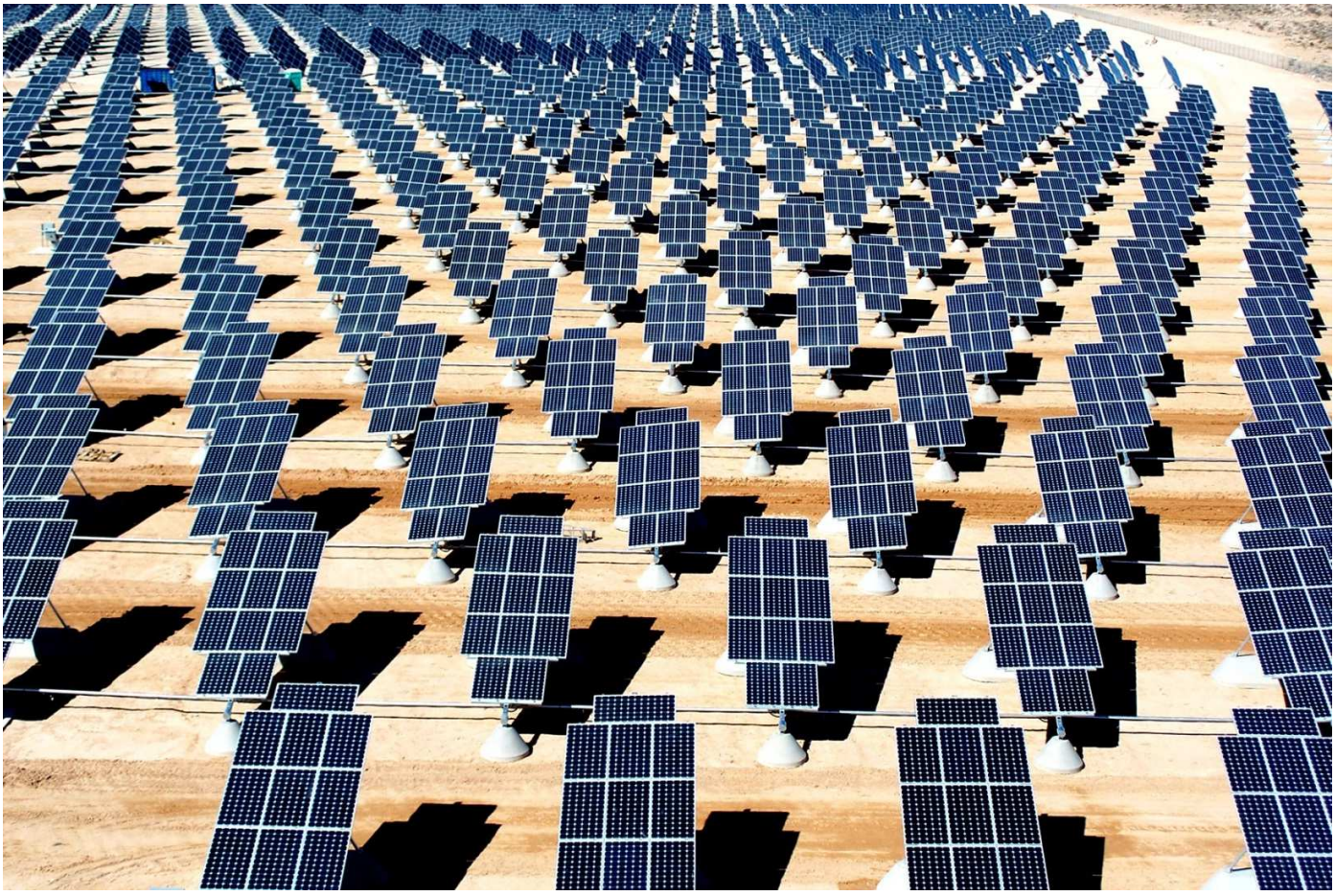
Rijksdienst voor Ondernemend Nederland

Market Study:
PV Energy in Brazil

April 23, 2015



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Executive Summary

Brazil has one of the cleanest energy matrices in the world; 41% of its overall energy production originates from renewable sources; this number is decreasing, however, because of recent droughts, resulting in less hydroelectric power. In the last six years, Brazil has shifted its focus towards diversifying its matrix, seeking other renewable resources such as wind power, small hydro, and biomass. Since 2014 Brazil has also moved towards centralized solar energy to diversify electricity production.

There is an expected demand of 1GW per year in new developments and the limited supply from within Brazil, which combined with regulations that require local production, have created favourable conditions for cooperation. Brazil faces challenges such as the need for technology, knowledge and R&D, skilled labour, a weak infrastructure and a complex political environment. This study has found that a whole new industry will develop in the next 5 years, where The Netherlands can assist with applied research, cultural change, education, engineering and logistics, financing, knowledge & technology and policy making.

Countries and companies wishing to do business in Brazil, face cultural differences as well as some obstacles to doing business. According to the World Bank (2014), Brazil is ranked 116 out of 189 for ease of doing business. However, there are a number of market entry strategies that may facilitate the process. Those who have historically been most successful maintain a local presence with a strategic, local (JV) partner. An advantage in the case of Dutch companies, is that the Dutch government offers a variety of grant and support programs that can assist them in entering Brazil's market.

Introduction

On behalf of the Ministry of Economic Affairs of The Netherlands, represented by RVO, Transfer Latin Business Consultancy has executed this market study.

This report explores the possibilities of collaboration between The Netherlands and Brazil in the area of photovoltaic (PV) energy. The study focuses on PV energy alone and does not include thermal solar energy. Photovoltaics are widely known as a method for generating electricity by using solar cells to convert energy from the sun into electric power.

Concrete recommendations follow regarding how to take advantage of the identified opportunities and how the Dutch government can be involved and support Dutch companies entering the market.

This market study comprises the following:

1. A market overview of the Brazilian energy sector and of the PV sector;
2. Relevant developments in Brazil in the field of PV energy, including policy developments;
3. Description of strengths and weaknesses in the PV energy sector (over the whole value chain) in Brazil;
4. Description of the finance structures in Brazil;
5. An overview of the manufacturing processes that already exist in Brazil and a detailed overview of relevant stakeholders and companies;
6. Opportunities and threats for bilateral cooperation with Brazil in general (short- and long-term);
7. Business needs in Brazil and opportunities for Dutch parties;
8. Advice to the Dutch government regarding their facilitating role.

Both desk and field research have been conducted in the Netherlands and in Brazil, but the major portion of the research was conducted in Brazil. Interviews were conducted with representatives of companies and industry organizations as well as with government officials and R&D institutions. The details of the interviewees are available as an appendix.

1 General View of Brazil

Brazil is a country of many cultures, ethnicities, and climates. With a population of over 204 million inhabitants, the country flourishes with its natural resources and its growing economy. Brazil is known to be one of the BRIC countries due to its fast growth in the last decade and is also known for being the largest economy in Latin America. Brazil is the 5th largest country in the world (by area) and its GDP makes it the 7th economy, ahead of Italy, India and Australia, for example. The official language is Portuguese which is spoken across the 26 states. These *Estados* are the 25 federal states, plus the Federal District which contains the capital city, Brasilia. The president of the country is Dilma Rousseff, who has been in power for the past 4 years and has recently been re-elected.

Brazil is characterized by large and well-developed agricultural, mining, manufacturing, and service sectors and has a middle class that is rapidly expanding. The country's historically high interest rates have made it one of the most attractive destinations for foreign investors. Brazil's biggest export partners are: China (17%), the United States (11.1%), Argentina (7.4%) and the Netherlands (6.2%).

Although Brazil's economy has had a slight downturn in the last few years, it still holds the title of largest economy of Latin America. In 2010, Brazil had a growth rate of 7.5% in its GDP, whereas in 2013 the growth plummeted to a mere 2.5%, and in 2014 to 0.1%. Nevertheless, Brazil is still expanding its presence in world markets. Also, unemployment is at a historic low and the high level of income inequality has declined substantially in the last 14 years.

With respect to renewable energy, Brazil has implemented many policies to diversify its generation with more green and sustainable sources. It has been achieving this with wind and biomass, adding to its vast hydroelectric portfolio. The Brazilian government has been stimulating the inclusion of solar power generation but its contribution is still negligible.

2 Energy Sector in Brazil

Brazil is known for its renewable energy matrix, where 41% of all energy is generated using mainly hydroelectric power and ethanol. The country is also economically self-sufficient in oil, with notable development of deep sea exploration and production by state-owned Petrobras. Recent developments include:

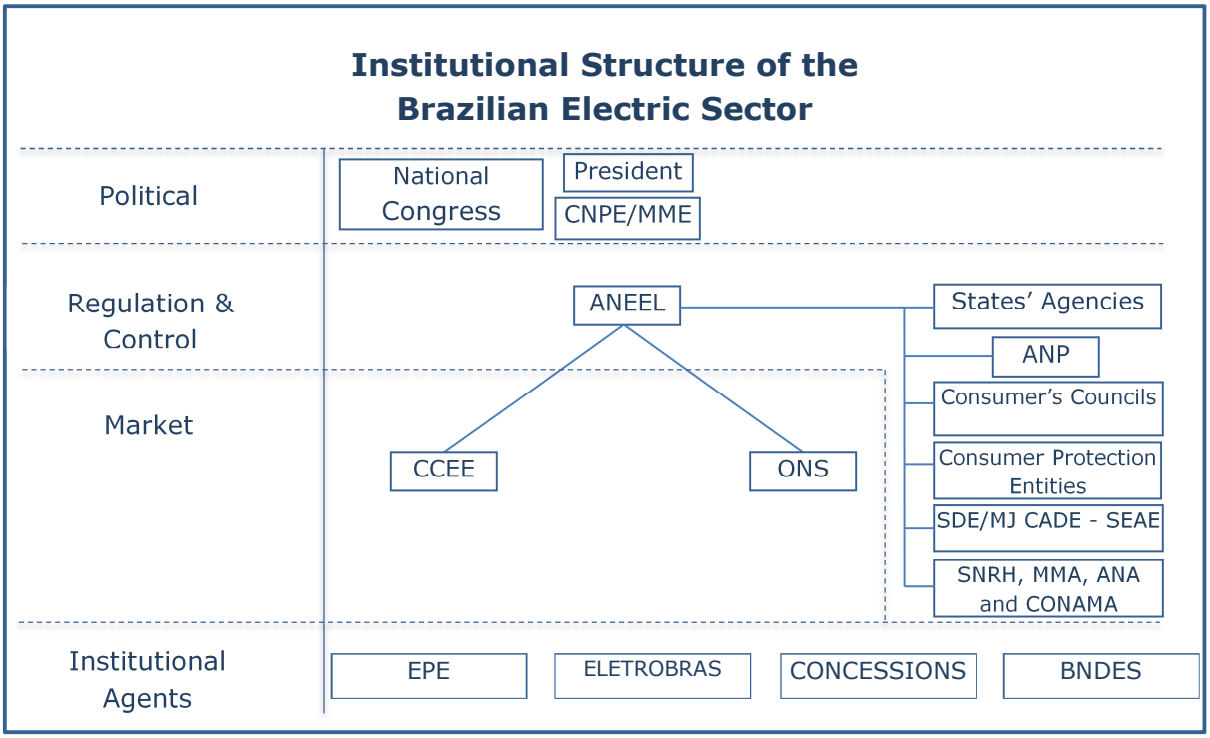
- The discovery of very large pre-salt oil reserves off the coast of São Paulo and Rio de Janeiro in 2008;
- A remarkable increase of investments in wind-energy especially in the northeast region;
- Significantly lower levels of hydroelectric power generation due to long lasting drought periods that caused a substantial rise in thermoelectric generation.
- Demand for energy is continuously rising. In 2013 it rose by 4.5% a grand total of 296.2 Mtep.
- Most recently, higher electricity prices were announced and are expected rise up to 50% this year

Electric energy is traditionally associated with hydroelectric generation in Brazil. Unfavorable climate conditions however, lowered its contribution to the electric matrix to 79.3% in 2013, down from 84.5% in 2012. The gap was filled by coal, natural gas and ethanol/biomass powered plants, with much higher costs and losses. Coal production rose by 75.7%, and the system's total losses amounted to 36Mtep, 18.4% more than in 2012. Despite the higher usage of fossil fuels, emissions are still lower than in China, the US and Europe at 115kg of carbon dioxide per MWh. On the other hand, wind energy as another renewable source, notably gained prominence with an increase of 30.3% to 6.5GW in 2013, now representing more than 1% of the total matrix.

The long transmission lines contribute to unnecessary losses in the system, which is also notoriously sensitive. Blackouts are a common phenomenon that tend to happen at least once a year in the last 4 years, and can be caused even by simple failures in substations. As a response to this problem, a higher level of interconnectivity between networks is being implemented, but distributed generation is also seen as a potential way to mitigate the risks of future blackouts.

2.1 Overview of Energy Sector – National and Regional Level

Regulation of production, generation, transmission and distribution of energy is a national affair. For the purposes of this report, we only explain the panorama of electrical energy. The states have different utility companies that operate on concession from the regulating agencies; the market environments where they operate, albeit also regulated nationally, vary substantially due to vastly different playing fields regarding both generation and consumption. Differences in consumption does influence the panorama of generation, but no state has different regulatory or fiscal scenarios for the generation itself. The system as a whole is composed of the framework of institutions whose relationships are illustrated below.



The government's influence in the energy sector is exclusive to the Ministry of Mines and Energy (MME) in combination with the National Council of Energetic Policy (CNPE), with support from the National Congress and the President. The policies developed by those bodies are regulated and controlled by the National Agency of Electric Energy (ANEEL), regarding financials with the Chamber of Commerce of Electric Energy (CCEE) and in operations with the National System Operator (ONS). ANEEL is under the oversight of representatives of the people, the federation's states, the National Oil Agency (ANP), and diverse public institutions. The authorized and regulated activities are then carried out by the Energy Research Company (EPE), ELETROBRAS, utility companies that hold concessions for their operations and the National Development Bank (BNDES) – all of which are either public-private partnerships with open capital or non-profit organizations. Utility companies dealing with electric energy usually do not participate in other markets, the activity of multi-utility companies is low in Brazil. More information about each institution can be found in the Relevant Stakeholders section (Section 3.6).

