

Framework Assessment for the Photovoltaic Business Opportunities in Brazil

Developed by:

**BSW-Solar
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To:

**Agência de Cooperação
Técnica Alemã – GIZ
Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH**

Berlin, 31st of July 2014



Implemented by:

giz Deutsche Gesellschaft
für Internationale
Zusammenarbeit (GIZ) GmbH



Framework Assessment for the Photovoltaic Business Opportunities in Brazil

Study about the solar market and business environment for installing solar PV systems in Brazil

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Developed for: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Project: PROFREE II, GIZ Brazil

Program No.: 12.2478.1-001.00

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Berlin, 31 July 2014

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Description of the Project

Solar PV is about to reach grid parity in most countries located close to the equator. At the same time more and more governments allow and promote both large-scale and decentralized grid-connected PV applications.

The project ENABLING PV aims at contributing to the sustainable deployment of solar PV in Brazil by exploring the new potential within the ANEEL Resolution 482/2012 (RN 482/2012), which for the first time established a compensation scheme (net metering) for distributed generation, as well as by analyzing the energy auctions for large size systems. The compensation scheme was introduced in 2012 and a specific solar PV auction at national level was announced in mid-2014, enabling new business models and the possibility to reduce consumer electricity bills by using electricity produced on-site.

To this end, this first report describes the legal and administrative framework of the above-mentioned policy options, creating a favorable business environment for installing solar PV systems in Brazil.

This project also aims at strengthening cooperation and knowledge transfer between relevant stakeholders and international investors in Brazil and Germany.

1. Energy Matrix and Deployment of Solar PV in Brazil

1.1. Overall Market Profile

Brazil has experienced an impressive economic and demographic growth in the past decades. This growth is expected to continue in the next years, impacting on electricity consumption rates. The PDE 2022, the ten-year energy plan published by the government, estimates that electricity consumption (excluding self-consumption) will grow from 466,5 TWh in 2013 to 672 TWh in 2022 (PDE 2022, 2013:42), requiring investments on the diversification of the energy matrix and driving the utilization of the high potential for renewable energies.

The electricity tariff is calculated considering acquisition costs, costs for the use of the transmission and distribution systems, as well as technical losses, and taxes and charges. The tariff also varies depending on the geographic area and the distribution company. For example, the tariff for the residential sector varied in 2013 from R\$ 22ct/kWh (approx. 7€ct/kWh) to R\$ 52ct/kWh (approx. 17€ct/kWh) (ANEEL, 2013). For the industry sector, the tariff in 2014 varies from R\$ 15ct/kWh (approx. 5€ct/kWh) to R\$ 44ct/kWh (approx. 14€ct/kWh). The Federation of Industries of the State of Rio de Janeiro (FIRJAN) estimates that approximately 35% of the electricity tariff for the industry sector is composed of taxes and other charges (FIRJAN, 2014).

1.2. Share of Renewable Energy Sources

According to the Brazilian National Agency of Electric Energy (ANEEL), the country's total installed generation capacity is around 130 GW (ANEEL, 2014a, as of 20 August 2014). Brazil has vast hydro-electric resources and accounts for more than 60 hydro-electric facilities with installed capacities of at least 100 MW. Twenty-three of these facilities have installed capacities greater than 1,000 MW. Together with Paraguay, Brazil operates by some measures the world's

second largest hydro-electricity complex, the Itaipu facility on the Paraná River, with a capacity of 14,000 MW. The remaining electricity generated in Brazil comes mostly from coal and gas-fired thermoelectric plants (REEEP Policy Database). This centralized energy system with a strong dependency in one energy source in high transmission losses is the vulnerable point of the Brazilian energy market. As of February 2014, reservoir levels in the Southeast and Central West regions of the country were at roughly half expected levels for the time of year, resulting in 6,260 MW of additional thermal capacity that had to be activated for permanent production even outside peak hours (REEEP Policy Database). Consequently, the higher production costs of those peak-load generation plants resulted in an increase of average electricity generation costs. Subsequently, Brazil faces the need to diversify its electricity supply and to follow a more decentralized approach in energy production.

Installed Capacity in 2012

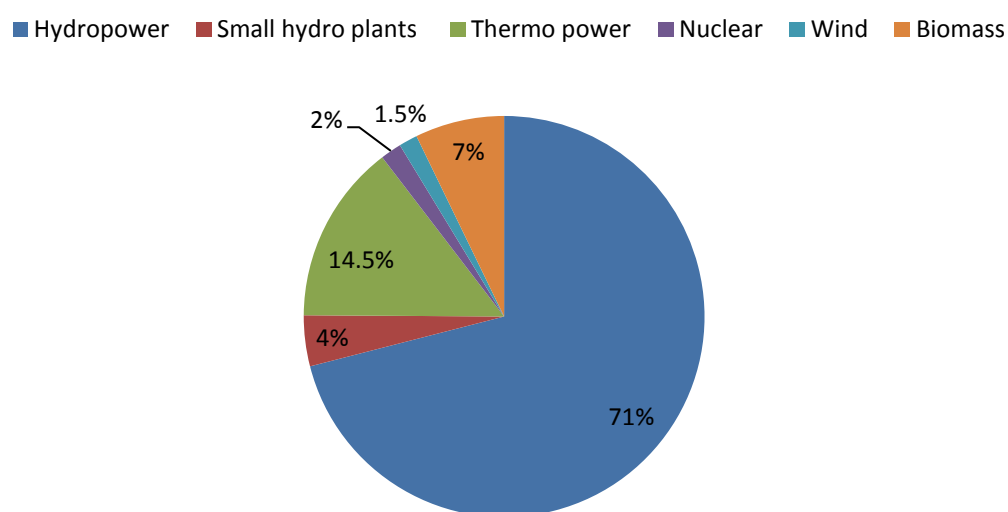


Figure 1: Installed capacity in 2012. Source: PDE 2022, 2013:100.

In the next years, approximately 36 GW resulting from hydro, thermo, wind and solar projects currently under construction and already authorized are expected to be added to the system (ANEEL, 2014a). Hydro plays a central role in the electricity system, accounting for more than 87 GW. Nonetheless, the participation of wind, biomass and solar has increased in the past years through national policies and programs supporting the diversification of the energy

system, such as the programs "PROINFA" and "Light for All" (*Luz para Todos*) created in the early 2000s.

The PROINFA¹ (Program of Incentives for Alternative Electricity Sources) was established in 2002 to support the electricity generated by wind, biomass, and small hydro installations and with the goal to equally increase their participation, achieving a total of 3.3 GW new installed capacity². Due to its design and local content rules, the program drove the development of the wind industry in the country. Furthermore, it is estimated that the program created 150 thousand new jobs (PROINFA, 2014).

The program "Light for All" started in 2003 with the goal of bringing electricity to 10 million people in rural areas³. The initial target was achieved in 2009 and the government estimates that 439.000 new jobs were created. The program has been extended and supports individual generation systems and systems with decentralized generation (e.g. among others, solar PV) in remote areas (PLT, 2014).

It is true that PV installations so far have played a minor role in terms of installed capacity in Brazil. There are currently 164 operating projects, totaling 12.287 kW (ANEEL, 2014a, as of 20 August 2014). Considering the country's advantageous solar irradiation conditions (up to 2.400 kWh/m²/year), solar is still an underrepresented energy form in the overall energy mix.

However, according to the Brazilian Energy Research Company (EPE), despite no binding target in the national energy strategy, the perspectives for an increase of the participation of solar energy in the next years are positive and specific energy auctions⁴ might act as a booster for the development of the technology and the industry in the country. This perspective is also shared among project developers working in the field, considering the dynamics of the market.

¹ For more details on PROINFA see Law 10.438/2002 and Decree 5.025/2004.

² According to Eletrobras, the state company responsible for trading the power generated by installations under the program for the first period of 20 years, 119 projects, totaling 2.6 GW, were implemented by December 2011.

