Ministry of Foreign Affairs

STUDY ON MARKET INFORMATION HIGH-TECH SYSTEMS AND MATERIALS (HTSM) IN THE ENERGY SECTOR IN BRAZIL

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INSTITUTO SENAI DE TECNOLOGIA ENERGIA

SENAI

STUDY ON MARKET INFORMATION HIGH-TECH SYSTEMS AND MATERIALS (HTSM) IN THE ENERGY SECTOR IN BRAZIL

SENAI
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1 Executive summary

The Brazilian energy matrix is predominantly composed of renewable sources, among which the hydroelectric plants stand out, which correspond to around 66% of the total domestic electricity supply.. Particularly noteworthy especially in recent years is the growth of wind and solar sources, which already represent about 8% of the energy offered.

According to the study of "Technological Prospecting in the Electricity Sector", carried out by ANEEL (National Electricity Agency) the evolution of the electricity demand until 2050 should require between 400 GW and 480 GW in installed capacity of the National Interconnected System (SIN).

According to data from ABEEólica (Brazilian Wind Energy Association), in 2019 wind energy reached the mark of 15 GW in installed capacity in Brazil. There are 601 wind farms with about 7,000 wind turbines spread across 12 states.

According to data from ABSolar (Brazilian Association of Photovoltaic Solar Energy), Brazil had, by the end of 2018, 2,454 MW of total installed capacity originating from solar plants.
Most commercially available photovoltaic modules are made of crystalline silicon (> 85%). Although technology is widespread in the market, there are still barriers / obstacles to overcome in order to make it even more technologically and commercially viable.

The generation of electric energy through biomass today represents about 9% of the total energy generated in the country.

The application of high technology in systems and materials (HTSM) is still long overdue in the Brazilian electric sector.

Several studies have been carried out to identify the gaps in the sector, but there was no practical application for the results of these studies.

Most of the companies operating in the country are branches of foreign companies and there is little technology development here in the country, the systems undergo adaptations to adapt to the conditions in Brazil so we consider research and development as a fertile field for the performance of new companies

2 *Recomendations*

As a result of the research carried out, we will list in this chapter the opportunities identified by sector:

- **WIND:**

• Equipment transportation technology;
• Innovative solutions for the operation and maintenance of wind turbines;
• Technology for inspection and maintenance of gearboxes;
• Tests for certification of wind turbines.

- **SOLAR PHOTOVOLTAIC:**

• Development of national technology that is competitive in terms of costs with imported materials, mainly from China;
• Development of national technology for the manufacture of bifacial panels;
• Integration of technologies such as artificial intelligence, machine learning with photovoltaic generation systems;
• Use of management and monitoring software;
• Use of technology for solar tracking.

- **BIOENERGY:**

• Implementation of monitoring and control systems;
• Development of technologies to increase the efficiency of biodigesters;
• Use of nanotechnology to accelerate the biodigestion process

- **ENERGY STORAGE:**

• Use of new materials for the production of batteries;
• Development of systems for monitoring and control;
• Development of new technologies to reduce the costs of storage systems;

This sector presents itself as one of the richest for investment in research and development because we have very few companies operating in the area and there is a market that lacks solutions