As for opportunity and solar radiation levels, geographical differences play an important role. Using the usual division of Brazil into its major regions, North, Northeast, Central-West, Southeast and South, the status for each region is summarized below.

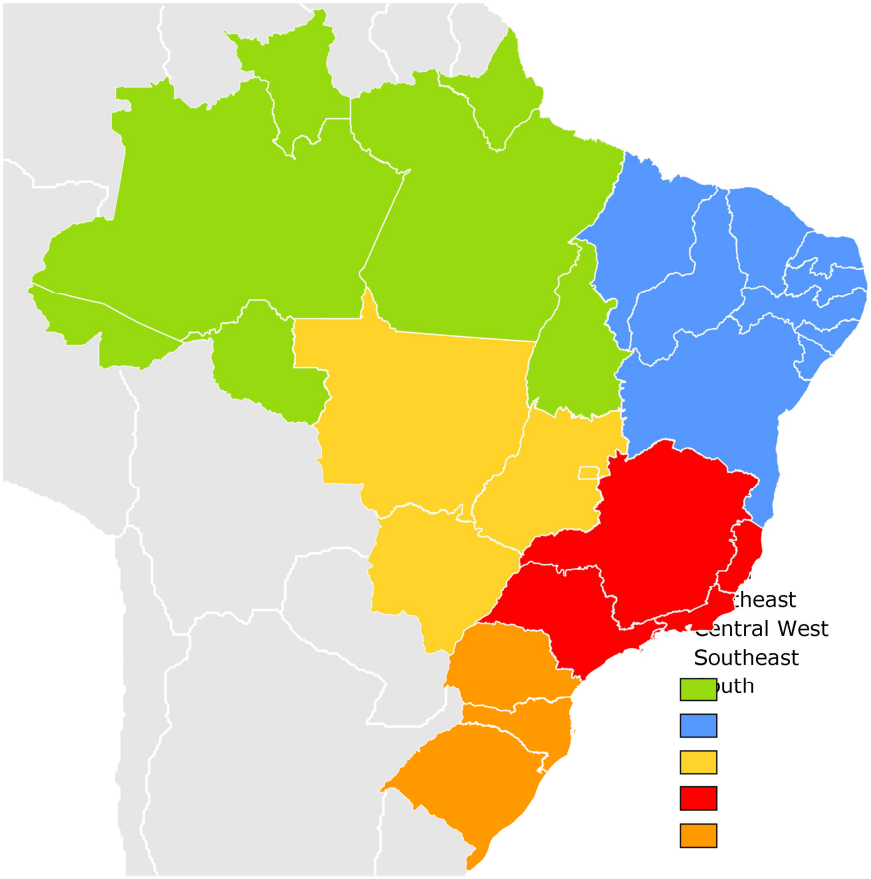


Figure 1: Map of Brazilian Regions

North

States: Acre, Amapá, Amazonas, Pará, Rondônia, Roraima, Tocantins
Demographics: 16 million people in 3,869,637.9km² = 4.12/km²
Electricity consumption: 30,196GWh
Solar radiation: 5.5kWh/m²

Description: With its low demographic density and high number of isolated communities, the North region is currently the leader in solar energy use. The lack of general infrastructure makes it less promising in terms of centralized distribution, but opportunity lies in (partial) substitution of oil/gas fueled isolated systems, in which this region is still rich.

Northeast

States: Alagoas, Bahia, Ceará, Maranhão, Paraíba, Pernambuco, Piauí, Rio Grande do Norte, Sergipe
Demographics: 53 million people in 1,556,001 km² = 34.15/km²

Electricity consumption: 79,907GWh
Solar radiation: 5.9kWh/m²

Description: This region is the most favorable for both solar and wind energy plants. Not only does it have the highest availability of radiation, it also has the strongest and most stable winds of Brazil. The higher demographic density compared to the North region also makes it compelling, but its privileged geography also means that wind turbines do not need to withstand harsh winters, hurricanes, earthquakes or corrosion, making them potentially much cheaper than now commercialized and thereby a more significant obstacle to photovoltaic plants than in the rest of the world.

Central-West

States: Distrito Federal (Brasília), Goiás, Mato Grosso, Mato Grosso do Sul
Demographics: 14 million people in 1,612,077.2 km² = 8.75/km²
Electricity consumption: 32,756GWh
Solar radiation: 5.7kWh/m²

Description: Home of the country's capital, this is where the first two solar cell factories announced to set foot in the short term. Regarding energy, this region's biggest contribution is in policy and regulation, as the most important institutions are located in Brasília.

Southeast

States: Espírito Santo, Minas Gerais, Rio de Janeiro, São Paulo
Demographics: 80 million people in 927,286 km² = 86.92/km²
Electricity consumption: 240,084GWh
Solar radiation: 5.6mWh/m²

Description: Responsible for 55.4% of Brazil's GDP and 51.8% of all electricity consumption, the Southeast is by far the most developed, most industrialized and economically most important region of Brazil. It is hence the biggest consumer and generator of electricity, but is also the most affected by the droughts of the past years. Businesswise, Dutch companies heading to Brazil will most likely find their first contacts and potential partners in either São Paulo or Rio de Janeiro.

South

States: Paraná, Rio Grande do Sul, Santa Catarina
Demographics: 27 million people in 927,286 km² = 48.58/km²
Electricity generation: 80,392GWh
Solar radiation: 5.2kWh/m²

Description: The South region of Brazil is well developed and has also been innovative with several plants using renewable sources. Although only for R&D purposes, it has the only grid-connected solar plant in operation in Brazil (Usina Cidade Azul with 1MW).

2.2 Renewable Energy

Renewable energy has become extremely important for Brazil, as the government is trying to implement policies in order to promote more renewable sources of energy. Projects like *Luz Para Todos*, which brings electricity to more than 10 million rural people, are being organized by the government in search of new ways of making the country more sustainable. In 2004 PROINFA was launched, a program to stimulate the development of renewable sources. In the summer of 2013, the government emphasized the importance of the energy sector and promised to increase the role of renewable energy sources significantly over the next seven years. The first objective is to produce nearly 70% of its energy from renewable sources by 2020. The second objective is to reach 16GW of installed wind capacity by 2021, which will account for approximately 9% of national electricity demand. Already Brazil has one of the cleanest energy matrices in the world, with approximately 41% of its overall energy production originating from renewable sources, compared to the worldwide average of 19%.

Even though Brazilian electricity production is dominated by renewable sources such hydropower, ethanol, wind power and biomass, Brazil is starting to develop solar energy generation. Currently, solar energy does not have a significant role in the sector, but this is starting to change.

Over 80% of the electricity generation installed capacity in the country is linked to sustainable sources. With 158 hydro plants operating in the country, the fundamental energy model of Brazil had long been based around hydroelectric power. Today, 70% of the renewable electricity still comes from hydro sources, such as the Itaipu Dam, a hydroelectric dam on the Paraná River. But because of the recent droughts in Brazil, hydropower has been unable to cope with the demand and other sources of energy are needed; and this is exactly where solar power can have an impact. Brazil receives more than 2.500 sun hours a year, and each day there are more than 4 kWh/m^2 solar irradiation (in the least sunny areas alone). In the Northeast part of the country, the solar irradiation per day reaches 6.5 kWh/m^2 (see appendix for solar map). This part of the country also has large parcels of land available, which could serve as solar farmland when the time is right.

2.3 SWOT Energy Market

Brazilians are justifiably proud of their clean energy matrix. With the country's abundant natural resources, it has historically been easier to generate energy with the readily available, such as water, than with coal or oil that requires additional effort to produce.

The country's strong dependence on hydro power has its disadvantages, which are and have been painfully experienced by the population for the past decade. With its extraordinary economic growth of this century's first decade, the demand for energy by industry peaked at the same time as the country started suffering from some of its harshest droughts in history. Not only are the existing hydro power plants not able to meet their normal

demand, but increasing hydro generation is expensive and requires a great deal of time due to complex engineering and cumbersome licensing requirements as well as lengthy construction periods.

Although the immediate response has been to enable expensive thermoelectric plants to raise capacity, these needs are being addressed by the government's plans for growth through diversification of its matrix. Wind power has grown fast, thermoelectric plants are increasingly using bio-fuels such as ethanol extracted from sugar cane, and PV's potential for simple, clean and rapid installation are increasingly perceived as a very logical solution.

Lagging behind in industrial development and education, Brazil has the opportunity to meet its energy challenges by investing in these very basic problems by partnering with countries that have advanced plants and high levels of education, as it certainly does not lack in natural and human resources.

Strengths	Weaknesses
• Very favourable natural conditions • Culturally connected with renewables • Strong demand	• Poor infrastructure • Large territory, high costs of transmission • No cultural association with PV • Low levels of education • Dependent on hydro power
Opportunities	**Threats**
• Broad development of all renewable sources • International Partnerships • Mini/Micro generation • Diversification of sources	• Increasing demand • Infrastructure constriction • Climate change • Political instability • Increasing price of electricity • High taxation

Influence of Oil Price on Energy

Research for this report did not find oil prices to have a direct influence on the future of PV in Brazil due to a few factors:

- The low contribution of non-renewable electricity generation in the matrix.
- The extremely high costs of thermoelectric generation. As it is mostly incidental, it can be many times more expensive than the price agreed to in the auction of 2014 for PV (R$500-600 vs R$200-250 per MWh).
- The price of fuel is regulated by the government and did not respond to the swings of the past year. When oil was high, the gasoline in Brazil was kept cheap, causing great losses to state-owned oil company Petrobras. When the oil price plummeted in end 2014, the gas price at the petrol-station actually got higher.

All the interviewees agreed that the oil prices pose no threat to PV.

There is, however, one source of concern mentioned by Andre Bertin of ZEHN Energy; there is a proposal by ANEEL (not yet reviewed) for the government to buy electricity from independent generators in times other than peak demand with prices depending on source. Diesel generated electricity would be bought for R$1420.34 (€403.79) per MWh, gas generated electricity for R$792.49 (€225.30) and all other sources would be paid R$388.48 (€110.44) per MWh. This is a significant deterrent to PV generation (or any other renewable source) for small operators.

3 PV Energy Sector in Brazil

The PV energy sector has yet to be fully developed in Brazil, as it is still a new technology for the country and not much is known about it by the general population. Even though it is something new, significant efforts have been made to develop both stand-alone and grid-connected PV energy systems, mainly for residential and commercial use. The primary and common motivation for the development of PV programs is the diversification of the energy sources traditionally used. The government is in search of new ways to develop the energy market into a more sustainable one and PV energy is an efficient and successful way to do so thanks to the large Brazilian solar resources. One of the main advantages that PV systems offer to the government is the fact that, unlike hydro-plants and wind turbines, these systems can be built close to big cities and can therefore benefit from this new energy source. Many developments have been built in order to get a healthy PV sector, yet these developments have not reached their full potential.

The areas where this kind of energy production is mostly needed are isolated areas, where there is low energy consumption, high dispersion of the population, where there is difficulty of access, and where there are environmental constraints. Awareness though, is also a big challenge. Barbara Rubim from Greenpeace Brazil stated that “in order to help the people understand the potential of PV, we are developing roof-mounted systems in two schools, one in Minas Gerais and the other in São Paulo. Our aim is to help the school and create awareness in the population”. Such initiatives can have a wide ripple effect: both projects are crowd-funded and the people involved “…will become multipliers. We are bringing interested people from all over the country to these schools to help, who will learn and share that knowledge back in their communities.”

3.1 Market Overview

Solar energy has been arousing interest in several countries as a technology considered clean and having reduced environmental impact. Brazil currently has about 200 companies that install and manufacture parts (mostly frames and support/fastening structures) in the solar energy sector and about 80% of them are micro and small enterprises located mostly in the south and southeast of the country. These companies specialize in both water heating systems and PV modules. About one million PV systems have been installed in the country so far (adding up to 30 MW of solar energy) and are used in the public, industrial, and residential sectors.

Photovoltaic solar cells are currently only being imported and are very expensive (almost 30% higher than international price levels) due to all of the regulations as well as transportation and installation costs. One reason why the installation costs are high is because there is a lack of expertise in this area and thus the companies with the expertise that is available are charging more than usual for these installations. These cells are not being produced in the country yet because the government only began to support the use of solar energy systems recently and the market is not fully developed. Brazil also lacks certain regulatory mechanisms (such as specific incentives to stimulate the PV sector and more definite policies) to effectively foster the use of PV energy; but even with these slight setbacks, Brazil has demonstrated that it is capable of bearing the costs of programs for the

introduction of energy produced with PV cells. Programs like the previously mentioned *Luz Para Todos* have been a success in the country.

Currently, the solar energy market is too underdeveloped to compete with other renewables such as wind energy, which makes entering the market very costly and time-consuming. However, there are many indications that the market is developing at a positive and stable pace. The country needs some diversification in the energy matrix to add to the traditional ways of producing energy, as well as for bringing environmental solutions to the reduction of C02 emissions created by already existing production methods. This solution can be the PV market, as it has much to offer, especially due to the excellent levels of solar radiation that at its lowest, is still twice as high as the average in Germany, which is a leader in PV; this alone creates huge potential for the Brazilian energy mix.

The Market Moves Fast

At the end of 2014, **Soliker** announced a €61 million investment as it moves operations from Campinas, São Paulo to Luziania, Goiás. The funds will be spent in setting up Brazil's first full cycle solar production facility, aiming at manufacturing from solar cells up to complete panels within the next years. Starting operations in 2016 the factory will initially only produce solar cell arrays - 130MW for the first year alone. Its medium-term objective is to export solar cells to other countries in Latin America, looking to gain a share in the market dominated by imports from China and Germany. **Soliker** already owns the land needed for its plant and for large scale solar generation, similar to their Spanish facilities that have been operating for 10 years on the same model.