³ For details on the new phase (2011-2014) of the Luz para Todos program see Decree 7.520/11.

⁴ The Brazilian Ministry of Mines and Energy (MME) published on 6 June 2014 the guidelines for another energy auction and it will be the first time that solar PV will not compete with other technologies, such as wind and biomass. For more details see section 2.

1.3. Regulatory Framework

The main regulatory framework of the electricity sector in Brazil changed after the energy crises in 2001-2002 and a new model to attract long-term private investments was introduced by Law 10.848 of 15 March 2004. This new model mainly focuses on energy auctions organised by the federal government to buy electricity and to ensure that the energy demand of distribution companies is fulfilled.

In addition to Law 10.848/04, Decree 5.163 of 30 July 2004 and its amendments⁵ detailed the main rules for the generation and sale of electricity. In Brazil, it is possible to sell electricity under the regulated market, known as ACR (*Ambiente de Contratação Regulada*) and composed by producers and distributors of energy, as well as under the free market, known as ACL (*Ambiente de Contratação Livre*) and composed by producers, distributors, and free consumers⁶. This study focuses on the framework of the regulated market.

1.4. Institutional Framework

In terms of formulation of national policies and guidelines, the National Council of Energy Policy (CNPE) works at a macro level and advises the president whereas the Ministry of Mines and Energy (MME) is responsible for planning, monitoring and implementing policies, being the competent authority to set guidelines and grant concessions in the energy sector. Working closely with the Ministry, the Monitoring Committee of the Electricity Sector (CMSE), the National Energy Agency (ANEEL), and the Energy Research Company (EPE) play important roles in the energy sector. The CMSE monitors the continuity and security of electricity supply, ANEEL is a federal agency regulating and supervising activities in the electricity sector and in charge of promoting the energy auctions whereas EPE supports the government with the planning and

⁵ Decree 5.163/04 has been amended a few times and amendments related to energy generated from renewable sources were mainly introduced by Decree 6.048 of 27 February 2007.

⁶ Free consumers are defined by Arts. 15 and 16 of Law 9.074 of 7 July 1995 and shall have a consumption $\geq 3\text{MW}$.

implementation of policies and is in charge of assessing trends in energy supply and demand (ABRADEE, M2).

Finally, the National System Operator (ONS) coordinates the Brazilian National Interconnected System - SIN (i.e. generation, distribution and transmission agents⁷) and the Electric Energy Trading Chamber (CCEE) conducts the energy auctions for buying and selling energy and manages the contracts under the free and the regulated markets (Araujo *et. al.*, 2013).

1.5. Current Market for Solar PV in Brazil

Up to the year 2012, the use of photovoltaics in Brazil has encompassed mainly small-scale isolated systems in areas without connection to the national transmission network (SIN). Although there are no official figures for the off-grid PV segment, the Brazilian Solar Industry Association's (ABSOLAR) Executive Director Rodrigo Lopes Sauer estimates approximately 30 MW of cumulative off-grid PV capacity currently installed in Brazil. The off-grid market growth has been steady during the last decade, mainly due to the aforementioned "Light for All" program and its predecessors. Even after this program will be finished, which is expected to happen in 2014, there will still be some demand for off-grid PV systems, especially in the northern regions of the country, replacing or complementing the fossil fuel-based generation at remote locations that are not directly connected to the national integrated electric grid. In addition, there are also auctions to purchase electricity from isolated systems based on the provisions of MME Ordinance 600/2010 and ANEEL Resolution 1.733 of 20 May 2014⁸.

According to the numbers presented by ANEEL at the seminar "Energia + Limpa 2014"⁹ and as shown in figures 2 and 3, as of April 2014, there were 120 solar PV systems installed under the new net metering scheme, with a total installed peak capacity of 1.99 MWp, resulting in an average size of 16.6 kWp per installation. Several studies had already announced the possible economic

⁷ There are 77 transmission system operators and 63 distribution system operators in Brazil (Abradee).

⁸ For further information see:

http://www.aneel.gov.br/aplicacoes/editais_geracao/documentos_editais.cfm?IdProgramaEdital=130#

⁹ The Seminar was organised by the Ideal Institute in May 2014 in the city of Florianópolis, Brazil.

viability of PV systems in the Brazilian residential sector before the introduction of the net metering regulation (Holdermann et al. 2013).

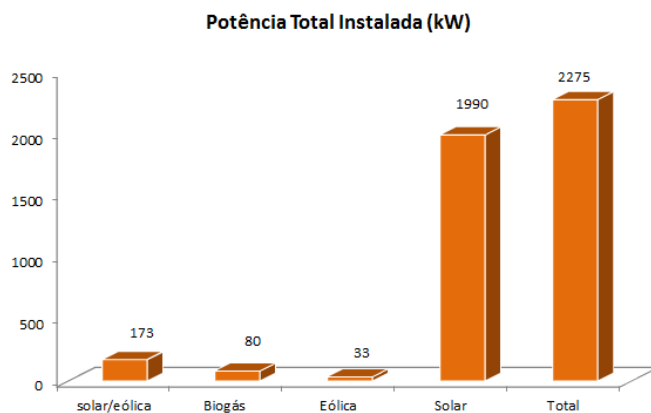


Figure 2: Total installed power under the net metering scheme in Brazil. Source: ANEEL, 2014

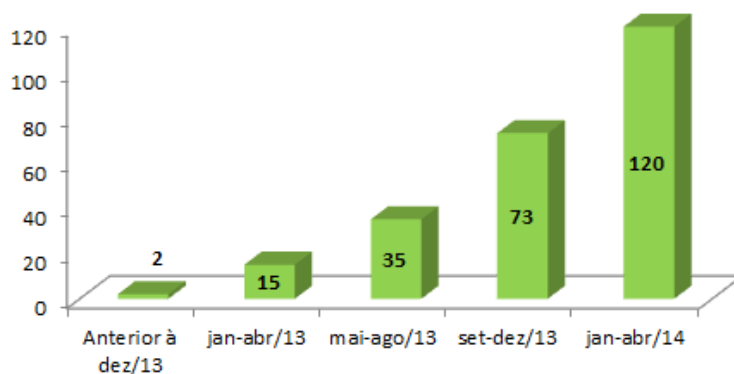


Figure 3: Number of accumulated PV-connections under the net metering scheme in Brazil. Source: ANEEL 2014

According to EPE, distributed rooftop solar power generation is already competitive with traditional electricity sources in some areas of the country (EPE, 2012). With the introduction of the net metering by ANEEL Resolution 482 in 2012, the outlook for small-scale PV systems is relatively positive. Based on the new regulation and as shown in figure 4, EPE is forecasting up to 1432.2 MW of cumulative installed capacity by 2022 (Preiser et al. 2014). As mentioned before, specific energy auctions¹⁰ might act as a booster for the development of

¹⁰ The Brazilian Ministry of Mines and Energy (MME) published on 6 June 2014 the guidelines for another energy auction and it will be the first time that solar PV will not compete with other technologies, such as wind and biomass. For more details see section 2.

the technology and the industry in the country, especially with respect to the segment of large-scale ground-mounted PV systems.