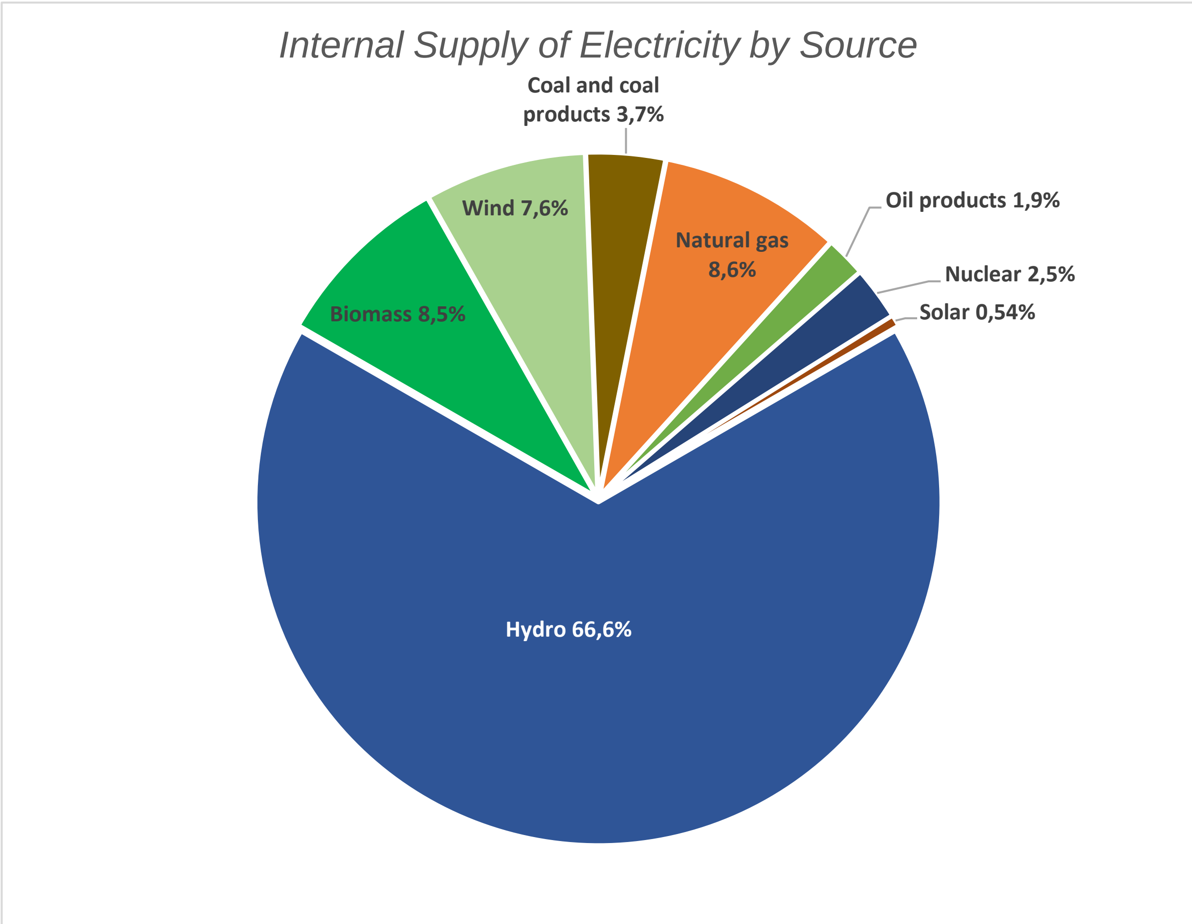
- **SMART GRIDS:**

This market is the one with the biggest gap, due to the lack of incentives and the abandonment of previously developed programs, little has been done to advance this technology.

3 *Brazilian energy sector*

The Brazilian energy matrix is predominantly composed of renewable sources, among which the hydroelectric plant stands out, which corresponds to about 66% of the total domestic energy supply. Particularly noteworthy especially in recent years is the growth of wind and solar sources, which already represent about 8% of the energy offered.

Chart 1 Internal Supply of Electricity by Source



According to data from the EPE (Energy Research Company), the installed capacity of the wind energy source should exceed 90 GW by 2050 and the solar source should exceed 4.5 GW by 2025.

According to the study of “Technological Prospecting in the Electricity Sector”, carried out by ANEEL (National Electricity Agency) the evolution of the electricity demand until 2050 should

require between 400 GW and 480 GW in installed capacity of the National Interconnected System (SIN).
Brazil's electricity market is regulated by the National Electricity Agency (ANEEL) that regulates public tenders for electricity sold to distribution utilities, sets tariffs for residential consumers in the regulated market, and is responsible for maintaining an economic balance that enables distributors to cover operating cost and recover an adequate return on investment. Meanwhile, a liberalized and unregulated system governs electricity trading between independent energy suppliers, and industrial consumers have the option of purchasing from the unregulated market.

