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Experience with auctions for wind power in Brazil

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ABSTRACT

In an international context, auctions are becoming increasingly common as a support scheme for renewable energies. In this case study, we analyze the Brazilian experience with wind power in the period from 2009 to 2015 with regard to the development of auction prices, rates of completion and market concentration.

Inflation-adjusted auction prices in Brazil decreased by 54% until the end of 2012, before subsequently growing again to 87% of the first round price. The declines in prices can be attributed to the increasing experience of actors and the increasing level of competition among project developers, investors and turbine manufacturers. Various factors played a role in the price increase, including both regulatory changes such as a modification of grid connection terms, as well as external factors such as the falling value of the Brazilian real against the US dollar.

Only 14% of wind projects from the first eight auction rounds were completed on schedule. The reasons cited for this include delayed grid connections, delays resulting from environmental feasibility permits, supply bottlenecks for wind power plants, the bankruptcy of the turbine manufacturer IMPSA or delayed financing approval by the Brazilian development bank BNDES. However, the number of project cancellations is low to date, so that a final rate of completion of between 89% and 98% is likely to be achieved.

The number of owners of wind power projects has increased from 16 to 49 actors. The market share of the five largest owners has declined from nearly 60% to 37%. The ratio of pre-qualified to awarded capacity was consistently at over five, and the Herfindahl Index suggests an unconcentrated market. These findings indicate that the level of competition is sufficient to ensure free price formation in the market.

The owners are primarily large, financially strong project planners, energy providers or investment firms.

1. Background and motivation

The international trend towards using energy auctions to determine the remuneration rates for renewable energies has prompted us to use case studies to examine how the support scheme is used in various countries around the world. We are in particular interested in the questions of how the auction prices have developed, whether the contracted projects have been completed within the respective deadlines, and which actors own renewable energies in the countries examined.

Only 25 countries in the world expanded wind power by more than 200 MW annually in 2013 or 2014 (see Annex F). Of these 25 countries, only eight utilized tenders as a national support scheme for wind energy. Among this group, Brazil plays a particular role. In 2013 and 2014, the country experienced the largest expansion of wind power. With a total of 15 auction rounds, Brazil looks back on a relatively long history of wind power auctions; in eight of the auction rounds, the completion deadlines have already expired.

There is a wide range of literature on the topic of tenders for wind power in Brazil. In recent years, numerous authors, including [1–5], have analyzed the Brazilian system of tenders for wind power. In addition, a number of combined studies have been published, which also contain case studies on Brazil [6–13]. Despite the extensive literature on the subject, recent experiences have not been systematically evaluated, and the existing literature does not include relevant analyses. For example, the development of auction prices is not described in a country-specific context, there are no analyses of the implementation process and no evaluations of ownership structures and market concentration have been carried out. With this publication, we aim to fill these gaps.

In addition to country-specific literature, a few articles consolidate the practical experience of tender schemes in different countries and

Abbreviations: ANEEL, Agência Nacional de Energia Elétrica (Brazilian energy agency); BRL, Brazilian real; CCEE, Câmera de Comercialização de Energia Eléctrica (Brazilian energy trading agency); Eletrobras, Centrais Elétricas Brasileiras (company that owns wind farms in Brazil); IBGE, Instituto Brasileiro de Geografia e Estatística (Brazilian Institute of Geography and Statistics); MW, Megawatt; MWh, Megawatt hour; PROINFA, Programa de Incentivo a Fontes Alternativas de Energia Elétrica (program to promote renewable energy sources); USD, US dollar

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draw general conclusions about the effectiveness and efficiency of auctions for renewable energies [9,14]. Del Rio et al. [14] and Elizondo Azuela et al. [9] conclude that auctions lead to a reduction of the support level. Del Rio et al. state that the experience in Brazil, Peru, Portugal, Uruguay, and the United Kingdom supports that thesis. Additionally, del Rio et al. [14] and Elizondo Azuela et al. [9] come to the conclusion that auctions for renewables tend to have low implementation rates in practice. Del Rio et al. mention the experience of Brazil, Ireland, France, Nova Scotia (Canada), Peru, Portugal, and the United Kingdom as examples. However, del Rio et al. [14] and Elizondo Azuela et al. [9] also highlight that low implementation rates could be mitigated by additional measures. Brazil is an interesting case with which to test these hypotheses, since it looks back on a relatively long history of wind power auctions compared to other countries.

2. Structure and methodology

In this case study, we will analyze the Brazilian experience with auctions for wind power. The study is structured around the three analysis criteria “development of auction prices,” “rates of completion,” and “market concentration.”