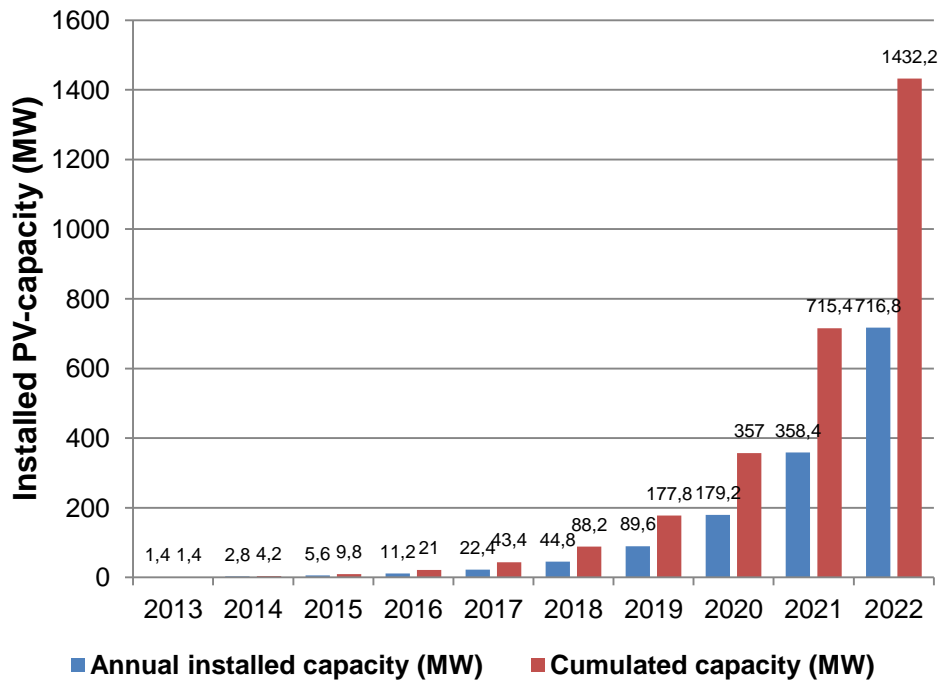


Figure 4: EPE Market projections for PV capacity installed under the Net-Metering Scheme in Brazil. Source: Preiser et al. 2014

2. PV Business Models for PV Enabling Policy Options

2.1. Energy Auction System - National Level

2.1.1. Main Description

Energy auctions are currently the main procurement mechanism used to acquire electricity in the regulated market in Brazil. Auctions offer the opportunity to explore an energy potential through a long term agreement, usually 20 to 30 years, which might vary depending on the source. With regards to parts involved and broadly describing their roles, distribution companies have a demand for energy, the government sets the guidelines and supervises the bidding procedure, and generation agents offer a certain amount of electricity.

The features of the auctions slightly vary depending on whether existing installations or new ones are target. Auctions for existing installations (*Leilão de Energia Existente*) aim at buying energy generated by power plants already under operation, which shall deliver the contracted electricity in the same or subsequent year of the auction. For these installations, the investments have already been amortized and the maximum price set by the government (i.e. the Ministry of Mines and Energy) to start the auction is usually lower than the price set for new installations.

Auctions for new installations (*Leilão de Energia Nova*) aim at buying energy from power plants that will be built and deliver the contracted electricity within 3 to 5 years. For these installations, the maximum price set by the government to start the auction is usually higher.

In addition, auctions can also be used to adjust the system in case of differences between the forecast made by distribution companies and demand (*Leilão de Ajuste*), as well as to contract surplus of energy and reinsure continuity of supply (*Leilão de Reserva*) or have a focus on renewable sources (*Leilão de Fontes Alternativas*). In general, auctions are technology-neutral, but they might be divided in sections with selected sources competing among each

other (e.g. wind, solar and biomass) or they can be technology-specific, meaning that only projects from the same technology will compete with each other. So far, only one technology-specific auction for solar has taken place in Brazil (in the State of Pernambuco). Nonetheless, a technology-specific auction with solar not competing with other technologies has been scheduled at the federal level to take place on October 31st 2014. For this auction, 400 solar projects requested their registration at EPE, totaling more than 10GW (EPE, 2014d). In addition, at the state level, it has also been reported that the State of Minas Gerais is planning to launch a specific tender for solar in late 2014¹¹.

2.1.2. Regulatory Framework

As mentioned in the beginning, the trade of electricity between parts of the Brazilian National Interconnected System (SIN) is mainly regulated by Law 10.848/04 and Decree 5.163/04 and its amendments.

In addition, the Ministry of Mines and Energy has the competence granted by Art. 87 of the Federal Constitution to issue supplementary instructions to achieve the provisions of laws, decrees and regulations. In the context of energy auctions, MME Ordinance 21 of 18 January 2008¹² set important provisions related to the registration procedure for energy auctions. In addition, MME Ordinance 236 of 30 May 2014¹³ is of especial relevance for solar PV generation projects as it set the rules for the first energy auction at national level with solar PV not competing with other renewable sources and will be referred to in this report as the "Solar-Auction".

Besides the Ministry, the energy agency ANEEL has the competence to issue supplementary rules for the implementation of the provisions mentioned in Decree 5.163/04 (Art. 75 Decree 5.163/04). In fact, ANEEL is responsible for preparing the auction notice document (*Editais de Leilão*) and the corresponding contracts for the purchase and sale of electricity (Art. 20 Decree 5.163/04) that

¹¹ The rules for the tender have not been published yet, but it has been reported in the press that the installation will have to be located in the state (Lagôa, 2014).

¹² Ordinance 21/08 repealed Ordinance 328/05, which had standardized the procedures to register at ANEEL and at EPE in order to take part in auctions.

¹³ MME Ordinance 236 of 30 May 2014 was amended by MME Ordinance 320 of 9 July 2014, which postponed the date of the auction from October 10th to October 31st, 2014.

are signed after the bidding process is completed. The Energy Research Company (EPE) also plays an important role in the auction system in the assessment and registration of technical projects as summarized below.

2.1.3. Main Stages for Project Development

a. Administrative and Technical Registration (*Habilitação Técnica*)

In order to participate in the energy auctions, all projects - including new ones and expansion of older installations - have to firstly be registered at ANEEL, which has up to 30 days to issue the registration certificate. This certification allows the project developer to request relevant licenses (e.g. environmental permit) from federal, state and municipal agencies (Articles 1 to 3 MME Ordinance 21/08).

In the sequence, once the ordinance regulating an energy auction is published in the official journal (i.e. *Diário Oficial da União*), a period is set (usually 1 month¹⁴) for entrepreneurs to require the registration for their projects at EPE, which will conduct a technical evaluation of the project. In the auction scheduled to take place on October 31st, 2014 (*Leilão de Energia de Reserva*), it will be the first time at national level that solar will not compete with other technologies.

A detailed list of documents that need to be submitted to EPE when requesting for the registration of the project is provided in Article 5 of MME Ordinance 21/08, which includes, among others, the proof of right to use the project site, permission to access distribution and transmission networks, and environmental permits.

In case of solar projects, it is also necessary to present a certificate of solarimetric data and a certificate of annual energy production (*Certificação de Produção Anual de Energia*), which estimates the average generation of the PV installation in a certain period. Both certificates shall be issued by an independent certifying company, which cannot be a shareholder or be involved



¹⁴ This period can be extended and exceptions might apply and a few documents might be accepted for evaluation even when handed after the initial deadline for registration. See Art. 5^o, § 4^o MME Ordinance 21/08.

in the development of the project. Additionally, this certifying company and its staff members¹⁵ have to be registered at the Federal Council of Engineering and Architecture (CREA). In addition, procedures and calculation method for the certificates must comply with national and international standards (EPE, 2014c).

According to project developers, EPE conducts a carefully assessment of project proposals. Initially, the main issues faced by the analysts from EPE when analysing project proposals were related with no compliance with the proof of land right and the lack of technical quality of the project. For solar projects, so far EPE has not required a history of continuous measurements of global horizontal and direct normal irradiation at the project site. However, from 2016 onwards measurements for at least twelve consecutive months will have to be handed in order to register a project (Art. 6-B MME Ordinance 21/08).

During the registration procedure, EPE can notify the agent to correct incomplete documents, disqualifying the project if the problem is not solved within the stipulated time period. The project can also be disqualified with a written justification if it does not meet the technical requirements. EPE can also require additional information. After the registration procedure is completed, EPE sends a list of enabled projects and the calculation of the marginal cost reference for the auction to the Ministry of Mines and Energy (Articles. 7 to 13 MME Ordinance 21/08).