According to the press release, Goiás was chosen because it offers the most competitiveness. Luziania is conveniently located near to Brasilia and thereby offers ease of communication between the private and public sectors, has outstanding solar radiation figures, offered tax incentives and also shows attractive investments in infrastructure. Vice-Governor of Goiás, Mr José Eliton sees "this company's success [as] the success of this state's economy", the Secretary for Industry and Commerce William O'Dwyer added that "this is a strategic partnership. The government of Goiás supports companies that promote sustainability". Building was wcheduled to start in January and the factory will eventually generate 98 direct and 3000 indirect jobs. **Soliker** was the second company to announce a production facility in Goiás; earlier in 2014 **S4 Solar** announced an investment of €9 million. Together they will be the only two solar cell manufacturers in Brazil.

Up- and Down-stream PV Sector

The Brazilian PV industry is highly underdeveloped, and until December 2014 there was no concrete reason for that to change. With the sale of almost 900MW through government auctions that guarantee their price for 20 years, finally a stable demand of significant size was created. As this report was being finished, another auction for approximately 1GW was announced to take place in August 2015. Local content requirements for attractive financing (see Section 3.4.1 BNDES) makes it feasible to expect that solar cells will be manufactured in Brazil by 2020.

In terms of the current situation upstream, however, there is still very little in place. There is only one factory able to assemble solar panels, TECNOMETAL with capacity for 25MW/year in Minas Gerais, and it is often idle. The production of solar panels is just part of this company's activities, which also include the engineering and manufacture of industrial process equipment. Marcellus Araújo, CEO: "we can say that this is year zero, until now it was a rehearsal", "but it is very promising…we are receiving more calls every day, we write more proposals than ever before, and we have closed sales on more and bigger projects these last months".

When it comes to potential, Brazil has a great deal. As most plants sold in the 2014 auction were around 30MW each, TECNOMETAL would not be able to supply more than one or two projects; as a result, many companies made alliances with foreign suppliers. Renova Energia, renowned developer of wind farms, announced a partnership with SunEdison for example. A step ahead were suppliers who established an office in Brazil, such as Canadian Solar, which purchased the project from a Spanish engineering firm and will develop three plants, totalling 90MW. Other examples of companies that announced they will produce locally are Globo Brasil, S4 Solar and SOLIKER, with the last two planning on manufacturing solar cells in Brazil in the next five years.

The downstream market is slightly less underdeveloped. The difference is that there are approximately 200 (micro and small) companies active in the field. "We saw the opportunity when we were developing a research project for solar heating…we saw that solar panels are going to be huge so we left the research and are now implementing" – Andre Bertin of ZEHN Energy. João Eugênio Jr of S4 Solar added that "there are just a few people who know about [solar energy], even less who are able to install a solar panel securely". The problems go further: SENAI, the main institute for industrial education in Brazil, only has one post-graduate course that deals with all renewable energies compressed into two years – and not a dedicated curriculum for PV that could educate from simple installation technicians onwards.

Current National Level Situation

As a result of the auction in 2014, many companies are taking steps to establish themselves in Brazil. As financing is conditional to local content rules (see 3.4 Financing), the first steps are being taken by companies who will assemble modules, with plans to grow that most likely will follow the local content schedule.

The national demand is predicted by EPE at about 1GW per year in auctions. There are no forecasts about distributed demand, even though it is agreed that it has just as much potential as centralized plants. The development of the market is fueled by the auctions, but once long term demand is established, the demand for distributed system follows.

Current Main PV State Level Situation

The current situation in some states in Brazil is one of promising potential and enthusiasm around PV, such as in Pernambuco with clear policies for stimulating the industry, or in Minas Gerais with much better tax incentives for distributed generation. There are signals in the market about future developments in other states, but as of this moment, the states that are worth paying extra attention to are:

- **Pernambuco:** Located in the northeast and with strong Dutch influence, Pernambuco is the only one to have carried out an energy auction even before the national government. As a state it can only stimulate the free energy market, so it has been promoting costless use of land close to the Suape harbour and will take on the costs of building infrastructure (roads, plumbing, grid connection and telecom) to the

factories. In the last 2 years, officials from Pernambuco have been attending trade shows and organizing trade missions, to identify foreign players willing to come to their state.

- **Minas Gerais and Tocantins**: These states offers tax exemptions to owners of distributed systems, who can then have up to 30% more revenue from delivering energy back to the grid than in other states.
- **Santa Catarina:** Has the largest operating solar plant in Brazil with 1MW that is set up for R&D purposes.
- **Locations of energy auction's winning projects:**

State	Projects	Total MW
Bahia	14	400
Ceará	2	60
Goiás	1	10
Minas Gerais	3	90
Paraíba	1	30
Rio Grande do Norte	1	30
São Paulo	9	270
		890

Energy Auctions

Every year, National Energy Auctions are organized by ANEEL, which attract a large number of companies who want to invest in the Brazilian energy market. These auctions invite all forms of energy development to bid for government power supply contracts and the government itself sets a ceiling price, while the developers bid down the rate at which they are willing to sell the power produced. Contracts for solar plants auctioned off are mostly 20-year energy supply contracts of at least 5 MW.

The first time solar energy was added to the open energy auctions was in 2012, which shows how young the market really is. In 2013, while only the second year having solar energy included in the mix, the auctions attracted 400 applications for PV plant development. This was also the first auction with a specific category created for PV projects, although it still competed freely with other sources. The rationale behind the addition of solar energy to the auction is the fact that Brazil currently produces less than 1% of its electricity through solar power and the government wants to change this by diversifying the country's energy mix.

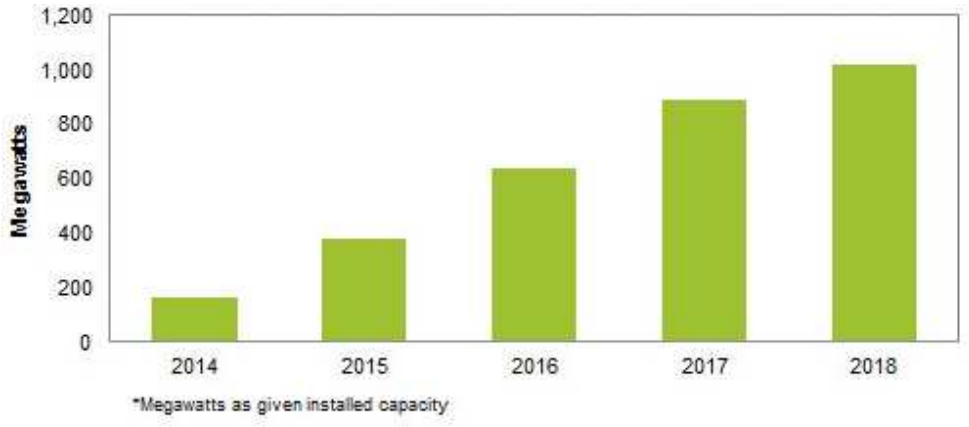


Figure 2 Brazil's Photovoltaic Outlook in Annual Installed Capacity (Megawatts)

In 2014, the first ever federal auction specifically organized for solar energy took place. At this auction, 31 PV park projects (totaling 890 MW) were awarded 20-year power purchase agreements at an average price of US$0.087/kWh against an initial price of US$0.106/kWh. This is one of the lowest prices for solar energy in the world, which is why it has also led to many questions regarding how many of these projects will actually be built, and when. All winning companies will invest a total of US$1.67 billion and are expected to start feeding the national grid by 2017. The advantage these new developers have is that many of these solar parks will be installed in areas that already have wind farms, which will reduce the amount to be spent on land and transmission lines immensely.

The Brazilian government has made it known that from now until 2018, at least 3.5 GW of solar energy will be auctioned out for new developments. Most recently, two new auctions have been announced for August and November 2015. The expectation is that it will be similar to the last one of 2014.

3.2 The Official and Unofficial Decision-Making Structures

Energy generation is tightly controlled by the Brazilian government on a national level, using instruments such as auctions and guided financing, where a minimum amount of 'local content' is to be met for a project to be financed by the Brazilian Development Bank (BNDES).

Officially, it is the Mines and Energy Ministry's (MME) responsibility to monitor the energy generation and consumption in the country. Responding to forecasts, several energy auctions are then commissioned every year, where the government buys the energy to be provided by future projects for a fixed price and time span. Solar photovoltaic projects were featured exclusively at such an auction for the first time in October 2014, where 889.600MW were sold for an average R$218/MWh (€68/MWh) for 20 years (2017-2037). Only companies established in Brazil are allowed to generate energy and to take part in these auctions. As part of MME, the National Agency of Electric Energy (ANEEL) coordinates the auctions. This report expands further on the mechanics of these auctions in Section 3.4.

In order to fund their projects, the companies count on BNDES for financing at low interest rates and advantageous conditions that cannot be met by private institutions. BNDES however, has among its rules the concept of 'local content', determining that a high percentage of the means are to be spent on Brazilian services and equipment. Subcontractors need to register with BNDES in order to supply to energy generation facilities.

Dutch companies can be suppliers, subcontractors or partners of Brazilian companies, but need to plan around the local-content requirements. Unofficially, this means that a relationship needs to be built with the auction winners and their suppliers. This can be an exceptionally long process, which usually starts with knowledge transfer and culminates with a local presence employing Brazilian resources.

3.3 Government Policy

The Brazilian government is strongly in favor of clean energy sources and, more recently, a keen supporter of PV energy. However, there have been very few specific regulatory mechanisms developed to stimulate the use of PV technology in Brazil. The few programs that have been developed to stimulate the use of solar energy are as follows:

- The Electricity Development for States and Municipalities (a program for rural electrification called PRODEEM), *Programa Luz do Sol* (Sunlight Program), Luz no Campo (National Program for Rural Electrification) and the *Luz para Todos* (Electricity for All) federal government initiatives encourage the development of alternative energy systems in rural and isolated parts of Brazil;
- The electricity regulator ANEEL has changed the rules to allow independent and individual producers to use renewable generation to connect to the national grid and a net metering Power Compensation System has been introduced to offer credits on energy bills;
- ANEEL has also granted discounts in the fees for usage of the distribution and transmission systems for plants with 1 to 30MW of installed capacity.
- Several credit options from the Brazilian Development Bank (BNDES) are available for companies operating in the renewable energy sector;
- The Global Reverse (Reversion) Reserve (RGR) is a funds provider for reversion, merging, expansion and improvement of public electric energy services.

The following sub-sections, discuss more specific policies, requirements and provisions, local content requirements, policies for installation, and import criteria.

Policy Developments

In the past few years, Brazil has had many policy developments because of its shift in focus towards renewable resources for large-scale electricity generation. Yet, as mentioned previously, very few incentives and regulatory

mechanisms have been developed to stimulate the use of PV technology. Most of the incentives have been initiated by PRODEEM, as it is one of the major promoters of PV solar systems in the country.

Policies that make it possible for the PV energy sector to prosper in Brazil are slowly developing. The following policies and regulations in the country are becoming increasingly important in the sector:

- Regulation 482 (introduced in 2012) makes it possible for all renewable energy producers to be in the energy mix thanks to many fiscal measures. This regulation also enables solar energy companies that produce a maximum of 30 MW to be eligible for the reduction of tariffs for the use of the transmission and distribution network.
- Regulation 481 (2012) grants PV plants with capacity of 1 to 30MW that start operations until 2017 with an 80% discount in transmission and distribution fees for 10 years, and 50% in the subsequent years. PV plants that start operation in 2018 onwards can apply for a 50% discount.
- Decree 3827/01 states that the taxes on industrialized products will decrease to 0%, including PV modules.
- Local content policies have been implemented (described in detail in section 3.4 Financing) and are expected to become more and more strict between now and 2020. From 2020 onwards, developers will have to use Brazilian-made cells in order to apply for low-cost funding from BNDES.
- The power systems that are not connected to the National Grid and are isolated systems that are of difficult access.
- The small-scale distribution generation which will not help the country on a larger scale, but which is extremely necessary for the promotion of solar energy production.
- Decree No. 4.873 is composed of eight articles which institute the Program for the Universalization of Electricity's Access and Use (*Luz Para Todos*). This Decree has been said to have two legal gaps which affect the promotion of electricity generation by renewables:
    1. Power systems that are not connected to the National Grid and are isolated systems that are harder to reach.
    2. Small-scale distribution generation which will not help the country on a larger scale, but which is extremely necessary for the promotion of solar energy production.
- The Brazilian Labeling Program (PBE) is a national program through which every PV system used in Brazil has to go in order to receive approval. No system is allowed to be used in the country if it is not approved. PV systems equipment required to be PBE-labeled includes: PV modules, inverters, charge controllers and batteries. Initially only crystalline-silicon PV modules were evaluated on their efficiency in standard test conditions like mechanical resistance, water tightness and corrosion, among others. The level of efficiency of PV modules can range from A to E.

Manufacturer	Equipment	Brand	Family/Model
UNITRON* Engenharia Ind. e Com. Ltda	Inverter	PROSINE	SW 1000i; SW 1800i; XS 1000; XS 1800
		UNITRON	300 SP – 12 - 220
	Charge controller	UNITRON	TOTAL CONTROL TC 1212
ORBE Brasil Ind. e Com. Ltda	Inverter	ORBE	ICS-500-024-127-1G01 ICS-300-012-127-1G01 ICS-300-012-127-1G03 ICS-300-012-220-1G04
PHOCUS AG	Charge controller	PHOCUS	CX10; CX20; CX40
Acumuladores MOURA	Battery	MOURA	12MC150M
KYOCERA Solar do Brasil Ltda	Charge controller	MORNINGSTAR	SS10; SHS10; PS15; PS30
	PV module	KYOCERA	KC50T; KC65T; KC85T; KC130TM

Figure 3 Manufacturers and PV equipment tested and approved by PBE (February 2009)

- The Working Group on Photovoltaic Systems (GT-FOT), a group within the PBE, is the one that is specifically in charge of labelling PV systems and all their components. This group has already approved various systems (as can be seen in figure 3) and since 2013, 35 PV modules from 35 producers have been certified and are available through Brazilian distributors.

