 2002, the government looked towards diversifying Brazil's predominantly hydropower-based generation capacity by promoting more bio-energy, small hydro and wind, through the PROINFA model.

The PROINFA programme was the first attempt to diversify the energy mix. The programme was developed in 2002, and implemented in 2004. PROINFA was a well-designed support mechanism. The programme provided a limited overall outlook for wind power development (1 429 MW by 2008), and encountered significant administrative barriers during its implementation phase. The lack of long-term targets for wind energy was seen as a major obstacle for faster development and attracting large renewable energy investors. The wind energy target for 2008 was only reached in 2011, which indicates that the eligibility criteria were not sufficient to attract local industry and major market players early on.

From 2007 through 2009 the reform of PROINFA was debated, due to its limited outcomes for wind power, and a number of legislative proposals were made at both state and federal level. The successful outcome of the first wind-only auction in December 2009 increased the opportunities for wind power in Brazil. While auctions were not an ideal solution from the industry's point of view, a number of factors contributed to their success:

- Improvements in wind energy technology and strong competition from new Asian manufacturers had driven down costs. The last decade saw an oversupply of wind turbines on the global markets.
- Due to the financial crisis, a manufacturing surplus was available on the global market, which made manufacturers and developers explore new markets, including Brazil which was seen as having a large potential.
- The national economy was growing, contributing to rising electricity demand.
- Brazil was seen as a potential manufacturing "centre" to supply other South American markets.
- The country's wind resources are extremely large, with capacity factors twice as high as the European average.

Six more auctions have been organised. A large number of major international players have established manufacturing and assembly facilities in Brazil, and the country now has a project pipeline of 7 000 MW up to 2016, and may reach 15 000 MW by 2020.

The regulated auctions for wind projects have to some extent helped in providing a solution for securing a continued investment stream for new projects. The conditions of the auction system, which included financial penalties for

[22] The Brazilian wind power sector advocates for the reinforcement of the grid infrastructure in the north-east region, via a transmission line running parallel to the coast. The line would connect São Luís and Recife, and would also benefit Ceará, Rio Grande do Norte and Paraíba.

[23] Recent projects have provided schools with computer lessons, built roads, refurbished a church and provided a doctor two days a week to communities – tangible improvements to the social welfare of isolated settlements. Companies such as Suzlon are increasingly running education programmes in the municipal schools close to the wind farms, providing information on the farms and wind technology (Azau, Rose and Aubrey, 2011).

avoiding speculators and unviable projects, have improved the attractiveness of the wind energy market.

However, the electricity prices awarded to wind projects reduced dramatically in the last five years due to the direct competition with conventional energy sources. The commercial margins are low across the entire value chain, and the tariffs are half their value under PROINFA.

Overall the current auction system is not ideal from the industry's point of view. The industry lacks market stability and long-term visibility on market volumes. However, Brazil is one of the fastest-growing economies in the world today with the potential for large growth for in the wind energy market. International manufacturers such as Enercon (Wobben) have been established in the country for a long period, but the market has recently attracted other large manufacturing companies such as IMPSA, Vestas, Gamesa, GE, Suzlon, Siemens, Alstom, LM and Sinovel.

Brazil's unique geography and wind resource represent an excellent opportunity for wind energy. The latest energy auction showed that wind projects can compete successfully with hydropower. An increasing number of large domestic and foreign players are committed to developing the Brazilian market, which increases the confidence of investors, and increases trust in the successful development of proposed projects. However, several policy elements could be improved, in order to sustain the growth of the industry over the long term:

- Clear and long-term targets for wind energy.
- Clear and long-term regulatory framework for wind.
- Planning permissions provided within a given timeframe.
- Permitting and siting procedures may be streamlined further.
- Despite Brazil's extensive national grid, adequate provision would be required to meet the auction requirements and enable large injections of wind power in several locations (especially Ceara, Rio Grande do Norte, Bahia, and Rio Grande do Sul).

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ANALYSIS OF ENABLING CONDITIONS FOR WIND ENERGY

Effective rule of law and transparency in administrative and permitting processes	The processes are clear and well defined. However there is a critical need for a common framework for wind farm approvals across the Brazilian states.
A clear and effective pricing structure	Power purchase agreements for 39 projects were awarded for 20 years during the latest 2011 A-5 auction, at BRL 105/MWh (approximately USD 62.9/MWh).
Provisions for access to the grid (incentives & penalties for grid operators)	EPE is responsible for ensuring the connection of the wind projects selected through the auctioning process.
An industrial development strategy	Not Applicable
A functioning finance sector	The Brazilian Development Bank is one of the largest lenders for renewable energy projects worldwide.
Expression of political commitment from government (e.g. targets)	A national long-term target for wind energy is desirable for ensuring robust growth of Brazil's emerging wind sector.
A government and/or industry-led strategy for public and community buy-in.	Not Applicable
An employment development strategy	Not Applicable
NOTE	**Brazil has some of the best wind resource worldwide. The current auction system is not ideal from the industry's point of view. The industry lacks market stability and long-term visibility on market volumes. However, Brazil is a large market with a potential for growth for wind energy. It is also one of the fastest-growing economies in the world today. A large number of major international players have established manufacturing and assembly facilities in Brazil, and the country has a project pipeline of 7 000 MW until 2016, which may reach 15 000 MW by 2020.**

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