In sum, the administrative and technical registration for an energy tender usually consists of the following steps:

REQUEST FOR REGISTRATION AT ANEEL	RES-E producer requests for registration at the National Agency for Electric Energy (ANEEL) prior to participating in an energy auction
	
REGISTRATION CERTIFICATE ISSUED	ANEEL has up to 30 days to issue a certificate
	

¹⁵ The responsible staff members need to be qualified and have the required certification to perform their activities, as for example the ART (*Anotação de Responsabilidade Técnica*) and the CAT (*Certidão de Acervo Técnico*) issued by the Regional Council of Engineering and Architecture (CREA). The national standards are set for example by INMETRO (quality control) and ABNT (technical standards), For more information see EPE, 2014c.




REQUEST FOR ISSUANCE OF RELEVANT LICENSES AND DOCUMENTS	RES-E producer requests the issuance of relevant licenses (e.g. environmental permit) to federal, municipal, and municipal agencies
	
REQUEST FOR REGISTRATION AT EPE	RES-E producer requests at the Energy Research Company (EPE) the registration of a project to take part in an energy auction
	
EPE EVALUATION PROCESS	EPE assesses the technical proposal and might notify the RES-E producer to provide additional information or disqualify the project
	
LIST OF ENABLED PROJECTS	EPE sends to the Ministry of Mines and Energy a list of projects enabled to take part in the auction

Diagram 1: Administrative and Technical Registration.

b. Bidding Process and Power Purchase Agreement (PPA)

The next phase is the bidding process conducted by the Electric Energy Trading Chamber (CCEE), a separate legal entity under the supervision of ANEEL (Art. 2, § 11 of Law 10.848/04). The Chamber works through an online platform and the bidding procedure is divided in two phases with the price as the relevant criterion and no additional quality criteria is relevant at this point. In the first phase, a descending price clock for biddings takes place and in the second phase, a pay-as-bid round starts¹⁶ (Barroso *et. al.*, 2014).

Once the bidding phase is completed, the system proportionally distributes the energy lots between the distribution companies. In regular energy auctions (i.e. *Leilão de Energia Existente and Leilão de Energia Nova*), demand is calculated based on the growth expectations of distribution companies.¹⁷ In auctions to secure the supply of energy (*Leilão de Reserva*), the government sets the demand and the energy contracted is used to increase the reserve margin of the system (Barroso *et. al.*, 2014:3). Winners of the bidding process (i.e. project developers) sign a contract to sell the electricity to the distribution companies.

¹⁶ The main design elements of auctions are kept, but prior to each auction, the guidelines ruling the tender are published at CCEE's website.

¹⁷ Distribution companies report their current and future needs to purchase electric power to the Ministry of Mines and Energy.

The power purchase agreement signed in the regulated market is called CCEAR (*Contrato de Comercialização de Energia no Ambiente Regulado*) and has to be registered at the CCEE (Art. 56 Decree 5.163/04). The types of PPAs that are signed can focus on quantity of electricity (kWh) or availability of supply (kWp). Agreements for quantity of supply have a fixed amount of electricity that needs to be delivered by the producer at a given price. Agreements for availability of supply foresee a fixed remuneration to the producer (irrespective of what is generated) and are usually used for hiring thermoelectric plants (ABRADEE, M6).

In sum, the bidding process and the signature of a power purchase agreement usually consist of the following steps:

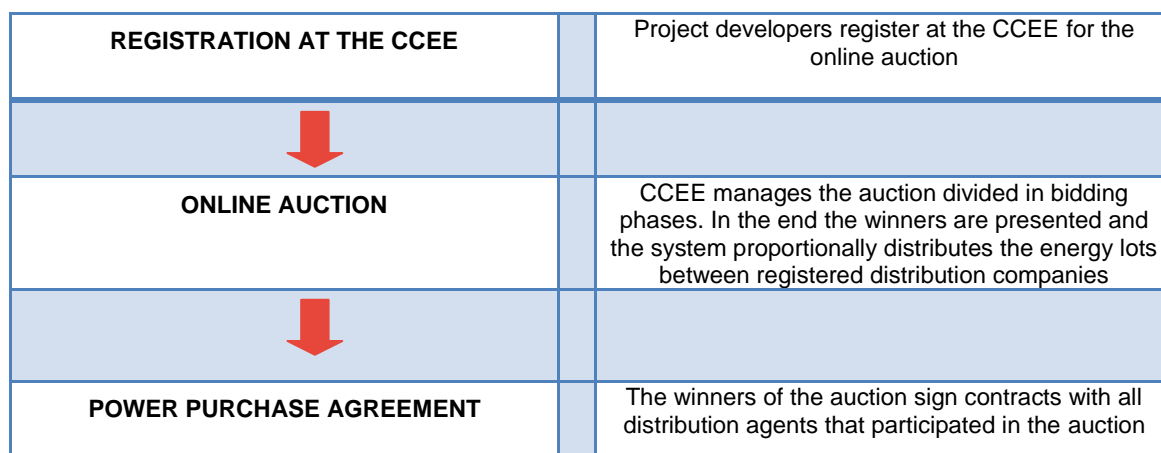


Diagram 2: Bidding Process and Power Purchase Agreement.

In the "Solar-Auction" scheduled to take place in October 2014, the power purchase agreement will cover a period of 20 years and the beginning of supply shall be October 2017. Nonetheless, producers may anticipate the start of commercial operation provided that distribution and transmission systems are also concluded for operation (Art. 2º, § 5º MME Ordinance 236/14).

However, differently from the provisions in MME Ordinance 132/2013, which foresaw that the producer is entitled to receive the payment even without delivering the contracted electricity in case the access to the transmission network was not available¹⁸ on agreed time, the new MME Ordinance clearly provides that the producer is not entitled to receive the payment in case of

¹⁸ In case the producer was not responsible for the unavailability.

unavailability of distribution and transmission networks (Art. 2^o, § 6^o MME Ordinance 236/14).

c. Funding of Projects

Projects can be financed through national and international funds. The Brazilian National Bank for Economic and Social Development (BNDES) provides financial programs for projects focusing on the production of renewable energy and has already financed several projects in the wind sector¹⁹.

BNDES recently released conditions for a specific funding program to support projects from auctions conducted in 2014 in the regulated market.²⁰ The bank also published the new methodology for accreditation and calculation of the local content requirement for modules and photovoltaic systems.²¹ As the industry is still not well established in the country and a high request for local content in the initial moment could hamper its development, the new methodology does not consider the nationalization index based on weight and value of the equipment (as it is the case in other programs), but instead requires a progressive nationalization of specific components, aiming to incentivize the development of the local manufacturing capacity. According to the bank, the new rules offer flexible alternatives to nationalization and reward a higher national content.²² Through the new program, companies headquartered in Brazil and legal entities under public law are eligible and the financial rules are based on the general guidelines of the traditional programs BNDES Finem and the Climate Fund.²³

¹⁹ Between 2003 and 2012, the bank approved almost R\$ 10 billion (approx. € 3 billion) for financing wind projects, totaling approx. 4GW of installed capacity. In 2013, R\$ 3.6 billion (approx. € 1 billion) to finance wind projects was approved (Melo, 2014).

²⁰ For more information on the specific funding program for solar projects see: http://www.bndes.gov.br/SiteBNDES/bndes/bndes_pt/Areas_de_Atualizacao/Infraestrutura/Energia_Eletrica/Leilao_Energia/energia_solar_2014.html.

²¹ The new methodology for accreditation of equipments is available at: http://www.bndes.gov.br/SiteBNDES/bndes/bndes_pt/Ferramentas_e_Normas/Credenciamento_de_Equipamentos/credenciamento_fotovoltaicos.html

²² See: http://www.bndes.gov.br/SiteBNDES/bndes/bndes_pt/Institucional/Sala_de_Imprensa/Noticias/2014/Energia/20140812_energiasolar.html.

²³ The Climate Fund is one of the instruments of the National Policy on Climate Change and was established in 2009 through Law 12.114.