Policies per State

As energy in Brazil is a national affair, the states do not differ much when it comes to policy, with the exception of Minas Gerais, Tocantins and Pernambuco.

Minas Gerais and Tocantins are granting temporary exemption from taxes charged to consumers who generate energy and sell it back to the utility companies. Called ICMS, this is a state value-added tax that in all other states is currently charged to the consumer when buying electricity from a utility company but also when selling it back. That means that the price the consumer pays when acquiring electricity can be up to 30% more than what can be expected as revenue when delivering it back to the grid. ICMS in these two states is not charged to the consumer supplying electricity back to the grid. It is expected that a similar exemption will follow nationwide in the short term.

The northeast state of **Pernambuco** has been dedicating a strong effort to getting ahead in developing the PV industry. The only state to have organized an energy auction in the mould of the national auctions, is investing into attracting foreign companies to the state. At the moment, land nearby the Suape harbour is available for manufacturing companies wishing to build plants without lease costs, and all utilities and infrastructure will be provided by the state.

Import Taxation

When importing any equipment into Brazil, a multitude of taxes apply cumulatively. At the moment, solar panels are exempt from IPI and ICMS, as can be seen in the following table:

Tax	Component			
	PV Module	**Inverter**	**Electric Meter**	**Accumulator**
II (Import tax)	12%	14%		18%
IPI (Tax on industrialized goods)	0%	15%		
ICMS (State value added tax)	0%	17-18% depending on which state		
PIS (Social contribution)	1.65%			
COFINS (Social security)	8.60%			

Additional taxes and fees may be charged on freight if done by sea (25% of the freight) with a mandatory fee of R$185 (€52.37) for registration of the import in addition.

3.4 Financing

Obtaining financing in Brazil can be difficult and almost always expensive. With an economy that appears to be heading towards a recession, with rising levels of debt defaults and less than optimal production results, the Brazilian Central Bank's interest is amongst the highest in the world at 12.75% per year. By the time credit gets to the consumers, a 15% interest charge per month on a credit card is normal.

Companies that need capital will usually turn to BNDES, the National Development Bank, as its conditions are much more attractive. Private financing is available through retail banks, investment funds and wealthy individuals. PV projects need a combination of both, or at least a combination of BNDES financing and own capital.

BNDES

The National Development Bank, BNDES, is Brazil's main financier and acts either directly or through most banks with offices in Brazil, providing credit for institutions of all sizes. As its name suggests, financing through this bank has as its main objective the development of the country. This state owned bank acts as one of the government's most important financial instruments, carrying conditions and interest rates that are far more attractive than any other bank in Brazil.

Solar energy projects that have won an energy auction or have a signed long term energy supply contract, can apply for financing through BNDES. If the project meets the conditions, credit will be supplied for 70-90% of the total costs for purchase of equipment or services within Brazil. The conditions are mostly based on the company's track record, (proven ability to conclude the project) and a guarantee of long-term demand (such as an energy auction). Equipment and materials necessary for the project must meet 'local content' conditions and also be registered in the FINAME program.

When the requirements for local content are met, the supplier can register the equipment in the FINAME – a general program for financing machines and equipment. The vast majority of Brazil's industry is familiar with it, and the registration process is almost completely automated. BNDES provides financing for the production and sale of equipment through this program, making it the anchor for guaranteeing its main goals of national development.

So far, there is no PV equipment registered in FINAME, and BNDES has not granted any financing for PV projects. "We have been studying the market and developing the PNP since 2012, and without long term demand and capable suppliers interested in the market, there was little we could do. The past auction was a great step for solar energy, which we believe has more potential than wind, and companies have already started taking steps to obtain

financing from us", said Felipe Guth from BNDES. Felipe added "we expect a boom in the whole supply chain, and I see even more potential for distributed generation in the future". When asked about what seems to be the biggest hurdles, it became clear that "our population has very little knowledge about the technology; it is not part of the culture like hydro power is, so generating that shift may be this industry's biggest challenge".

Local Content

Local content refers to minimum requirements of supply sourced within Brazil. This is a common phenomenon when dealing with state-related institutions in Brazil and these requirements vary per industry and application.

For PV, BNDES introduced the *Plano de Nacionalização Progressivo* (Progressive Nationalization Program). This program details materials and processes needed to produce the Module (the solar panel) and System (inverter, electrical components, support/fastening components + module), and establishes a basic, an optional and a bonus level of local content. A balanced scoring system uses that schedule to calculate a *Fator N*, which is used in calculating the amount of financing that the project can receive from BNDES. From 2014 to 2020, the PNP requirements follow three main steps:

- **2014-2017**
  - Module: the module should be assembled in Brazil, and its frame must be sourced within the country. Glass (or polycarbonate/acrylic), backsheet, EVA and junction box are optional, so can be imported. Everything else (silicon, ingot, wafers, solar cells) will be a bonus if sourced in Brazil.
  - System: Electrical components and support/fastening must be Brazilian. The inverter is optional.
- **2018-2019**
  - Module: the junction box is added as basic requirement to the previous schedule. The solar cells are optional and all the rest is still a bonus.
  - System: all the components should be manufactured in Brazil.
- **2020 onwards**
  - Module: adding to the previous requirements, the solar cells will have to be made in Brazil.

Private Financing

According to the industry representatives interviewed, there is no private financing available exclusively for solar projects known within the industry. Some of the past auction's winners are subsidiaries of foreign companies, or had strong ties with them, and may have obtained their financing abroad.

If a project is financed by BNDES, it will only be partially funded, and 10-30% of the capital will have to be obtained from other sources. This can be either from the company's own capital, investment funds or a bank loan. For any of these methods, general practices apply and no special treatment is given to solar energy.

Incentives

Brazil has had many incentives proposed in the area of renewable energy in general, yet for PV energy, there are still too few incentives to truly promote the use of solar energy in the country. However, these few incentives have motivated the development of the sector and are gaining national status.

The following incentives are already implemented and are projected to have a huge impact in the PV energy sector:

- Projects like PRODEEM, *Luz Para Todos, Programa Luz Solar, Luz no Campo*, and *Programa Luz do Sol* are receiving revolving funds from the government to help communities in rural areas without electricity to install solar energy generators.
- The Annual National Energy Auctions, which are organized by ANEEL, attract a large number of companies who want to invest in the Brazilian energy market and are a great success in attracting new companies to bring their developments to Brazil.
- Tax incentives are offered for certain PV equipment. On a state-level, ICMS, the State Value Added Tax, exempts only equipment specified on Decree 3827/01, which states that the taxes on Industrialized Products will decrease to 0%. On a federal-level, IPI, the Tax on Industrialized Products exempt all PV modules from IPI and ICMS; which means that all PV modules costs should be reduced.
- A Net Metering system was introduced by Regulation 482 in order to provide incentives to grid-connected distributed generation. This system ensures that the electricity supplied to the grid has the same economic value as the energy sold by the utility to Brazilian consumers. It also contributes to reducing the overall costs of PV systems as it eliminates the need for batteries for back-up. The 'net excess generation' of a client is being rolled forward and credited to the next month's electricity bill.
- Plants with capacity of 1 to 30 MW are granted through Resolution 481, an 80% discount in the fees charged for transmission and distribution for the first 10 years of operation if active up to and including 2017, and 50% discount after. Plants that start operations from 2018 onwards can also apply for a 50% discount.

Other incentives which are yet to be implemented in Brazil are as follows:

- Exemption of some taxes has recently been announced by Eduardo Braga, Minister for Mines and Energy. The problem with Resolution 482 is that consumers need to pay taxes both when they buy energy as well as when they sell it back to the grid. The net revenue for the consumer when selling energy per kW/h is up to 30% less than the buying price for the same kW/h.
- Import taxes are also expected to change. First, as there are no Brazilian solar cells, exemption is expected to be granted on the Import Tax for them and for other components of PV systems not produced locally. As the national industry evolves according to the local content schedule, import tariffs will get higher to protect the industry.

There are insufficient incentives to promote the intensive use of PV as an energy source in Brazil, even considering the country's large solar energy potential; in addition, the country still needs specific regulatory mechanisms in order to expand the share of this source of power in the national energy matrix.

3.5 Manufacturing

There is only one player active in manufacturing solar modules: TECNOMETAL has a plant with capacity of 25MW per year installed, but it is not running at capacity. There are no known manufacturers of inverters or any other PV specific equipment.

The situation is bound to change quickly if the winners of energy auctions are looking into obtaining financing from BNDES. The local content rules are in place to develop the whole supply chain.

Several companies announced that they will start assembling PV modules in Brazil in 2015; among others there were signals from S4 Solar, SOLIKER and Globo Brasil. All the interviewees for this study confirmed that the market is getting interesting and a big boom in developing the supply chain is just around the corner.

Relevant Raw Materials for PV

Brazil has large silicon resources, but is not able to produce it at the levels required for solar cells or electronic components. There are no indications of any change in that situation. Glass, polycarbonate, acrylic, aluminium and materials used in electrical components are readily available.

Production and Assembly of Components

Local assembly of PV modules, using frames sourced in Brazil, is the first step in the local content regulations and the market signals that already in 2015 more manufacturers will be active. So far, TECNOMETAL is the only company with active assembly operations.

Brazil has enough technology and large enough players to produce inverters, but there are none active at the present time.

For the remaining components, it is expected that until 2020 a fast development in the supply chain will take place.

Research and Development (R&D)

Even though PV technology is underdeveloped and facilities in Brazil are lacking, there is some interesting and exciting activity in R&D. As a highlight, CSEM Brasil has been successfully developing 3rd generation solar cells.

Set up in the mould of CSEM in Switzerland, this wholly national institute was initially set up to develop technology for EMBRAER, the Brazilian airplane manufacturer, world's 3rd largest after Boeing and Airbus. The production of Organic Photovoltaic panels (OPV) has already been developed and demonstrated, and the institute's spin-off *SUNEW* is supposed to start production soon. At this point, they are already working with FIAT for roof-mounted panels on cars and with VOTORANTIM for floating panels to be set up on large lakes.

Other than CSEM, there are academic institutions that explore the technology and are familiar with PV, but are very abstract and hardly ever make find a connection to the industry. Generally, research done in Universities ends up being geared towards the academic needs of education. Still within education, SENAI has a few extensive programs for R&D that explore ways of transposing the most actual development of the industry into professional technical education, as for example with the auto-industry with labs to educated mechanics to service the newest cars in the market. Unfortunately, SENAI does not have anything like that for the PV industry.

In general terms, there is very little in place when it comes to R&D. Applied research is a fundamental need in the market.

3.6 Relevant Stakeholders

As the industry develops, the main stakeholders that are active in the sector are still of an institutional or governmental nature. Although the market has strong signals of private companies starting operations soon in Brazil, these are yet to become factual. The list below explains shortly each stakeholder.

Name of Institution	Description
Acende Brasil	Non-profit organization that acts as watchdog of the energy sector. Mostly analyzes the market's developments and the results of policy changes and energy auctions.
ANEEL	ANEEL is the Brazilian Electricity Regulation Agency and is linked to the Ministry of Mines and Energy. Its mission is "to provide favourable conditions for the electric power market to develop a balance between the agents and the benefit of society".
ABSOLAR	Brazilian Association of PV is the class association that represents the interests of all (member) companies involved with PV.
Apine	Apine is the Brazilian Association for Independent Electric Energy Producers and acts as a representative body of independent producers. Apine interacts with the executive and legislative powers involved in the Brazilian electric sector.
BNDES	BNDES is Brazil's state-owned development bank and financed approx. 130 wind projects over the period 2003 – 2012 (BNDES, 2012). Recently, eligibility for BNDES financing has become more difficult, as the requirements have become stricter.
CCEE	Chamber of Commerce for Electric Energy is ANEEL's arm to regulate the financial aspects of the whole sector.
CEPEL	CEPEL is the Electric Power Research Center of Eletrobras and has over 30 years of research and development (R&D) experience regarding electric power generation,

	transmission and distribution.
ELETROBRAS	Biggest electricity generator of Brazil, state-owned company with open capital that once was responsible for the entire electric sector. From its division that ANEEL, ONS, CCEE and EPE emerged. Now responsible for 164 plants with 42GW total capacity.
EPE	The Brazilian federal energy planning company EPE was created in 2004 to help the government plan its energy supply. EPE is responsible for projecting energy supply and demand, supporting the government and power regulator Aneel in implementing policies, as well as carrying out studies for new power projects to be offered at government auction.
GREENPEACE	The environmental organization has a strong presence in the lobby for renewable energy with the government, with main focus on PV at this moment. Its campaigns are also drivers for population awareness of the technology.
Ministério de Minas e Energia	Ministry of Mines and Energy is at the top of the whole sector and is responsible for high level policy activities such as commissioning the energy auctions and changes in taxation.
ONS	National System Operator is ANEEL's arm for the operational aspects of the generation, transmission and distribution of electric energy in Brazil.
SENAI	National organization for industrial education, to which all industries must contribute by a percentage of revenue. Therefore large part of employee training is also done in partnership with SENAI.

3.7 Notable Developments

Many developments have taken place within the PV sector to ensure its growth. The introduction of a separate PV energy auction in the National Energy Auctions could be seen as a positive development as it is ensuring the growth of the sector as well as bringing more interest from investors in and outside of the country. The number of PV plants in Brazil could begin to rise soon because of the success of these auctions and make Brazil a potential competitor in the international PV market.