4 High Tech Systems and Materials (HTSM)

4.1 Wind

Wind turbine technology

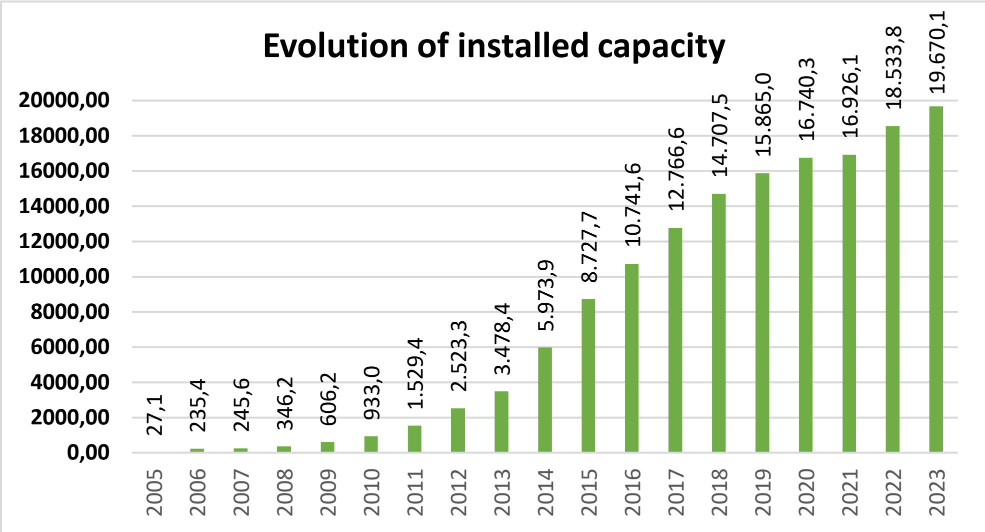
4.1.1 Indicators

According to data from ABEEólica (Brazilian Wind Energy Association), in 2019 wind energy reached the mark of 15 GW in installed capacity in Brazil. There are 601 wind farms with about 7,000 wind turbines spread across 12 states.

In addition to the 15 GW of installed capacity, there are already 4.6 GW contracted through auctions or already under construction. This means that by 2023 we will have installed at least 19.6 GW. By 2050, according to data from the EPE (Energy Research Company) this capacity should exceed 90 GW.

The chart below shows the evolution of installed wind capacity since 2005 and the projection until the year 2023:

Chart 2 Evolution of installed capacity (Source: Adapted from ABEEólica)

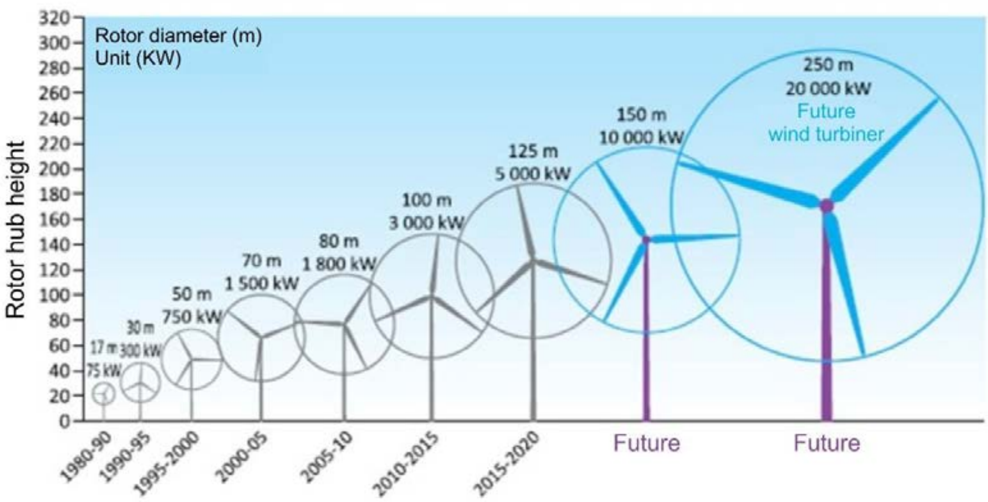


According to data from ANEEL (National Eletricity Agency), wind energy investments are around **€ 1.3 million / MW** resulting in an investment of **€ 87 billion** by 2050.