The "BNDES Finem" program usually supports projects aimed at expansion and modernization of the energy generation infrastructure. Through the program, companies headquartered in Brazil and legal entities under public law are eligible, meaning that joint ventures are necessary for international companies interested in receiving funds from BNDES. The minimum amount of funding is set at R\$ 20 million (approx. € 6.5 million) and the bank's participation is up to 80% with a maximum amortization period of 20 years (FINEM, 2014).

In addition, the Climate Fund supports investments in generation and distribution of renewable energy sources, as well as in technological development and development of the production chain linked to renewable sources. Through the fund, States and municipalities, as well as companies headquartered in Brazil are eligible for support (Clima, 2014). The minimum amount of funding is set at R\$ 3 million (approx. € 1 million) and the bank's participation is up to 90% with a maximum amortization period of 16 years.

2.1.4. Barriers and Recommendations

Barrier 1: Lack of Technology-Specific Auctions for Solar

As it was previously mentioned, solar has been competing with wind energy in the auctions conducted so far at the national level and solar projects have not been successful in offering a lower price. Just to illustrate, in the national auction held in November 2013, the selling price for wind energy was R\$ 124/MWh (approx. € 41/MWh). The price to enable the development of solar projects in Brazil is estimated to be around R\$ 230/MWh (approx. € 76/MWh) (Spatuzza, 2014), which already shows that both technologies are not on the same competition level in Brazil.

Besides energy auctions at national level under the regulated market (ACR), there is also the possibility of having auctions at the state level under the free market (ACL), as it was the case in the auction held in December 2013 by the State of Pernambuco. This auction was specific for solar technology and the start price was set at R\$ 250/MWh (approx. € 82/MWh). As a result of the auction, five bidders were awarded projects accounting for 122.82 MW

(Pernambuco, 2013) and the average selling price was R\$ 228/MWh (approx.€ 75/MWh) (Belfort, 2014).

It has to be stressed that this barrier is likely to be overcome by the end of 2014 as the Brazilian Ministry of Mines and Energy published MME Ordinance 236 on 6 June 2014 with guidelines for an energy auction to take place in October 2014. It will be the first time at national level that solar PV will not compete with other technologies, such as wind and biomass. Nonetheless, the maximum starting price for the auction has not been released yet (as of July 29th, 2014).

Recommendation:

To take part in technology-specific auctions with solar not competing with other renewables where the prices might be more feasible to the development of projects and foster the industry in the country.

Barrier 2: Delay of Signing the Power Purchase Agreement

According to a project developer, the auction held by the State of Pernambuco in December 2013 had a quick registration process with rules similar to the ones set at national level; however, not everything is going as planned. There is an environment of uncertainty as the demand for the energy auctioned is lower than expected. As a result of the auction, five bidders were awarded projects accounting for 122,82 MW (Pernambuco, 2013). Despite the fact that the auction took place in December 2013²⁴, the PPAs with the distribution companies haven't been signed (as of 10 June 2014) and there is uncertainty if the energy that was auctioned will actually be sold. It is important to highlight though that auctions at the state level occur in the free market - differently from auctions at the federal level that are under the regulated market - and buyers are usually not energy suppliers.

Recommendation:

In case of auctions in the free market taking place at the state level, it is highly recommended to have an adequate estimation of demand for electricity from the interested buyers in order to avoid delays in the signature of PPAs.

²⁴ For the list of companies who won the auction, see Spatuzza, 2014.

2.2. ANEEL Resolution 482/2012 – Net Metering

2.2.1. Main Description

The net metering system established by the energy agency ANEEL formalizes and grants access to the public grid for the first time. Consumers can install small electricity generation systems (e.g. solar PV) in their properties (residential or commercial units) and then feed this electricity into the grid and compensate their consumption.

The ANEEL Resolution 482/2012²⁵ divides generation units in two types, namely micro generation units, which shall have an installed capacity of $\leq 100\text{kW}$, and mini generation units, which shall have an installed capacity $>100\text{ kW}$ and $\leq 1\text{MW}$.

In essence, net metering is a billing mechanism that credits solar energy system owners for the electricity they add to the grid. For example, if a residential customer has a PV system on the home's rooftop, it may generate more electricity than the home uses during daylight hours. For this excess electricity fed back into the grid in a given month the owner of a generation system receives credits on his electricity bill. Customers are only billed for their "net" energy use, meaning they pay the difference between the energy consumed and the energy generated. Differences in the rate structure resulting from peak and off-peak tariffs are taken into account. If there is an excess of electricity in a given month, this excess electricity generates energy credits that can be later used by the same producer to reduce the electricity bill in the following month. This compensation system not only enables PV producers to produce their own electricity and reduce their energy bill in one location, but also enables PV producers to use the credits of the generated electricity to compensate the electricity consumed in another location. These energy credits are valid for a period of 36 months and if used to offset the consumption of another unit besides the one generating the electricity, this unit needs to be previously

²⁵ Units are differentiated in micro and mini generation mainly due the voltage level at the connecting point. Micro can be connected to the secondary distribution voltage level (e.g. 220V), whereas mini should be connected to the primary distribution voltage level (e.g. 13.8 kV).

registered, the owner needs to be the same (proven by CPF or CNPJ²⁶), and all units need to receive electricity from the same distribution company.

It is important to highlight that Brazilian electricity rates currently include a minimum consumption amount (typically a residential customer using a single-phase connection pays for a minimum consumption of 30 kWh per month, a customer using a two-phase connection pays for a minimum consumption of 50 kWh per month and a customer using a three-phase connection pays for a minimum consumption of 100 kWh per month, even if in reality the consumption is lower). This minimum consumption is always charged on the electricity bill and ensures that PV system owners/consumers in group B (low voltage) pay a certain value to cover the costs of grid availability and PV system owner/consumers in group A (medium and high voltage) pay the value of contracted demand.

2.2.2. Regulatory Framework

As explained in the previous section, Law 10.848/04 and Decree 5.163/04 set the main regulatory framework of the energy system in Brazil, but the energy agency ANEEL can publish additional rules (Art. 75 Decree 5.163/04).

Exercising this competence, ANEEL published Resolution 482 of 17 April 2012 (RN 482/2012)²⁷, which regulates the compensation system for distributed generation in the country. The aforementioned resolution was amended in December 2012 by ANEEL Resolution 517 (RN 517/2012).

In addition, in the so-called “PRODIST” regulation²⁸, technical standards and processes for power distribution are defined and in particular in Section 3.7 the rules and process requirements for small-scale power generators when requesting access to the grid are defined.

²⁶ The CPF (Cadastro de Pessoa Física) is a registration number issued by the Brazilian Federal Revenue (Receita Federal) to each individual. The CNPJ (Cadastro Nacional de Pessoa Jurídica) is issued by the same authority, but it is a registration number to identify companies.

²⁷ A German translation of the ANEEL Resolution 482/2012 is available at: <http://www.americadosol.org/wp-content/uploads/2013/02/Resolution-482-2012-neu-deutsch.pdf>.

²⁸ An overview of all relevant standards is available at: <http://www.aneel.gov.br/area.cfm?idArea=82> (Portuguese only). A German translation is available at: <http://www.americadosol.org/wp-content/uploads/2013/02/PRODIST-Modul-3-Sektion-3-7-Rev5-deutsch.pdf>.

2.2.3. Main Stages for Project Development²⁹

An accurate assessment of the customer's needs is the starting point for specifying, designing and installing a PV system. Knowledge of the customer's electrical loads and energy use are important considerations for determining the size and design of a PV system. The IDEAL Institute and the GIZ have developed an internet tool that can assist consumers in a preliminary assessment for sizing an appropriate PV generator.³⁰

The company³¹ assigned by the customer to design and install the PV system has to follow an administrative process before the system is constructed and interconnected. The interconnection process adheres to four basic steps: 1) grid connection application, 2) utility application review, 3) installation and commissioning, including determining the connection point, and 4) connection of the PV system, including an interconnection agreement.³²

All required permits and documentation for the utility interconnection, including technical codes and standards³³, need to be assembled and submitted to the distribution company thereby requesting access to the grid. Technical interconnection issues include safety, power quality, and impacts on the utility system. Detailed technical descriptions of the generation facilities, exact design and specifications for interconnection with the grid should be included in the request.