The introduction of Net Metering as an incentive to attract the residential sector has been a success because of its low costs for the government as well as the interest it has sparked among consumers. According to the Managing Director of BSW-Solar, Jörg Mayer, "The Brazilian market is a good example of how net metering models can work" and because of the success of Net Metering, the PV market might be on the verge of a breakthrough. Significant efforts have been made to develop stand-alone and grid-connected PV energy systems in Brazil, mainly for residential and commercial use.

The PV market is still underdeveloped but it is starting to flourish thanks to the many government policies that have been introduced in order to foster the growth of the PV market, and the government will continue to develop new policies to ensure this growth continues at a steady pace. Technological developments will follow after a stable market has been formed and new R&D projects will be set up to focus on developing new ideas instead of on researching possibilities for the market to grow.

Most recently (March 2015), two new exclusive auctions were announced to take place in August and November 2015. So far very little is known about them, but the expectation is for a similar format and sizes as the first one held in 2014 (approximately 1GW total, 30MW average project size). The news came together with promises from the Minister of Mines and Energy, Mr Eduardo Braga, to suspend the charges of ICMS (state value-added tax) for surplus electricity sold back to the grid from micro-generators. This could increase the consumer's net revenue by up to 30%.

4 Market Potential Assessment

For a country that has almost 1GW already sold, another 1-2GW to come in 2015 and a total of at least 3.5GW expected within 5 years, but only has one small factory in operation with 25MW/year capacity, this country's market potential is of incredible magnitude. The potential for distributed generation only adds to the clear picture that the coming years will see a boom in the development on all fronts.

With nearly every aspect of PV being in demand and without confirmed supply, it is important to note that so far, these are all promises. Offices are being established, factories announced operations in the short term and all interviewees to this study are extremely positive about the future, but there is remarkably little PV in operation right now.

4.1 Business Needs in Brazil

With such a broad potential, Brazilian needs are high in both the short and long term. In the process of structuring the market towards the development of a supply chain, now is the time for companies to invest in relationships in order to become key links in the future.

For both large centralized systems, as for smaller rooftop systems there will be demand for the short and long term. Short term opportunities seem to be stronger in large systems that are already sold, also due to another two auctions happening still in 2015. Provided that a cultural shift is needed for rooftop systems to really reach the potential demand, those seem to be more of a longer term opportunity.

Short-Term Opportunities

- **Centralized systems 10-100MW**: An immediate demand of 900MW and another 1-2GW forecast for 2015 means that the shortest term opportunities are directly related to all needs for such plants.
    - **Supply of all elements for PV modules and components for centralized systems**
    - **Design of PV plants:** the first auction already saw many winning projects that were bought by the developers from engineering consulting firms. The same is expected for the next auction this year. For both cases, further detailing and consulting in implementation of the systems will also be needed.
    - **Applied Research:** for the next auctions the projects will be expected to be more efficient, where applied research plays a fundamental role.
- **Partnerships:** as the industry is just starting to develop, establishing partnerships are at the easiest level.

Long- Term Opportunities

- **Education:** lack of formal education and professional training are a potential bottleneck for the industry. All levels are in need, from in-company training to higher education were mentioned to be lacking.
- **Financing and investments:** Another great potential hurdle is the lack of available currency for the development of the industry. From small PV systems to large PV plants, they all need affordable financing.
- **R&D:** Brazil's fortunate geographical position and abundant solar radiation mean that higher efficiency can be attained than now, according to Barbara Rubim "the PV panels we see now, lose performance when

the temperature is higher than 25 degrees Celsius". Brazil also has capacity to build inverters, but they still need to be developed.

- **Distributed (rooftop) systems:** With expected increases in electricity costs to the consumer and available supply directed (at first) at the auctioned projects, distributed systems are expected to reach higher demand, with
- **Components with low added value:** support and fastening structures, for example, can be fairly simple to attend the actual demand, but with time more efficiency is expect and more competition will be in place, making it an ideal field for gradual business development.
- **Transmission and distribution "**are potentially the biggest bottlenecks for the large projects being developed", according to Gustavo Vajda from Canadian Solar. "We already saw that with wind farms, that were completed and operative, but were not yet connected to the grid".
- **Professional services**: such as logistics and installation are not available now and demand will grow exponentially as more small and large systems are developed.

4.2 Promising Areas for Cooperation

All facets of the industry show a great degree of underdevelopment, making it interesting for cooperation as a whole. It was noted during research that there are already many partnerships between Brazilian and German institutes and companies, where Germany has been helping Brazil most of all with convincing and structuring the vague idea of solar power into a functional sector.

Also taking into consideration the large international players confirming activities in Brazil, such as SunEdison and Canadian Solar, this study found that promising areas for cooperation were:

1. **Government**: as policies are still of a broad and national character, state and municipal bodies are analyzing the potential for PV by visiting and learning from other countries; it is the right time to make partnerships.
2. **Cultural change:** perhaps the biggest hurdle now; the population at large has almost no idea what PV actually is.
3. **Education:** the availability of all levels of education to people who want to be active exclusively in the PV sector is non-existent, as it is merely part of other curricula.
4. **Knowledge, technology and applied research:** the research centres are few and far between; most are of an academic nature and little applied research is available.
5. **Business models:** "it is easier to buy a car than it is to buy a PV system" mentioned Barbara Rubim of Greenpeace Brazil. The upfront costs for distributed systems, are just too high.
6. **Financing:** even though BNDES is a great source of financing, it won't finance a whole project. When it comes to systems smaller than 5MW, it won't finance at all. There aren't any specific instruments in place.
7. **Components:** manufacture of components that can be simple at first, and get complex as the industry advances, are a great opportunity because of the expected demand and gradual development of the product and company.

8. **Services:** logistics, design, installation, operation and maintenance of PV plants will be in high demand in a short time, as most plants need to be active by or before 2017 for contractual reasons or to benefit from larger discounts in transmission and distribution.

Brazilian Knowledge about the Dutch PV Sector

Brazilians have a strong affinity with the Dutch, but not when it comes to the Dutch PV sector. In the interviews conducted for this study, Dutch football, trade and The Netherland's historical involvement with the northeast of Brazil were mentioned with high regard. When asked about Dutch PV, many didn't know anything about it and some commented on the proximity with Germany being interesting.

5 Market Entry Strategies

There are several ways to enter the Brazilian market, namely, Greenfield, acquisition, joint venture, strategic alliance and export through an agent. In this section each of these market entry strategies is discussed briefly.

Greenfield

Greenfield Investment is a form of foreign direct investment where a parent company starts a new venture in a foreign country, which in this case, would be a newly created entity in Brazil as a subsidiary of a Dutch company. Corporate entities can be set up in Brazil in one of two different structures: there is a choice between establishing a *limitada* (comparable with Dutch BV) or an S/A (comparable with Dutch NV). At a high level, the *limitada* usually gives you trading flexibility and ease of implementation. For more complex operations and limited liability, the S/A is the best choice.

The benefits of this strategy are complete ownership and full control of all processes. There are, however, several disadvantages to this strategy: taking into account Brazil's bureaucracy, the establishment of the entity can be a cumbersome process (at least three months), and there is a high probability of making mistakes with forms and licenses. It also needs great commitment in capital and managerial effort, and the entity needs a native legal representative.

Acquisition

Brazil maintains a liberal posture towards foreign investment, with low restrictions to investments in most industries. Thus, most activities may be freely executed by companies under the control of foreign citizens or foreign entities (there are few existing exceptions which are expressly determined by law). There is no difference in the treatment of foreign companies, from a legal standpoint, in all matters relating to tax, labour rights, social security, or civil and commercial law. A company incorporated in Brazil is Brazilian regardless of the nationality of its shareholders. However, take into account that local content requirements and import taxes still apply.

In general an acquisition can be a jump-start for the industry, but in fact is a complicated and lengthy process in Brazil. Besides, cultural differences can be problematic in integrating a Brazilian and a Western company.

Joint Venture / Strategic Alliance

By setting up a joint venture with a Brazilian counterpart, bureaucratic hassle (native legal representative and knowledge on Brazilian laws, regulations and licenses) can be circumvented. Furthermore, risks and rewards can be shared, and technological knowledge can be synergized. The downside of this market entry strategy is twofold. First the company is not wholly owned, and therefore not fully in control of the decision making process. Second, the Dutch company is partially liable for operative risks of the joint venture.

A joint venture in the Brazilian solar energy sector that has been announced and is promising, is the one between SunEdison, a global solar energy company headquartered in the United States, and Renova Energia, a Brazilian-

based project developer company. Each company owns a 50% stake in their joint venture which aims to operate 1GW of solar electricity in Bahia. This joint venture is counting on financing by BNDES.

Export through Agent

This market entry strategy is probably least attractive due to Brazil's protective government. Profits are low (due to local content requirements and import taxes) and there is little to no control of local operations. On the upside, it is the strategy with the lowest risk and can be operative in a short time, for example, allowing for immediate response to unforeseen demand.

5.1 Business Culture in Brazil

Brazil has historically been very welcoming of foreigners. The Netherlands is the 4th largest source of Foreign Direct Investment in Brazil with centuries old ties to the country. It is though, unique place to do business and is certainly not an easy one. Relationships of trust are paramount, and they can take a long time to build.

When considering the business of PV, given its small representation and the immense potential that will unfold rapidly, many big players are making their moves through the establishment of local offices or setting up partnerships.

The government officials, industry association, institutes and companies that this study contacted were all open for all kinds of contacts from The Netherlands.

5.2 Bilateral Cooperation

The Brazilian companies that contributed to this study stated that they are very open to the idea of cooperating with Dutch companies and institutions. It is clear that the market can become competitive quickly and more competitive advantages will be greatly needed.

In general, Brazil has an enormous business potential. The most important opportunities countrywide can be listed as follows (PWC, 2013):

- Huge internal growth potential;
- Diversified economy;
- Fast-changing business conditions;
- Inflation is under control;
- Abundance of semiskilled and unskilled labour;
- Tax incentives are negotiable in some locations;
- Experienced industrial modernization during the last decade.

Brazil and The Netherlands maintain a long lasting business relationship which dates back centuries. Compared to other BRIC countries, Brazil has the closest national culture to western countries, with easier communication and abundant treaties. Some of the industries that have profited from Dutch knowledge and equipment include Maritime, Offshore, Aerospace, Machinery, Agriculture, Livestock, Dairy, Sports and Media.

The Brazilian industries that are of interest to The Netherlands in Brazil are continuously stimulated to seek partnerships. For example, the Oil and Gas operators in the pre-salt fields off the coast of Rio de Janeiro, have close cooperation agreements with Dutch suppliers that are insured by the Dutch government. During 2012's trade mission an agreement between Petrobras and the Dutch government was signed. This €1 billion financing was a strong incentive for the Brazilian company to source equipment in The Netherlands.

Local policy and regulations play an important role in the attractiveness of Brazil. Many regulations are directly imported from the European Union's regulations and guidelines. For example, in the design of office buildings, the state of São Paulo demands some of the exact same standards as The Netherlands, making it a less cumbersome step for the manufacturers of, for instance, safety equipment, to export to this state.

Although Brazil is a very promising country for business, entrants need to keep in mind the potential factors that might affect successfully conducting business there. In the "Ease of doing business ranking", a ranking produced annually by the World Bank, Brazil only ranks 116 of 189 in 2014. The most important reasons for this are:

- Complex business regulations are a heavy burden;
- Considerable documentation and bureaucracy are involved in day-to-day operations; for the solar energy sector these can include the inefficiency of public distribution companies and the long and elaborate process to obtain all kinds of licenses;
- There are multiple taxes and high taxation on payroll;
- There are no special federal tax incentives to attract foreign investors;
- Foreign ownership of rural land is restricted.

The best way for Dutch companies to enter the Brazilian market is through a partnership with a local company, as SunEdison did with Renova Energia for an auction winning project, which will cover some of the grounds now occupied by one of Renova's wind parks. Another way to start cooperating with Brazilian companies is through first working with local universities to learn about the market potential and to teach Dutch PV knowledge at the university level. After having done this, investment opportunities might come more easily than if a Dutch company tried to enter the market alone.

5.3 Dutch Government Support

Dutch Government Presence in Brazil

The Dutch government has a solid diplomatic presence in Brazil which can provide support for doing business in the country. The following governmental bodies are present in Brazil.

- Embassy: The Dutch Embassy located in the capital Brasilia, can provide detailed information and long-term (institutional) support to the PV energy industry. The diplomatic body can also provide political assistance when needed.
- Consulates General: Present in São Paulo and in Rio de Janeiro, can help with procedural necessities and advice related to companies in their jurisdiction. Both consulates count on experienced economic departments and the consulate in São Paulo also counts on an innovation attaché.
- NBSOs: Netherlands Business Support Offices are small offices located in strategic areas for foreign business in Brazil. These offices can assist Dutch parties in developing databases and getting in contact with local business and important networks. A new office opened in December of 2014 in Belo Horizonte, Minas Gerais which has a branch-office in Porto Alegre.

Role of the Dutch Government

The bilateral cooperation between the Dutch and the Brazilians dates back centuries and Brazil maintains a strong relationship with, amongst other EU countries, The Netherlands. As the PV energy sector in Brazil is still an underdeveloped market, not many Dutch companies and research institutes have experiences operating in Brazil. Those who are active or have done business in Brazil face protective regulations, such as (import) taxes and bureaucratic procedures.

In general, Dutch companies and research institutes have expressed their satisfaction about the role the Dutch government plays when doing business in growth markets. Government to government activities are seen as helpful, especially if market players are (partially) government owned. According to the interviewees, the Dutch government should have a facilitating role when supporting parties internationally. As an example, Brazil has a cooperation agreement with Germany for help in the development of Brazil's institutional organization and capacitation programs. One interviewee mentioned a visit to Germany that included a day trip to Delft, The Netherlands, where they visited two companies active in metering being incubated in the city. This partnership with Germany was set-up between Ministers from both countries. The same approach was advised by one of EPE's directors, who added that is valuable to generate support through a direct contact in between the Embassy and EPE (specifically the ambassador and EPE's president).