4.1.2 Technology

As it will be presented, wind generation will have significant growth in the Brazilian energy matrix. To achieve this goal, wind turbine technologies have evolved in terms of scale size, new designs and the efficiency of converting wind-borne kinetic energy to axis energy (SEBRAE, 2017).
The chart below shows the evolution of wind turbines according to their scale and power generation:

Chart 3 Evolution of Wind Turbines



Another important issue to ensure the participation of wind energy in the 2050 electric matrix concerns the reduction of component manufacturing costs, development of integration of wind turbine technologies with other sources of energy, energy and grid, mitigation of blades noise, visual impact of wind turbines and the optimization of operation, maintenance and monitoring systems (CGEE, 2017a).

Regarding the design of future wind turbines, the configuration of the blades, rotor and tower will provide better performance and physical stability to the equipment. These features will allow the turbines operate in different wind and climate regimes and in various applications such as onshore or offshore wind farms, hybrid power generation and in distributed generation. The precise characterization of the wind resource is the basis for the development of more agile and efficient forms for the energy conversion process. The application of new materials capable of withstanding high mechanical and thermal stressess and with anti-corrosion properties will allow the construction of these components (CGEE, 2017a).

4.1.2.1 Advanced instrumentations, including robotics and cloud computing

In the field of instrumentation, the sector lacks technologies that allow the monitoring and mapping of wind quality.
The development and implementation of a wind generation forecasting tool is one of the main demands of network operators. Such tool will be able to identify the operation mode of the wind farm and will be part of the communication systems integrated to the dispatch centers and will inform the generation forecast in the next hours, days and also guide the operator about the turbine operating conditions and when maintenance must be done (CGEE, 2017b).

Also according to the Center for Strategic Studies and Management (CGEE) there are already studies focused on the development of laser monitoring systems that, incorporated into the central control system of wind power plants, that can increase system efficiency by reducing maintenance downtime and even by reducing yaw system travel times. This technology is under development and its initial applications are a reality. In the same development of control systems for wind power plants and turbines, an evolution should be expected in the application of maintenance tools and monitoring of the wind power station operating conditions of the with the inclusion of turbine trouble signaling and signaling systems. Future problems and indication of the maximum time for preventive maintenance of a particular component. To this end, wind turbines will need to be increasingly monitored with new sensors to be installed in towers, rotating systems and even the electrical parts (CGEE, 2017a).

4.1.2.2 Electronics

No clear opportunity has been identified for this sector at this time.

4.1.2.3 Embedded systems, including artificial intelligence and big data

With the evolution of control systems, it is natural the incorporation of artificial intelligence and new communication systems, or for wind turbines to be capable of sequential execution (CGEE, 2017a):

1. Self-diagnosis (function already displayed in several components);
2. Failed modules isolation;
3. Self-healing ability to regenerate which is the last step in using new materials.

4.1.2.4 High Tech Materials

As indicated in the previous item, the application of self-regenerating materials is one of the next steps in the manufacture of wind turbines.

4.1.2.5 Nanotechnology

No clear opportunity has been identified for this sector at this time.

4.1.2.6 Printing

No clear opportunity has been identified for this sector at this time.

4.1.2.7 Semiconductor Equipment

No clear opportunity has been identified for this sector at this time.

4.1.3 Manufacturing process

The companies in this sector are very closed, not allowing us to obtain data on their production processes.

4.1.4 Challenges

According to an interview with the technical director of the Brazilian Wind Energy Association (ABEWinda), the main challenges for the wind energy sector are:

- Equipment transportation technology;
- Innovative solutions for the operation and maintenance of wind turbines;
- Technology for inspection and maintenance of gearboxes;
- Tests for certification of wind turbines. Currently the tests are carried out in the wind tunnels located at the Fundação Universidade Estadual do Ceará (FUNECE) and by the Technological Center of the Eletrobrás company located in the city of Aparecida de Goiânia in the state of Goiás and the tests are regulated by INMETRO.

- Due to the lack of evidence of the use of some of the technologies researched in this sector, we understand as an opportunity the development of feasibility studies for the application of the technologies listed below:

  - Electronics;
  - Nanotechnology;
  - Printing;
  - Semiconductor Equipments;

4.1.5 Players

To talk about the players of the wind energy market we will divide the companies according to the following:

1. Wind generators Manufacturers (Assemblers);
2. Tower manufacturers;
3. Blade manufacturers;
4. Manufacturers of Subcomponents, Inputs and Internal Elements for Towers;
5. Manufacturers of Sub-Components and Rotor Supplies - Blades and Hub;
6. Nacele Subcomponent Manufacturers.