With regards to standards and labeling for solar systems and their components, Ordinance 004 of 04 January 2011 from the Brazilian Institute for Metrology and Standardization and Industrial Quality (INMETRO) provides for the compulsory labeling of all PV systems and equipments before being applicable for power production in Brazil. This accounts for both, national and international products

²⁹ The Ideal Institute developed a guidebook for micro producers available at: <http://www.americadosol.org/guiaFV/>.

³⁰ The solar simulator "Simulador Solar" can be used free of charge at the site <http://www.americadosol.org/simulador/>

³¹ As previously mentioned, in order to qualify for installing PV systems in Brazil, any company offering such services need to make sure that their responsible staff have the required certification required, as for example the CAT (*Certidão de Acervo Técnico*) and the ART (*Anotação de Responsabilidade Técnica*) issued by the Regional Council of Engineering and Architecture (CREA).

³² A comprehensive step-by-step guide to the whole process is available at the "Guia de Microgeradores Fotovoltaicos", which can be accessed free of charge at <http://www.americadosol.org/guia-de-microgeradores-fotovoltaicos/>

³³ For additional information see: <http://www.americadosol.org/certificacaobrasil/>

(INMETRO, 2011). With submitting all product and company specific paperwork, the product is tested in a laboratory recognized by INMETRO. Once one sample component has been certified, the certification is automatically valid for all components of the same type. Bearing in mind the need to adapt the requirements for conformity assessment of solar systems and their components, Ordinance 004/2011 is under review and new rules are under discussion.³⁴

According to RN 482/2012 and PRODIST Section 3.7³⁵, the distribution company has 30 days to review the application for grid access and issue an opinion. In case minor additional work on part of the PV project developer is needed, this should be finalised within 60 days. Once the opinion is available and all additional requirements are fulfilled, the PV system can be acquired and installed. After completion of the PV system, the distribution company needs to inspect and authorize the system. After the inspection request has been received, the distribution company has 30 days to carry out the inspection visit and testing on site and additional 15 days afterwards to issue a technical report.

In addition, the distribution company is obliged to install metering equipment that can measure the flow of electricity in both directions; the installation shall be taken care of before the inspection of the PV system. In case technical aspects need to be corrected after the inspection, the corrections shall be taken care of prior to requesting a connection point. After requesting a connection point, the distribution company has seven days to approve the connection point and connect the installation. For small PV installations integrated in an existing power supply for electricity consumption, the connection point for the PV plant is equivalent to the existing grid connection point of the household or commercial entity. Typically a new meter (either bidirectional or a second one capturing the amount of access electricity fed into the grid) has to be installed by the distribution company when connecting the PV system to the grid. Costs

³⁴ Ordinance 128 of 19 March 2014 was under public consultation in March-April 2014. For more information see: http://www.puntofocal.gov.ar/notific_otros_miembros/bra344r1_t.pdf

³⁵ PRODIST provides the general rules and technical standards. Based on those general requirements and the specifics of the respective distribution area, each distribution company is publishing their own interconnection requirements. Those are typically available on the website of each distribution company. A complete list with links to the requirements of all distribution companies is available at: http://www.americadosol.org/wp-content/uploads/2013/11/Normas_tecnicas-net-Metering-das-concessionarias-120131022.pdf.

associated with on-site meter adjustments required for net metering are borne by the small power producer and included in the electricity bill. The distribution concessionaire is responsible for operation and further maintenance, including technical replacements. Moreover they are required to collect data and to conduct evaluations at no cost to the participating consumer.

Upon acceptance of the grid access request and once the opinion is available, the distribution company will prepare an interconnection agreement for execution by the distribution company and the “producer”, namely the party that will be responsible for the generating facility. Detailed technical descriptions of the generation facilities, exact design and specifications for agreed upon interconnection with the grid and a detailed description of the chosen metering equipment should be included in the interconnection agreement.

In sum, main stages for project development consist of the following steps:

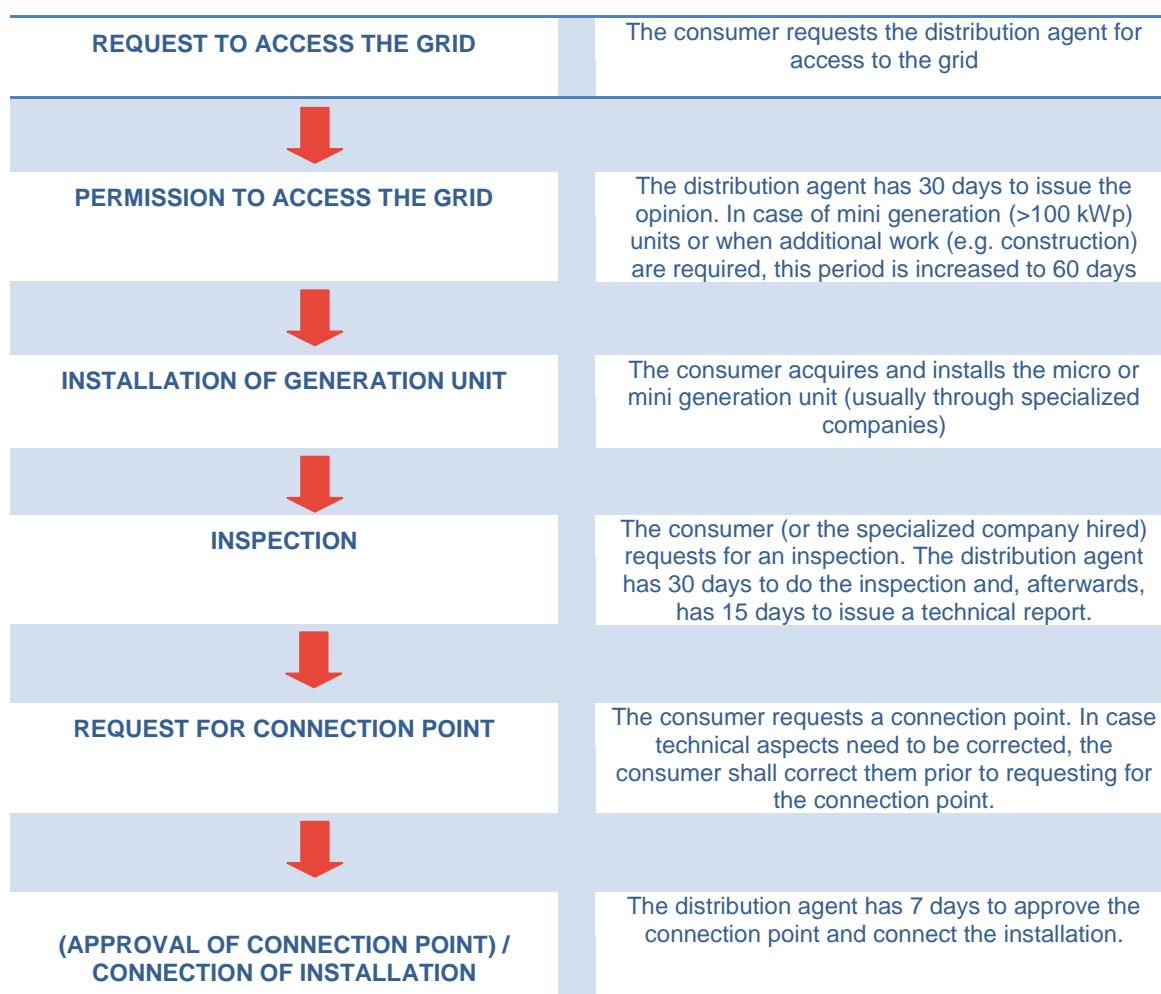


Diagram 3: Connection procedure for mini and micro generation units.