In an emerging market such as Brazil, economic diplomacy is of high importance. Market sector studies (especially in immature markets) are a way to inform outside companies of the sector. Also, involvement of the sector in these studies is key, as there is a lot of international knowledge and expertise available. An economic mission to Brazil with a PV sector focus (broad sector missions have less impact) is advised. The government should set the mission agenda in close cooperation with research institutes, universities, and companies to support matchmaking between Brazilian and Dutch parties (SME's). During these missions, the Dutch government should promote the industry as a whole. The goal of the mission should be a win-win situation for the Brazilians and the Dutch. There should be expressions of what the Netherlands can give as well as take from the mission.

Seeing is believing and therefore pilot projects are a way of showing what the Dutch have to offer. Other EU countries are sometimes more willing to finance large-scale (pilot) solar projects or projects with a higher risk profile. For example, Atradius Dutch State Business does not finance projects outside the 12 mile zone; therefore, Dutch parties cooperate with German or Danish companies to obtain funding from their governments. Others indicate that public money should be used to support export via credits, bank guarantees, trade agreements, etc. (More in Appendix F)

6 Conclusions and Recommendations

In summary, Brazil has one of the cleanest energy matrices in the world, and can be considered one of the most promising markets for solar energy in Latin America because of its solar radiation of 6.5 kWh/m^2, which is twice as high as the leading country in solar energy, Germany. The government of Brazil supports the development of the solar energy sector and introduced energy auctions for renewable energy in 2009 and a separate auction for PV energy in 2014. Sector specialists see a bright future for the PV energy sector in Brazil; however, the sector has to fully develop before it can become a successful one.

The Brazilian government has demonstrated its support for clean energy and specifically PV energy in the following ways: They have set a few regulatory frameworks with favorable tax incentives for both local and international players. The state owned bank BNDES aims to be the main financier of PV plants. To protect Brazil's local market, the government has introduced policies that will ensure the sourcing, production, and assembly of components locally. These policies will surely accelerate the opportunity for foreign players to enter the market by means of setting up a local facility, strategic alliance, joint-venture or via acquisitions. Currently very few players from the rest of the world (Germany, USA, and China) are active in this underdeveloped PV market; and those companies who have a local partner (for example via a JV) have done a bit better in fulfilling the local content procedures.

Although the conditions are favorable, Brazil also faces many challenges to the expansion of PV energy such as requiring environmental licenses (complex and subject to change), a lack of sector expertise (skilled labor and know-how), a lack of manufacturing and assembly plants, a good power grid infrastructure, issues in connection to the grid, logistical issues (due to lack of infrastructure) and the development of small PV energy projects (in rural areas).

Many chances arise from these shortcomings. A whole industry needs to develop and essentially, anything related to PV can find a foothold in Brazil if it is able to recognize their place within the opportunities, which are in the short term: centralized systems (10-100MW), supply of all elements and components for these centralized systems, design of PV plants, applied research and partnerships with the already established players. And in the long term: education, financing and investments, R&D, distributed (rooftop) systems, components with low added value (that tend to become more complex in the long term), transmission and distribution, and professional services.

Recommendations to Dutch Companies

Brazil is an exciting market for foreign entrepreneurs to invest in the PV energy sector, and the time to build and strengthen business relationships in Brazil through this market could not be better.

The Netherlands has the experience, knowledge and technology to assist Brazil in various areas of the sector and would therefore have many opportunities in the PV energy sector in Brazil. The Netherlands is recognized for its exceptional skills in cooperation, innovation, creativity, design, high-tech solutions and trustworthiness. Therefore, the Dutch can assist in the design of PV farms, the design and production of solar cells, operation and maintenance

(O&M) and asset management strategies, grid integration & smart-grids, supply of technology for smart-metering as well as environmental, health and safety issues. The Dutch are experts in high efficiency and low cost solutions which, translated to the PV energy sector, means a strong position in the manufacture and delivery of production equipment. Also, Dutch companies should take advantage of their bond between manufacturers and research institutes because this is what makes Dutch products to be of great quality.

The Dutch vocational training is also a field that should not be overlooked. Right now, education in Brazil for PV is close to nonexistent, and in the long term this lack of technical knowledge in the first line of operations – especially in distributed/rooftop systems – will be a significant bottleneck. As Brazilians truly believe in their own way of getting things done, not only should the development of this 'way' be closely observed, but perhaps also be co-developed by Dutch vocational institutions through partnerships with local institutes in the SENAI network.

The Dutch Ministry of Economic Affairs and its official local network can be of assistance. Besides the already mentioned need to speak the Portuguese language, strong knowledge regarding legislation as well as investment programs is necessary for success. Here, a good judicial advisor could also be of great help since regulations are complex and continue to change. Also, personal networks become much more important than in European countries, as in Latin America, personal contacts are of great importance to succeed in any market.

The most valuable way to optimize a market entry strategy, is to involve other companies and together make use of extended support from the Dutch government, going further than monetary subsidies. A formed cluster of at least three institutions, can apply for the PIB (Partners in International Business) subsidy. This program applies to activities ranging from fact finding missions, through promotion and matchmaking, up to long term strategy support where not only financial support is offered, but also the unique resources of economic diplomacy become available to remove trade and investment barriers. A cluster can also involve non-commercial institutions, such as a University.

As an initial step towards Brazil, this study recommends immediate action by all parties that have an interest in Brazil. The time is now. A visit to Intersolar South America in September 2015, the biggest PV trade event in South America, is the earliest feasible option to expose Dutch expertise to the Brazilian PV industry as a whole. If by then a group of institutions committed to exploring this country can be formed, the use of Holland Branding for the sector would be easier and highly beneficial.

As an average SME it is recommended not to solely focus on government bodies and institutions. You need to look for partners in the business environment. Even though government bodies are very important in Brazil, in practice, an SME generally does business with local companies that are well involved, not with the government.

In addition to the many support the Dutch Official local network has to offer, for a company entering this new (and underdeveloped) market, it is necessary to be rigorously supported by advice from professionals and experts in the field as well. This is because those who are unfamiliar with the complex Brazilian market and the Brazilian way of doing things may encounter unforeseen difficulties in achieving good business. The best advice would be set up

shop locally, but if resources lack the least a Dutch company should do is contract a local point guard that can offer hands-on business support when needed.

Provided that the Dutch PV sector does indeed move towards Brazil, after successful first impressions are made a local contact becomes important. The Brazilian business environment is complex, its market for electricity is unclear and the PV sector will have to develop so rapidly, that managing remote relationships will become difficult. A central business point that is both accessible to Brazilian (potential) partners in their own language and with an ample understanding of the culture, and can function as the local business support to the Dutch companies, can greatly improve the chances of success and be a significant competitive advantage.

Recommendations to the Dutch Government

- **Regarding PV as a whole:**
  - Seek contact with ABSOLAR and other key institutions described in this study.
  - Set-up meetings to inform (especially SME's) about local content requirements, (important/local) taxes and environmental legislation, cultural differences and do's and don'ts in Brazilian business.
  - Organize the next economic mission to Brazil with a sector focus on PV energy and a mission leader who can represent the sector.
  - Know and show what the Dutch PV sector is all about. Pilot projects and participation in trade fairs such as Intersolar South America are a great way to reach the Brazilian stakeholders.
  - Know and understand the incentives, funds, credit facilities (similar to Atradius), programs and subsidies of other European countries and possibly adjust the Dutch instruments in order to improve the Netherlands' competitiveness.
  - Establish cooperation agreements with the Brazilian government. One interviewee mentioned a visit to Delft, where he noticed that the Dutch could help Brazil not only with metering technology but also with local policy for incubating tech companies.
- **Specific for large ground mounted PV systems:**
  - Seek approximation to government bodies in high political level, such as the Ministry of Mines and Energy, ANEEL, EPE and BNDES.
  - Stimulate larger and established Dutch companies to get involved with the energy auction's and past winners. Companies that have local operations in Brazil, can get involved immediately with the next auction.
- **For commercial, industrial and residential rooftop systems:**
  - Seek partnerships with government bodies and other organizations that have already some commitment with PV technology, such as the states of Pernambuco and Minas Gerais and Greenpeace Brazil.
  - Stimulate cooperation with media and educational institutions that can experience such systems in The Netherlands to stimulate cultural awareness.

As a government it is important to have a good overview of what is happening in the sector and be aware of the different initiatives, to align with them and to facilitate development where needed. The advice to the Dutch Ministry of Economic Affairs is to keep facilitating business in Brazil, continue to build the relationship with the Brazilian government, the embassy and The Netherlands Business Support Offices (NBSO) where needed. Organizing an economic mission is the most effective way to help companies with their first contact with this potential market. Brazil being a complicated place to start doing business, an economic mission helps companies as a low cost introduction to the country, providing exposure to the available subsidies and an introduction to representatives to the available network. Stimulating a mission from Brazil to The Netherlands has an equal high value, making the Dutch resources more tangible and Dutch companies more trustworthy in the perception of Brazilian representatives.

For the development of the international agenda, the advice of the private sector is to involve them as they have a great deal of knowledge and can share their experiences. Dutch parties have excellent international networks (companies and research and knowledge institutes) and are part of European projects. Via these contacts, the sector knows what is happening in other important EU PV energy expertise countries such as Germany. The Dutch can, when needed, tap into this network, intermediate and acquire facilities, products and services. The advice to the Dutch Ministry of Economic Affairs, in this respect, is to listen to the (private) sector, follow them internationally and align (or even join hands) with the international strategy of the Dutch Ministry of Economic Affairs with other EU countries. Having a broader view is also desirable as the playing field is changing so that not only Dutch owned companies operate, but also former Dutch companies (now part of global players) who face different international strategies due to their global presence.

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890 MW of PV clears in Brazil's reserve auction by Christian Roselund of PV Magazine. 02 November 2014.

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Manual de Engenharia Para Sistemas Fotovoltaicos by João Tavares Pinho and Marco Antonio Galdino of CEPEL - CRESESB. March 2014.

O Mercado Brasileiro de Geração Distribuída Fotovoltaica em 2013 by IDEAL. November 2014.

Os brasileiros diante da microgeração de energia renovável by Greenpeace and Market Analysis.

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The Brazilian Photovoltaic Market: Potential for New Investments? By Eleonora Azzaoui of Hertie School of Governance. 04 August 2013.

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Photovoltaics in Brazil: Market, Policy Trends and Choice of PV Technology Presentation by Prof. Ricardo Rüther of UFSC and IDEAL.

Solar Energy for Brazil by Bridges to Brazil.

Solar Power for Homes Net Metering Explained by Solarmatrix Australia's Youtube Channel. 01 December 2011.

Appendix A: Interviews

The following people were interviewed for this study. Contact details are available as agreed by the interviewees.

Name, Position	**Company/Institution**	**Contact**
Rodrigo Sauaia, CEO	**ABSOLAR**	contato@absolar.org.br www.absolar.org.br
Régis Martins, Executive Director	**APINE**	apine@apine.com.br www.apine.com.br
Felipe Guth, Renewable Energy Sources Department	**BNDES**	felipe.guth@bndes.gov.br www.bndes.gov.br
Hugo Albuquerque, Director of Sales **Gustavo Vajda**, Project Manager	**Canadian Solar**	hugo.albuquerque@canadiansolar.com gustavo.vajda@canadiansolar.com www.canadiansolar.com
Diogo Cordeiro, Business Development Manager	**CSEM Brasil**	diogo.cordeiro@csembrasil.com.br www.csembrasil.com.br
Eduardo Azevedo, Executive Secretary Energy	**Estado de Pernambuco**	eduardo.azevedo@srhe.gov.pe.br www.srhe.gov.pe.br
Barbara Rubim,	**Greenpeace Brasil**	brubim@greenpeace.org www.greenpeace.org/brasil/
Erick Castro, CEO/Principal	**Nótus Renováveis**	erick.castro@notusrenovaveis.com.br www.notusrenovaveis.com.br
João Eugênio Jr., CEO	**S4 Solar**	www.s4solar.com.br
Sidnei Petrin, Director of Professional Education	**SENAI**	spetrin@sp.senai.br www.sp.senai.br
Marcellus Araújo, CEO	**Tecnometal**	nikole.almeida@dyasolar.com.br www.dyasolar.com.br
Andre Bertin, Engineering and Development manager	**ZEHN Energy**	andre.bertin@zehnenergy.com
José Carlos de Miranda Farias, Director of Electric Energy Research	**EPE (Empresa de Pesquisa Energética)**	www.epe.gov.br faleconosco@epe.gov.br

Appendix B: List of Members of ABSOLAR

The following companies are active in Brazil and members of ABSOLAR and considered relevant for the Brazilian PV sector.