The source of the data presented is the update report of the mapping of the wind energy industry production chain in Brazil produced by the Brazilian Agency for Industrial Development (ABDI, 2018).

4.1.5.1 Wind generators Manufacturers

Wind turbine manufacturers are commonly referred to as assemblers because for the most part they receive components manufactured by other companies and are commited to systems integration. The complete integration of the wind turbine takes place directly in the wind farm because at this moment the assembly of the tower and the hub, the blades and the nacelle are coupled. Its manufacturing units are generally dedicated to nacelle and rotor hub also include, in the case of further verticalization, the manufacture of towers and blades.

According to the wind industry supply chain mapping report, we currently have seven wind turbine manufacturing companies in Brazil, of which only one is of national origin (WEG), the others are listed in the table below.

Table 1 Wind turbine manufacturers (Adapted by the author)

Manufacturer	Location		Production capacity (towers /
	City	State	
ACCIONA WINDPOWER	SIMÕES FILHO	BAHIA	150
SIEMENS GAMESA RENEWABLE ENERGY	CAMAÇARI	BAHIA	300
GE WATER & PROCESS TECHNOLOGIES DO BRASIL	CAMAÇARI	BAHIA	384
VESTAS DO BRASIL ENERGIA EÓLICA	ITAITINGA	CEARA	200
WEG EQUIPAMENTOS ELÉTRICOS	JARAGUÁ DO SUL	SANTA CATARINA	144
WIND POWER ENERGIA	CABO DE SANTO AGOSTINHO	PERNAMBUCO	Data not available
WOBBEN WIND POWER	SOROCABA	SÃO PAULO	250
	CAUCAIA	CEARA	
	JUAZEIRO	BAHIA	
	GUAIBA	RIO GRANDE DO SUL	

4.1.5.2 Tower Manufacturers

Tower manufacturers are divided into:

- Steel towers's manufacturers;
- Concrete tower's manufacturers.

Regarding the manufacturers of concrete towers, we do not have an estimated number of productive capacity of the companies but all of them are of national origin.
Among the steel tower's manufacturers, only ENGEBASA is of national origin and all of them have foreign participation.

The table below lists the manufacturers of concrete towers.

Table 2 Manufacturers of concrete towers (Adapted by the author)

Manufacturer	Location	
	City	State
CASSOL	ARACATI	CE
CONFER CONSTRUTORA FERNANDES LTDA (NOVO)	RIO GRANDE	RS
CTZ EOLIC TOWER	FORTALEZA	CE
DTS - DOIS A TOWER SYSTEM PRÉ-MOLDADOS	NATAL	RN
EOLICABRAS	PEDRA GRANDE	RN
NORDEX - ACCIONA	*Mobile*	
WOBBEN	JUAZEIRO	BA

The table below lists the manufacturers of steel towers.

Table 3 Steel towers manufacturers (Adapted by the author)

Manufacturer	Location		Production Capacity (towers/year)
	City	State	
GESTAMP WIND STEEL PERNAMBUCO	CABO DE SANTO AGOSTINHO	PERNAMBUCO	600
TORRES EÓLICAS DO BRASIL	CAMAÇARI	BAHIA	200
ENGEBASA MECÊNICA E USINAGEM	CUBATÃO	SÃO PAULO	190
TORRES EÓLICAS DO NORDESTE	JACOBINA	BAHIA	200