2.2.4. Barriers and Recommendations

Barrier 1: Taxation

a. Taxation of Electricity

When the electric bill arrives at the consumer, he or she pays for buying energy (remuneration of the generator), the transmission (the transmitting company's costs) and the distribution (services rendered by the distributors), plus the charges and taxes determined by law, destined to the government. Tax components include *ICMS (state tax)*, *PIS (federal tax)* and *COFINS (federal tax)*:

- *Tax on Circulation of Merchandise and Services (ICMS)*: foreseen in article 155 of the 1988 Federal Constitution, this tax lays on the operations related to the circulation of merchandise and services and is the competency of the State governments and the Federal District. The ICMS is regulated by each state's tributary code, or in other words, established in law by the legislative houses. Thus they may vary. The distribution utility has the obligation to carry out the charging of the ICMS directly on the bill and pass them on entirely to the State Government.
- *Social Integration Programs (PIS) and Contribution to the Social Security Financing (COFINS)*: charged by the Government to maintain programs aimed at the worker and to serve the Federal Government's social programs.

As decided by CONFAZ Convenio ICMS Number 6 (05/04/2013), under the current scheme, gross taxation instead of net taxation is applied ("all electricity consumed from distribution companies shall be taxed, even if it is later compensated through net metering"). This means that all excess PV electricity that is not self-consumed but fed back into the grid for gaining net metering credits, is burdened with the above taxes and surcharges. Consequently, excess PV kilowatt-hours don't compensate grid kilowatt-hours on a 1 to 1 basis, since the value of the injected PV kWh is decreased financially.

Calculating the average value loss for the PV electricity when injected into the grid, one needs to inject approximately 3 kWh to compensate only 2 kWh consumed from the distribution company. It is important to highlight though that a few states³⁶ in Brazil are discussing and implementing legislative changes providing that the ICMS applies only to the difference (if positive) between the energy consumed and the energy injected in the grid.

Though there is another aspect which needs to be taken into account as well, the ICMS tax rate is depending on consumption levels. For example, in the State of Rio de Janeiro in 2014, if the residential consumption is up to 50kWh per month, it is exempted from ICMS, but if it is between 51kWh and 300 kWh, the ICMS rate is 18% and if it is >300 kWh, the ICMS rate is 29%.³⁷

Hence, installing a PV system and thereby decreasing the consumption level can also have a positive impact on the electricity bill.

Recommendations:

When planning a PV installation, make sure that the PV self-consumption lowers the residual offtake from the grid below the threshold of the current ICMS rate, if applicable in that federal state.

b. Import tax/Customs duties on imports

As the local Brazilian market is still in its infancy, there is a lack of local production of goods. Since most PV equipment is imported, national import taxes arise. A rate of 12% occurs for photovoltaic modules and 14% for inverters. Exemptions are made for members of the Common Market of the South (MERCOSUR) (ABINEE 2012:57). Final product prices are heavily impacted by import tax policies, consequently PV module prices are increased significantly in comparison to global market prices³⁸.

³⁶ See Law 20.824 of 31 July 2013 from the State of Minas Gerais.

³⁷ See: <http://www.light.com.br/para-residencias/Sua%20Conta/composicao-da-tarifa.aspx>. For a complete overview of the ICMS rates per state for all sectors see: <http://www.abradee.com.br/financeiro/mapa-das-aliquotas-icms-brasil>.

³⁸ For an overview of import taxes and customs duties (in German) is available at: http://www.americadosol.org/wp-content/uploads/2013/08/estudo_importacao_deutsch.pdf

Recommendations:

Consider procuring locally produced components as long as market demand does not accept the resulting price differences for imported products.

Barrier 2: Lack of Attractive Financing Options for Small PV Systems

Currently, most residential customers installing a small PV system under the RN 482/2012 can afford to do so as they have enough money in the bank and do not need a loan. However, to increase access to and broad adoption of PV systems it will be necessary to develop better credit lines for small residential systems.

The Brazilian Development Bank (BNDES) offers loans below-market rates, but mainly targets larger projects. The new rules for supporting solar projects previously mentioned also address the larger projects taking part in auctions in the regulated market in 2014.

Recommendations:

To increase access to and broad adoption of PV systems it will be necessary to develop better credit lines for small residential systems. Meanwhile, project developers should strive for acquiring higher shares of equity.

Barrier 3: Structure of Retail Rates (Ratemaking)

Current residential retail rates are somewhat prohibitive to using or at least maximizing the benefits of net metering. Residential customers using a single-phase connection pay for a minimum monthly consumption of 30 kWh, even if their real consumption is lower than 30 kWh. Customers using a double-phase connection pay for a minimum consumption of 50 kWh, and customers using a three-phase connection pay at a minimum for 100 kWh. Therefore, there is little economic appeal to increase energy efficiency or decrease electricity consumption by means of installing a net-metered PV system and generating electricity on-site. Consequently, PV installations will be dimensioned smaller than the self-consumption optimum but relatively expensive at the same time.

Recommendations:

Consider accurately the existing ratemaking of the customer in order to maximize his / her net-metering-profit out of self-consumption. Regulators should review the rate making structure and promote structural changes in favor of energy efficiency measures and distributed generation in form of small-scale PV systems.

Barrier 4: Unpractical Interconnection Process

Besides net metering being a rather new possibility for consumers, it is also an entirely new process for distribution system operators they are now required to deal with. Deadlines, such as the 30 day period for issuing an opinion with respect to grid access permission, are often run over by a couple of weeks or even months. This is not necessarily a result of vicious intention, but often times a problem of lack of internal resources; or internal processes have not been properly set up yet to guarantee for streamlined internal execution of interconnection requests by small distributed generators. For the PV system owner, there are ways of submitting a claim for delays in the interconnection process; first he can send a complaint to the company internal arbitration board. After not getting any feedback from there in a given time period, a claim can be submitted to ANEEL. However, currently there are no penalties foreseen for distribution companies in case they are not meeting the timelines as foreseen by ANEEL Resolution 482/2012. Some distribution companies have already begun to unite the steps of inspection and commissioning of the PV system with changing the meter and connecting the installation. Hence, a company employee has to visit the site only once instead of twice, thereby increasing efficiencies.³⁹

³⁹ In contrast to the German case and situation, it is required that a distribution company employee carries out a site visit in order to finalize the interconnection procedure (similar to the US). Higher education standards in Germany and other system specifications allow for a less labor-intense approach on part of the distribution operator. However, the differences in the German and Brazilian situation and the resulting consequences shouldn't be underestimated.

Recommendations:

Different distribution companies can enhance the process significantly if they coordinate the streamlining and thereby create similar processes. Such coordinated processes will make the connection procedures for PV developers more predictable. Another important point will be the communication with installation operators – examples from the U.S. as well as the European projects PV LEGAL and PV GRID have shown that close communication between plant and grid operators are a key requirement for efficient processes⁴⁰.

2.3. General Challenges

Apart from the barriers that are specific to auctions or net metering, the certification of inverters and the lack of qualified staff appear as market entry barriers, though they are conquerable by company efforts. Still, both require coordinated initiatives to generally improve the market environment for accelerated PV growth.

Barrier1: Certification of Inverters⁴¹

National Brazilian codes and standards have been set up⁴². They typically are very ambitious – mainly based on German and Italian standards – but enhanced by Brazilian specifications.. Furthermore, according to a project developer, Brazilian laboratories mostly aren't equipped yet to carry out the needed tests. In addition, the know-how regarding testing is often missing.

Current certification requirements (as defined by INMETRO Ordinance 004/2011) are rather costly as tests require two samples of each inverter type to be certified. Furthermore the inverters can get damaged by the test process –

⁴⁰ For more information on the EU projects see: PV LEGAL (<http://pvlegal.eu/>) and PV GRID <http://www.pvgrid.eu/> .