2.1. Auction prices

For the evaluation of the auction prices of an auction round, the results of the auction (pay-as-bid) were weighted according to the volume awarded. Auction prices are shown in Brazilian real as a nominal and an inflation-adjusted value. The auction prices are also converted to US dollars based on the monthly exchange rate at the time of the auction. Inflation adjustment is based on the Brazilian producer price index C27 “manufacturing of electrical machines and equipment.” The auction results come from the publications of the Brazilian energy trading agency CEEE[1] [15], the inflation index from the database of the Brazilian Institute for Geography and Statistics IBGE[2] [16].

Our calculation of potential causes driving the development of the price of winning bids was based on information from expert interviews and secondary literature. Based on the topical nature of the subject, we have also included non-academic literature (e.g. trade journals, newspaper articles) and statements made by relevant stakeholders in the category of secondary literature. The aim of this research was to discover signs of legislative changes and changes in the framework conditions that could have a potential impact on the costs of wind power projects and thus on auction prices. With regard to stakeholder statements and the non-academic secondary literature, we always cited numerous sources in order to provide additional support for the respective claims. Furthermore, whenever possible, the plausibility of statements was verified using additional publicly available data.

The analysis of the criteria “cost development” took into account all 15 auction rounds from December 2009 to August 2015 in which the participation of wind power was permitted.

2.2. Rate of completion

For the evaluation of the rate of completion, the respective implementation status of the projects (commercial operations/construction phase/planning phase) was analyzed. The status of network expansion and the assessment of the Brazilian energy agency ANEEL[3] were also taken into account. The status of the wind projects and the status of network expansion come from the databases and publications of the Brazilian energy agency ANEEL [17,18], as well as the Brazilian energy trading agency CCEE [15].

The analysis of the rate of completion took into account all eight auction rounds in which the implementation deadline had expired by January 2016 at the latest.

2.3. Market concentration

In the chapter on market concentration, we analyze the ownership structure of Brazilian wind farms. For this we use the indicators “cumulative number of owners,” “market share of the five largest owners” and “Herfindahl Index.”

The basis for all three indicators is the clear definition of an owner and the designation of an owner to each wind farm that is awarded a power purchase agreement. The selected owner of a wind farm is not an insignificant factor, for behind each direct owner (e.g. a project company) there can be a number of parent companies and shareholders. When calculating the indicators, it is not the project companies but rather the investors behind them that are relevant, as they are the actors who effectively determine the bidding strategy.

The primary data on the ownership structure comes from the Brazilian energy agency ANEEL (status: April 2016), which publishes information on the ownership structure of the respective wind farm. The procedure for selecting the owner of the wind farm is essentially the following: If the 1st level company is a project company, the 2nd level majority shareholder is selected. If the 2nd level majority shareholder of the respective company is a holding company,[4] the 3rd level majority shareholder is taken into account for the analysis. In an additional step, we examined the financial interpendencies between the owners that were identified. The precise procedure is described in Annex A.

For the analysis of the market concentration, we use several indicators. The indicator “market share of the five largest owners” shows how the influence of the largest companies has developed – whether for example the largest companies were able continue to expand their influence or not. In addition, the indicator “cumulative number of owners” shows whether market conditions are sufficiently attractive for the market entry of new actors or whether there are indications of barriers to market entry. We also analyze the Herfindahl Index. In mathematical terms, the Herfindahl Index is calculated by adding the squared market share of each owner [19]:

$$\text{Herfindahl Index} = \text{market share}_1^2 + \text{market share}_2^2 + \ldots + \text{market share}_n^2$$

Compared to the indicator “cumulative number of owners,” the Herfindahl Index takes into consideration the market shares of all actors and not only a predefined set of the largest companies. Furthermore, based on [19], the Herfindahl Index allows for the following interpretations: A value below 0.1 suggests that the market is unconcentrated, a value between 0.1 and 0.18 can be characterized as moderately concentrated and a value above 0.18 suggests that the market is highly concentrated.

3. Tenders and other business models for wind energy in Brazil

3.1. Business models for wind energy

In a global comparison, Brazil is considered to be one of the world's rapidly emerging economies. As a result of an economic growth rate averaging 3.8% per year in the period from 2003 to 2012, electricity production increased by 4.8% per year [20,21]. The increase in electricity generation occurred primarily through hydropower, which in 2012 accounted for 75% of the Brazilian electricity mix [20]. Wind

[1] CCEE stands for “Câmera de Comercialização de Energia Eléctrica”.
[2] IBGE stands for “Instituto Brasileiro de Geografia e Estatística”.
[3] ANEEL stands for “Agência nacional de energia eléctrica”.

[4] In Brazil, the individual project companies of a wind farm can be combined under one holding company.