Company	Type	Website	Address
AD Corretora de Seguros	Insurance broker	www.ad.com.br	Unknown
Alsol Energias Renovaveis S.A.	Distributed systems	www.alsolenergia.com.br	Unknown
Alubar Energia S.A.	Electrical components	www.alubar.net.br	Avenida Carlos Gomes, 1200 Conj. 605 Porto Alegre – RS CEP: 90480-001
Araxá Energia Solar Ltda	Consulting	www.araxasolar.com.br	Rua Emílio Blum, 131 - 2º andar Salas 204 e 205 Florianópolis - SC CEP 88020-010
Arteche	Electrical components	www.arteche.com.br	Avenida Juscelino Kubitschek de Oliveira, 11400 Curitiba – PR
Blue Sol	Distributed systems	www.bluesol.com.br	Av. Antonio Diederichsen, 400 Ribeirão Preto, SP CEP: 14020-250
Brasil Comercializadora de Energias	Consulting	www.brcomercializadora.com.br	Rua Helena, 260 cj 72 São Paulo - SP CEP: 04552-050
BRL Solar	Unknown	www.brlsolar.com.br	Unknown
Canadian Solar Brasil	Developer	www.canadiansolar.com	Rua Barao do Triunfo 427, 12th floor São Paulo – SP
Cegelec – Actemium	Construction	www.cegelec.es/en	Av Engenheiro Eusébio Stevaux, 1444 São Paulo - SP
CESP	Utility and developer	www.cesp.com.br	Av. Nossa Senhora do Sabará, 5312 São Paulo – SP CEP: 04447-011
Comercial Elétrica Redimax	Retail and courses	www.redimax.com.br	Unknown in Sao Paulo
Companhia de Energias Renováveis	Developer	www.cer-energia.com.br	Unknown in Curitiba
Constalica Soufer – MadreMax	Metal Structures	www.madremax.com.brindex.html	Av. Dolores Martins Rubinho, 945 Distrito Industrial II São João da Boa Vista - SP CEP 13877-757
Correa Porto Sociedade de Advogados	Law firm	www.correaporto.com.br	Av. Paulista, 726 - 17th floor São Paulo – SP

			01310-910
CSEM Brasil	R&D	www.csembrasil.com.br	Avenida José Cândido da Silveira 2000 Belo Horizonte - MG CEP: 31.035-536
Dinâmica Energia Solar	Unknown	www.dinamicaenergiasolar.com.br	Rua Vicente Pelicano, 1297 São Carlos SP CEP 13571-000
EBES Sistemas de Energia S.A.	Consulting	www.ebes.com.br	Rua Neuza, 433 Diadema - SP
Elektro Comercializadora	Utility	www.elektro.com.br	Rua Ary Antenor de Souza 321, Campinas – SP
Elementos Empreendimentos	Consulting	www.elementos.com.br	Alameda Paranavaí nº 392 Santana do Paranaíba - SP CEP 06539-045
Eletrônica Santerno	Electrical components	http://www.santerno.com/br/home.html	Av. Pereira Barreto, 1395 - 13º andar - Torre Sul Santo André - SP CEP: 09190-610
Encalso Construções LTDA	Unknown	www.encalso.com.br	Praça Dom José Gaspar, 134 - 4º Andar São Paulo - SP CEP 01047-010
Enel Green Power LTDA	Developer	www.enelgreenpower.com	Praça Leoni Ramos, 1, 5º andar – Bloco 2 Niterói – RJ CEP 24210-205
Engecorps Engenharia S.A l	Consulting	www.engecorps.com.br	Alameda Tocantins 125, 4°andar Barueri – SP
Eudora Energia	Unknown	www.eudora-energia.com.br	Unknown
First Solar	PV Modules	www.firstsolar.com	Av. Cidade Jardim, 400 Suite 713 - São Paulo – SP CEP 01454-000
Flextronics	Electrical components	www.flextronics.com	Rodovia SP 340 Km 128 7A Tanquinho – SP
Fronius do Brasil	Electrical components	www.fronius.com.br	Av. Dr. Ulysses Guimarães, 3389, Galpão 4 Diadema - SP CEP: 09990-080
FRV do Brasil	Developer	www.frv.com	Av. Santos Dumont, 2828 Conj.1406/1408 Torre Santos Dumont Fortaleza – CE
Genera	Consulting	www.generaspa.it	Av. Roque Petroni Jr 999 - 13 andar São Paulo - SP

			CEP 04707900
DNV GL	Certification	www.dnvgl.com	Avenida Alfredo Egídio de Souza Aranha, 100 São Paulo – SP CEP 04726-170
Helio Energias Renováveis	Distributed systems	www.helioenergiasrenovaveis.com.br	Rua Vicente Linhares 500, Sala 507 Fortaleza - CE
Insole	Distributed systems	www.insole.com.br	Av.Domingos Ferreira 2215, Sala 301 Empresarial St Sicília. Recife – PE
Jema Energy do Brasil	Eletronic components	www.jemaenergy.com	Rodovia Marechal Rondon Km 252,5 Botucatu – SP CEP: 18607-810
Kroma Comercializadora de Energia	Consulting and developer	www.kromaenergia.com.br	Av. Ayrton Senna da Silva, 1111 Jaboatão dos Guararapes - PE CEP: 54400-020
Meta Solar	Distributed systems	www.metasolar.com.br	Unknown in Rio de Janeiro
Meyer Burger AG	PV Technology	www.meyerburger.com	Unknown in Sao Paulo
MSPAR Energia e Participações SA	Unknown	Unknown	Unknown in Sao Paulo
Multi-Contact (Stäubli)	Electrical components	www.multi-contact.com/products/solarline/33	Rua Henri Dunant, 137 - Conj.D São Paulo – SP CEP 04709-110
Multiempreendimentos	Consulting	www.multiempreendimentos.com	Rua João Fernandes Vieira, 489 Recife – PE CEP 50050-200
Neosolar Energia Ltda	Retail and courses	www.neosolar.com.br	Avenida Brigadeiro Luís Antônio, 3005 Casa 4 São Paulo - SP CEP 01401-000
Nótus Soluções Renováveis	Consulting	www.notusrenovaveis.com.br	Rua Dr. Gilberto Studart, 55 - Sala 1001 Fortaleza – CE CEP: 60190-750
On Line Engenharia	Consulting	www.onlinesistemas.net	Av Isaac Póvoas – Ed. Conj. Nacional – 14 andar Cuiabá - MT
Pacifc Hydro	Developer	www.pacifichydro.com.br	Alameda Santos, 700 – Cj. 62 São Paulo – SP CEP: 01418-100
Paes Neves Serviços de Energia – Eco Watts	Consulting	Unknown	Unknown

Phoenix Contact Ind e Com Ltda	Electrical components	www.phoenixcontact.com	Rua Francisco Corazza, 20-100 São Paulo - SP CEP: 05038-130
Pro Solar	Distributed systems	www.pvsolar.com.br	Unknown
Pure Energy	PV Modules	www.pureenergy.com.br	2155 Av. Dona Constança de Góes Monteiro Maceió – AL
Quantum Engenharia Elétrica	Consulting	www.quantumengenharia.net.br	Rua Dom Pedro II, 63 – Capoeiras Florianópolis - SC CEP: 88090-840
Renova Energia SA	Developer	www.renovaenergia.com.br	Av. Roque Petroni Junior, 999 - 4º andar São Paulo – SP
Romagnole Produtos Elétricos	Electrical components	www.romagnole.com.br	Rua Rocha Pombo, 335 Mandaguari, PR CEP: 86975 000
Schneider Electric Brasil Ltda	Electrical components	www.schneider-electric.com	Avenida das Nações Unidas, 18605 São Paulo – SP CEP: 04795-100
SER	Consulting	www.serbrasil.com.br	Av. Prof. Magalhães Neto 1550 sl 1407 Salvador - BA CEP: 41810-012
Servtec	Consulting	www.servtec.com.br	Rua do Bosque, 1281 São Paulo – SP
Sices do Brasil	Electrical components	www.sicesbrasil.com.br	Avenida Portugal 1174, Condomínio empresarial ONIX, galpão 3 e 4 ITAPEVI – SP CEP: 06696-060
Sistechne – Intertechne	Electrical components	www.sistechne.com.br	Av. Iguaçu, 100 Curitiba – PR CEP: 80230-020
Solen Comercio e Serviços de Energia Solar	Unknown	www.solenenergia.com.br	Unknown
Sollex Energia Ltda	Utility	www.federalenergia.com.br	Avenida Paulista, 777, 1 Andar São Paulo – SP CEP: 01310-200
Sowitec do Brasil	Developer	www.sowitec.com	Avenida Luís Viana Filho, nº 6.462 - Edifício Wall Street Empresarial - Torre East, Salas 1.507 a 1.523, Paralela Salvador – BA CEP: 41730-101
SunEdison	PV Modules	www.sunedison.com.br	Av. das Nações Unidas, 12.399 - 7° andar – sl 77 A

			São Paulo - SP CEP: 04578-000
Sunlyx Brasil Participações &Consultoria em Energia Solar	Consulting	www.sunlyx.com/SUNLYX/HOME.html	R Bandeira Paulista, 275 - Andar: 1 São Paulo - SP CEP: 04532-010
Thesan	Mounting systems	www.thesan.com	Avenida Paulista 2300 São Paulo - SP
Uberluz	Consulting	www.urbeluz.com.br	R. Tabapuã, 500 cjs 103/104, São Paulo – SP CEP: 04533-001
Unitech Soluções em Energia	Electrical components	www.unitechsolucoes.com.br	Rua Andaluza, 87 – Vila São Paulo – SP CEP: 04286-040
Weg	Electrical components	www.weg.net	Avenida Prefeito Waldemar Grubba, 3300 Jaraguá do Sul – SC CEP: 89256-900
Yingli Green Energy do Brasil SA	PV Modules	www.yinglisolar.com/br	Rua Iguatemi, 192, 13˚ andar, conj. 133 São Paulo – SP CEP: 01451-010

Appendix C: Relevant Stakeholders

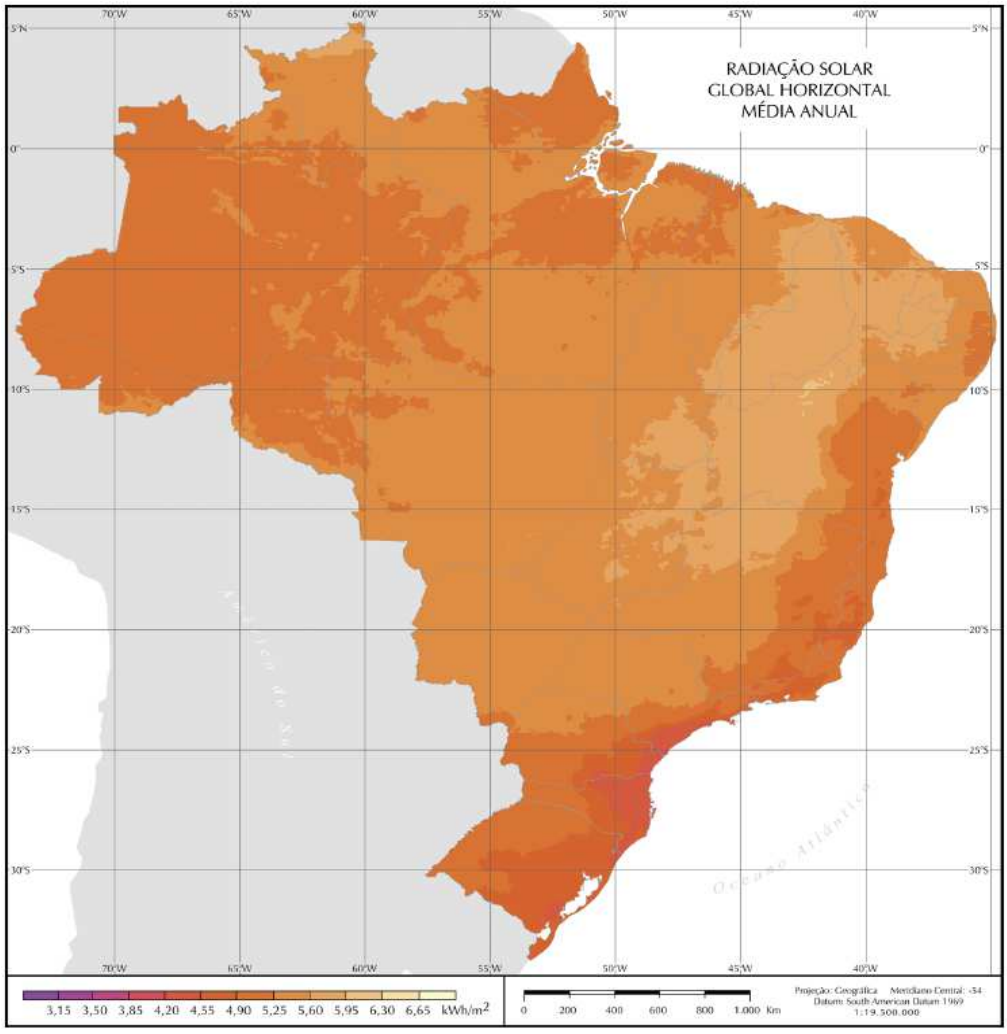
The following Institutions were mentioned in the report as relevant stakeholders. The following table has included relevant contact information.