For more information on the projects in the U.S. see: <http://nwsolarcommunities.org/wp-content/uploads/2013/05/ESSP-IC-Report-Final.pdf>, <http://www.sdge.com/newsroom/2014-02-03/new-online-application-fast-tracks-solar-interconnection-process> or <http://energycenter.org/sites/default/files/docs/nav/policy/research-and-reports/Interconnection%20Process%20Best%20Practices.pdf>

⁴¹ This barrier is described based on information from the interview with Mr. Frank Neumann.

⁴² For more information see: <http://www.americadosol.org/certificacaobrasil/>

so they are not sellable as new inverters. The supplier is responsible for the delivery of the samples to the laboratory. The testing costs of each model are R\$ 3,000 (equivalent to € 1,000). The costs associated with the product's registration on the INMETRO and all the logistics necessary for the delivery and recollection of the charge controllers in the laboratory, including import taxes, are responsibilities of the company. In addition, each year the certification has to be renewed for each particular inverter model.⁴³ According to German inverter manufacturers, those costs can easily reach ranges of between 40.000 € and 100.000 €/year for selling their products on the Brazilian market. As there currently is only a very small or almost non-existing PV market in Brazil, inverter manufacturers are hesitant to invest in the Brazilian certification process, as the costs are rather high and would require large sales volumes to be compensated. As of today, there are no Brazilian inverter manufacturers who might fill this market gap.

Generally, most grid operators require testing results from international laboratories as well as a manufacturer's self-declaration for compliance with ABNT 16149. A good example is the grid operator COELCE, who accepts international certification, hence allowing inverters to be installed on their electric system. Others request additional tests or conduct their own testing of inverters like COELBA. Summing up, the landscape of inverter certificates accepted by grid operators is manifold which results in high efforts for getting prepared for the different market regions.

The current situation regarding inverter certification is a rather substantial barrier to enabling and growing a PV market in Brazil.

Recommendations:

Inverter manufacturers need to become acquainted with the national and regional certification requirements before offering their products. Complying with the international standards is a prerequisite, but further certification might be necessary. Regulators might think about accepting international standards during the market uptake phase when only few PV Megawatts have indiscernible influence on the grid, so that suppliers enter the market and

⁴³ For more information see: <http://lsf.iee.usp.br/lsf/index.php/ensaios-para-o-inmetro/ensaios-de-inversores>.

generate economies of scale. This guarantees that certification capacity is available outside and even grows inside Brazil. In a second phase, standards can be raised if needed for the Brazilian technical environment. To elaborate on that, a committee of manufacturers, associations, regulators and experts might help to verify the intersections and deviations of international and Brazilian standards.

Barrier2: Lack of Qualified Staff

Lack of qualified and experienced installation technicians, project managers and engineers with knowledge and background in the solar industry is posing a great challenge in workforce recruitment. There is a need for education programs in solar installations, that can be managed by certified training organizations or even stakeholder associations maybe supervised by foreign competence. Evidence shows that a qualified, trained, and certified workforce performs installations that result in fewer problems at the time of inspection and, as such, have a direct impact on lowering costs and efforts for project developers, consumers and inspection authorities. Furthermore, the creation of a skilled workforce will ensure safe system installations and increase consumer acceptance and quality product demand.

A general lack of qualified installation technicians results in a need of case-wise approval procedures by distribution companies in order to ensure quality control with respect to the installed PV systems. However, an individual approval procedure for every single PV installation has direct and significant consequences in terms of the amount of qualified staff that is required on part of the distribution company to perform such approval procedures. If those personnel were not readily available, approval procedures most likely become a major bottleneck for PV deployment.

Recommendations:

Develop training programs to expand skilled workforce.

Develop entry level knowledge assessment, professional certification, and company accreditation programs.

3. Further Developments and Next Steps

The development of the Brazilian PV market enters a critical phase. Due to the overall strong economic development, favorable natural conditions and last but not least the continuously growing demand for energy the potential for PV in Brazil is enormously high. Nevertheless, experiences in other markets have shown that despite such positive conditions the rise of a nascent market can easily stall unless identified barriers are tackled in a resolute manner.

Moreover, the close exchange with local experts has shown need for additional measures, such as:

- strengthening the collaboration between RES industry and public bodies (administrative and regulatory bodies) to improve the business environment for PV investments;
- linking the interests of the different stakeholders on the Brazilian PV market;
- defining clear technical codes and standards for a more efficient and effective PV project development;
- enhancing the application of support schemes (in particular the net-metering schemes) both on the side of the regulators as well as on the side of the PV investors;
- providing quantitative information on PV business cases for a better assessment of possible investments;
- disseminating detailed guidelines on how to plan and install PV systems in Brazil.

To this end, the consortium proposes a twofold approach. On the one hand it deems necessary to produce:

- further user-friendly information on PV-business cases and its profitability;
- guidelines how to profit from PV-business opportunities in Brazil and
- detailed recommendations for the reduction of the identified barriers.

On the other hand, we suggest supporting the establishment and professionalization of organisational structures of the private solar energy sector (associations-partnership). These measures should include capacity building and knowledge transfer of methodologies that proved to be effective in other markets.

4. Summary

With respect to the establishment of a solar market in Brazil many encouraging developments have taken place over the last two years, including the introduction of a net metering scheme and auctions specifically directed towards solar resources. The underlying political ambitions are driven by a strong demand for additional energy supply and a growing population. Especially the solar auctions might act as a booster for the development of the technology and the industry in the country. The October 2014 auction is the first one at national level with solar PV not competing with other renewable sources. Also with the introduction of net metering by ANEEL the outlook for small-scale PV systems is relatively positive, forecasting 1,4 GW of installed net metering capacity by 2022. However and as of today, with barely 12 MW of grid connected PV installations, the Brazilian market is still in its infancy. Off-grid applications with an estimated cumulative capacity of 30 MW remain as a larger segment. On the positive side, the processes for grid-connected PV are defined and the challenges to overcome their barriers are known as well as ways of managing those barriers for the investors.

Since financing is one of the most challenging issues for project developers, the new funding support by BNDES might help mitigate this entry barrier significantly. Within net metering, certain constraints need deliberate analyses for identifying and approaching the most promising target segments. As long as taxation on net-metered electricity is not removed or diminished, PV costumers with optimal rate profiles should be targeted first. Same applies to customers whose minimum consumption rates have an effect on dimensioning the PV installations. Taxation on imports recommends finding joint ventures or local component suppliers

For entering the market, it is highly recommended to look for local partners who provide legal expertise and help overcoming the barriers in an efficient way. Companies employing their own Portuguese speaking sales staff have a marketing advantage. Also business networks can more easily be explored, sales representatives can quicker be found, if the foreign company associates

with regional or national stakeholder organizations. For analyzing one's market opportunities, it is advisable to examine the economic viability of the most relevant market segments in advance and in detail. Sensitivity calculations on changing system prices, net metering taxes or electricity rates can help taking profound decision for individual projects.

In summary, there are a number of starting points provided by this report that hopefully will contribute to enabling even broader PV market adoption rates in the residential, commercial and industrial sectors. Brazil is striving to be the driver of PV development in South America. The current phase appears auspicious for investors and project developers who want to take a pole-position in a growing market.

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Annex I. Interviewed Experts

We would like to thank all interviewed experts for their very valuable input and their support for this study. We highly appreciate their expert knowledge and their availability in the framework of the Project Enabling PV in Brazil.

- Marco Aurélio Lenzi, ANEEL
- Thiago Ivanoski; Thiago Barral, Bernardo Aguiar, EPE
- Jose Gabino Matias, ABRADDEE
- Jens Wirth, KfW
- Guilherme Gandra; Antonio Carlos Tovar, Marcelo Melo, BNDES
- Rodrigo Kimura, Araxa Solar
- Hewerton Martins, Solar Energy do Brasil
- Thomas Schulthess, Sowitec Brasil
- Hans Rauschmayer, Solarize
- Frank Neumann, SMA
- Bastian Telg, Wirsol
- Rodrigo Lopes Sauaia, ABSOLAR

Annex II. Relevant Legal Documents

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