Name of Institution	Contact Information
Acende Brasil	Rua Joaquim Floriano, 466 Edifício Corporate, Conjunto 501 - 5º Andar São Paulo - SP CEP 04534-004 Tel.: +55 11 3704-7733
ANEEL	SGAN 603 módulo J Brasília DF CEP 70830-110 Telefone Geral: +55 61 2192-8600
ABSOLAR	Av. Paulista, 1636, 7º andar, conj. 706 São Paulo - SP CEP 01310-200 Tel.: +55 11 3197-4560
Apine	Qd. 06 Ed. Business Center Tower Brasil XXI, bl C – Sala 212 – Brasilia – DF CEP 703222-915 Tel.: +55 61 3224-6731 / +55 61 3226-3130
BNDES	Avenida República do Chile, 100 Rio de Janeiro - RJ CEP 20031-917 Tel.: +55 21 2172-7447
CCEE	Avenida Paulista, 2.064 - 13º andar São Paulo - SP CEP: 01310-200 Tel.: 0800 10 00 08
CEPEL	Av. Horácio Macedo, 354 Rio de Janeiro – RJ CEP: 21941-911 Tel.: +55 21 2598-6000
ELETROBRAS	Av. Presidente Vargas, 409/13º andar Rio de Janeiro – RJ CEP: 20071-003 Tel.: +55 21 2514-5151

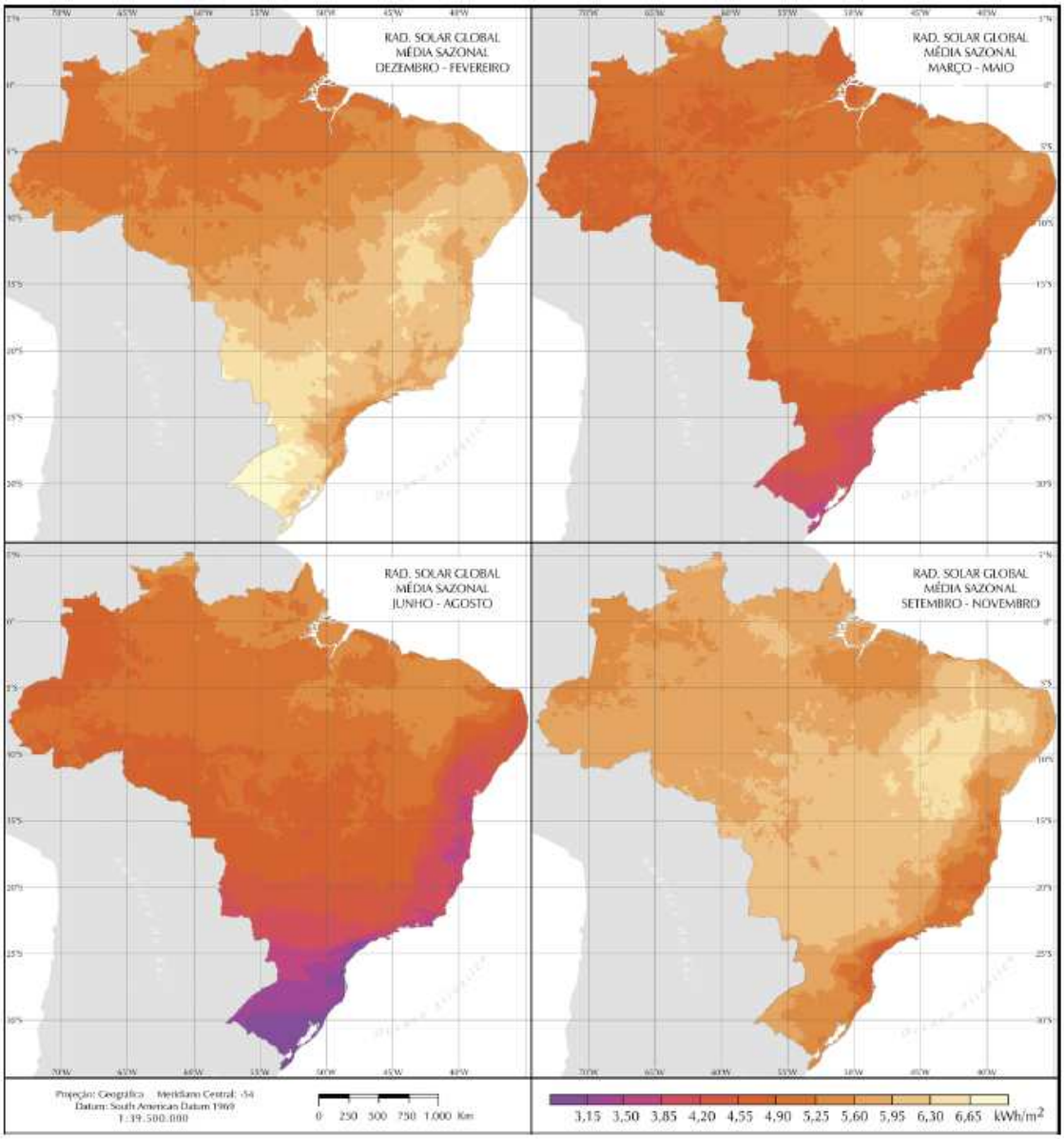
EPE	Main office (Technical and Operational base): Av. Rio Branco, 1 – 11º andar, Centro Rio de Janeiro - RJ CEP: 20090-003 Tel.: +55 21 3512-3100 Fax: +55 21 3512-3198 Headquarter SCN, Qd. 01, Bl. C, nº 85, Sl. 1712/1714 Edifício Brasília Trade Center Brasília - DF CEP: 70711-902 Tel.: +55 61 3022-2724
GREENPEACE	Rua Fradique Coutinho 352 Pinheiros - São Paulo/SP CEP: 05416-000 Tel.: +55 11 3035 1155
Ministério de Minas e Energia	Esplanada dos Ministérios Bloco "U" Brasília - DF BRASIL CEP: 70065-900. Tel.: +55 61 2032-5555
ONS	Rua Júlio do Carmo, 251 Rio de Janeiro – RJ CEP: 20211-160 Tel.: +55 21 3444-9400
SENAI	Rua Jerônimo Teles Jr, 125 São Paulo – SP CEP: 05154-010 Tel.: +55 11 3901-9305

Appendix D: Useful Maps

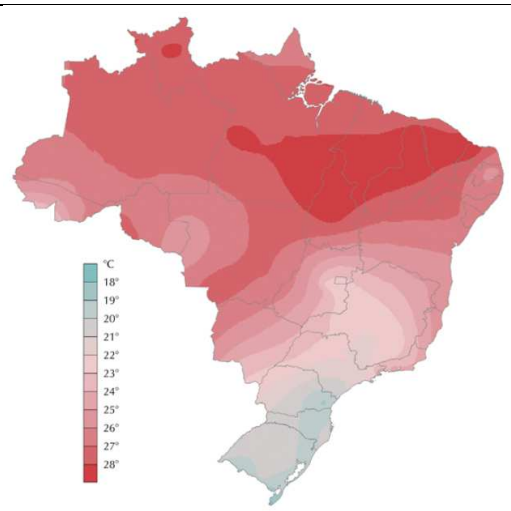
From the Brazilian Solar Atlas (2006), these maps illustrate different aspects pertinent to solar energy generation:



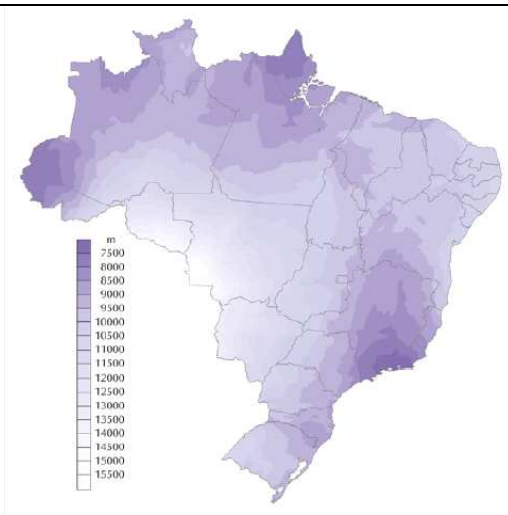
Annual mean of horizontal solar radiation



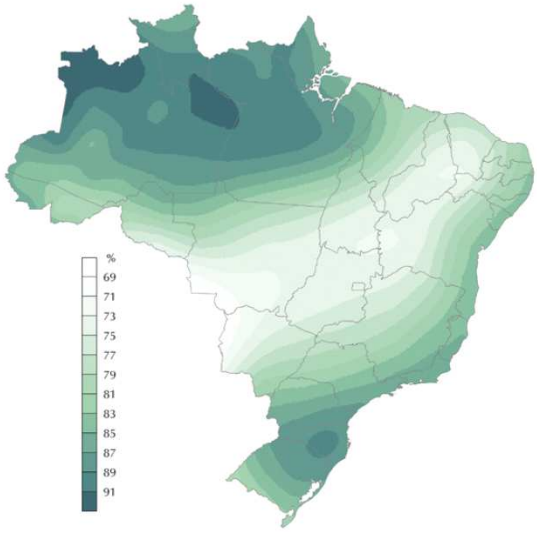
Seasonal mean solar radiation. From top left, clockwise: December to February, March to May, June to August, September to November



Annual mean of temperature in Celsius



Annual mean of visibility



Annual mean of relative humidity

Topography

Map of Brazilian States and Cities

Appendix E: Rooftop Payback Sample Calculation

The increasing price of energy makes PV more attractive for distributed generation. So far in 2015 households are paying up to 30% more than they did in 2014, with more increases expected before the end of the year.

As an example, the calculation below is based on a tool from INSTITUTO IDEAL (Institute for Alternative Energy Development in Latin America) and shows a rough sketch of a typical Brazilian household in the upper middle class, who would be able to invest in a PV system.

Disclaimer: variation in prices of equipment, exchange rate, installation costs and future increases in energy prices are not taken into account.
Source: http://www.americadosol.org/simulador/index.php

Sample Household

Number of adults	5	
Monthly electricity usage	430kWh	
Electricity cost (per kWh)	R$0.52875	€0.16
Monthly costs on electricity*(c)	R$245	€75.76

*includes R$17,62 on fees

Calculation:

PV system needed in area	16-20m^2	
PV system needed in kWp (a)	2,4kWp	
Cost per kWp (b)	R$7k-10k	€2.2k-3k
Investment (a*b)	R$16.8k-24k	€5.2k-7.4k
Payback (investment/c)	~69-98 months	
	~6-8 years	

Appendix F: Instruments of Support by the Dutch Government

RVO programs

Business partner scan

A business partner scan provides you with an overview of possible partners in Brazil. These can be agents, distributors or production partners. The partner search will be conducted in collaboration with Dutch embassies, consulates and Netherlands Business Support Offices. They know the local market and can cope with language and cultural barriers. After identifying possible partners these companies will be asked if they are interested in potential cooperation. Involved costs: € 500,-.

Website: http://www.rvo.nl/onderwerpen/hoi/netwerkpartners-zoeken/internationale-zakenpartners/zakenpartnerscan (only in Dutch)

DHK Subsidy

This subsidy has a €4 million fund for supporting demonstration projects, feasibility studies and knowledge acquisition in developing countries (such as Brazil). Conditions:

- Demonstration projects and feasibility studies: can only be requested by groups of 2 or more companies of any size.
- Knowledge acquisition activities: can only be requested by an individual company that has to be an SME (in Dutch: MKB)

Website: http://www.rvo.nl/subsidies-regelingen/dhk-voor-opkomende-markten (only in Dutch)

Economic missions

RVO regularly organizes economic missions to interesting countries under the guidance of a member of the government. The presence of members of government and the network of diplomats can open doors and provide you with interesting contacts and remove barriers to business. Involved costs: EUR 950,-.

Website: http://www.rvo.nl/onderwerpen/internationaal-ondernemen/exportbegeleiding/missies-en-handelsreizen (only in Dutch)

Finance for International Business (FIB)

The Dutch government provides 35% of the funding amount by loan (co-financing), with a maximum funding amount of € 2.5 million per company per country. No collateral requested. Because the government effectively participates in the financing part, financiers are more willing to fund the investment. In 2013 total budget was € 7.5 million.

Website: http://www.rvo.nl/subsidies-regelingen/finance-for-international-business-fib (only in Dutch)

Starters International Business (SIB)

The Starters International Business facility provides advice and support for companies who wish to develop an internationalization strategy for Brazil. The company can apply for a voucher (max. €2.400). With this voucher the company can hire an advisor from one of the cooperating organizations, who will examine the risks and possibilities and who will develop a plan of action.

Starters International Business is designed for SME entrepreneurs:

- With little or no experience of doing international business e.g. Brazil;
- Who want to embed international business in the structure of their company;
- Who have adequate resources (HR, timing, funding);
- Who are willing to invest time and money to examine and start up business activities in Brazil.

Website: http://www.rvo.nl/subsidies-regelingen/starters-international-business-sib (only in Dutch)

Partners for International Business (PIB)

If clusters of companies and knowledge institutes want to enter Brazil, RVO could support via the Partners for International Business (PIB) program. Through economical diplomacy the government aims to remove business barriers. In 2014 the total budget is about € 6.3 million.

PIB focuses on the Dutch 'Topsectors' (Energy, Life Sciences, Creative Industries, Water, Agro-Food, Horticulture, High Tech Material & Systems, Logistics en Chemicals). The cluster should consist of at least 3 companies. There are 27 focus countries, Brazil is one of them.

Website: http://www.rvo.nl/subsidies-regelingen/partners-international-business-pib (only in Dutch)

Energy in Horizon 2020 (EU)

Horizon 2020 is the biggest EU Research and Innovation program ever with nearly €80 billion of funding available over 7 years (2014 to 2020). € 5.4 billion is assigned to Energy. Any organization that is active in research, technological development and innovation can participate. The European Commission generally requires cooperation with foreign partners.

Website: http://english.rvo.nl/subsidies-programmes/horizon-2020-research-and-innovation

Miscellaneous programs

Exportkredietverzekering (EKV)

Atradius Dutch State Business offers Dutch exporters of capital goods or international construction projects a wide range of insurance and guarantee products when doing business in emerging markets, including Brazil.

Credit insurance on behalf of and for account of the Dutch State usually involves export transactions with credit periods or a completion time in excess of twelve months. These always involve the supply of capital goods such as machinery or equipment.

Through its insurance and guarantee products Atradius can assist you in winning export transactions and increase your financing capacity with your bank.

Website: www.global.atradius.com

Fund for Dutch Enterprises (FOM)

FOM provides medium and long term loans to companies or joint ventures in Brazil that are majority owned or controlled by Dutch enterprises. In many cases, no appropriate commercial financing is available for these joint ventures and subsidiaries for the construction or expansion of a production plant or to buy new equipment. Also, tenors are often too short or excessive security is needed. FMO offers these joint ventures and subsidiaries the opportunity to strengthen their financial structure, by providing often unsecured or subordinated loans. As a result companies are in a better position to attract working capital from local banks.

FOM specifications:

- Financial package is tailored to the specific needs of the local enterprise;
- Financing amounts to a maximum of EUR 10 million;
- Maturity can range from 3 to 12 years.

Conditions:

- Local joint venture/subsidiary must be majority Dutch owned;
- The Dutch company must provide certain guarantees to strengthen the financial structure of the local enterprise;
- FOM will not finance Dutch companies that have entirely or largely transferred to emerging markets.

The costs of FOM-finance - interest and fees- are in line with market conditions and based on the risk-profile of each individual case. FMO is open for companies from all sectors, however the companies must have a focus on: Agribusiness; Water; Energy and Financial institutions.

Website: www.fmo.nl