4.1.5.3 Wind Blades Manufacturers

There are currently four manufacturers of wind blades in Brazil: WOBBEN, which manufactures only for its own consumption (local and export); TECSIS; AERIS and LM Wind Power.
AERIS has experienced significant growth over the past four years. The expansion of its client portfolio more than tripled its capacity compared to 2014. To meet VESTAS demands, for example, AERIS built a specific unit on its Pecém site and hired around 400 employees for its operation. Currently the company is preparing to serve also the foreign market. WOBBEN, which also has a blade manufacturing unit in Pecém, provides blades for Brazilian parks from this site, while the Sorocaba unit is exclusively dedicated to export.
In 2016 TECSIS inaugurated a new unit in Camaçari / BA, initially aimed at serving the domestic market, while the Sorocaba units produced blades mainly for export. Investments of around R $ 220 million were foreseen in Camaçari, for a production capacity of 2,500 blades / year, in 12 production lines, employing about 6000 employees.
This unit has three operative lines (three molds). Recently, however, the company finalized its contracts with its previously main customer (GE), which resulted in the closure of Sorocaba's production units and the dismissal of a large number of employees. The cutting and assembly plant for kits in Sorocaba was transferred to Camaçari.

The table below lists the main companies in the sector.

Table 4 Wind blades manufacturers (Adapted by the author)

Manufacturer	Location		Production Capacity (blades/year)
	City	State	
AERIS	CAUCAIS	CEARA	2000
LM WIND POWER DO BRASIL	IPOJUCA	PERNAMBUCO	1000
TECSIS TECNOLOGIA E SISTEMAS AVANÇADOS	CAMAÇARI	BAHIA	2500
WOBBEN WIND POWER	CAUCAIA	CEARA	1500
	SOROCABA	SÃO PAULO	

4.1.5.4 Manufacturers of Subcomponents, Inputs and Internal Elements for Towers

Table 5 Manufacturers of Subcomponents, Inputs and Internal Elements for Towers

Subcomponents, Inputs and Internal Elements	Manufacturer	Location	
		City	State
LAMINATED STEEL SHEETS	USIMINAS	IPATINGA E CUBATÃO	MG E SP
	GERDAU	OURO BRANCO	MG
STEEL LAMINATED BARS AND BLOCKS	GERDAU	PINDAMONHANGABA	SP
FLANGES	UNIFORJA	DIADEMA	SP
	GRI FLANGES DO BRASIL	CABO DE SANTO AGOSTINHO	PE
FIXERS	METALBRAX	GUARULHOS	SP
	TECNOFIX	JABAQUARA	SP
	METALTORK	DIADEMA	SP
	INDUSTRIAL REX	BRAÇO TROMBUDO	SC
	CISER	JOINVILLE	SC
DOORS / HATCHES	ALUS		
	ENGEBASA	CUBATÃO	SP
	ATLANTA	SOROCABA	SP
INKS	RENNER COATINGS	CURITIBA	PR
	INTERNATIONAL (AKZO NOBEL)	SANTO ANDRÉ	SP
	JOTUN	ITABORAÍ	RJ

Table 6 Manufacturers of Subcomponents, Inputs and Internal Elements for Towers

Subcomponents, Inputs and Internal Elements	Manufacturer	Location	
		City	State
CONCRETE	PRODUCED USING CEMENT FROM LOCAL SUPPLIERS SUCH AS: MIZU, CIMPOR, LAFARGE, VOTORANTIM, ETC		
MOLDS	CSM	SCHROEDER	SC
METAL INSERTS	TENSACCIAI	SÃO PAULO	SP
	RUDLOFF WIND TORRES EÓLICAS	SÃO PAULO	SP
PROTENSION STEEL CABLES	BELGO	PIRACICABA	SP
	PROTENDIDOS DYWIDAG	GUARULHOS	SP
	RUDLOFF WIND TORRES EÓLICAS	SÃO PAULO	SP
CONCRETE ADDITIVES AND STICKERS	MC BAUCHEME BRASIL	VARGEM GRANDE PAULISTA	SP
	BASF CONSTRUCTION CHEMICALS	SÃO PAULO	SP
ELEVATOR	ARTAMA METALMECÂNICA	JARAGUÁ DO SUL	SC
	AVANTI BRASIL	FORTALEZA	CE
	HAILO SISTEMAS	JAGUARIUNA	SP
	POWER CLIMBER	JABOATÃO DOS GUARARAPES	PE
LADDER	ATLANTA	SOROCABA	SP
	HAILO SISTEMAS	JAGUARIUNA	SP
	KATHREIN	SÃO PAULO	SP
	ALUSTAR	SÃO BERNARDO DO CAMPO	SP
	BARGA	CABO DE SANTO AGOSTINHO	PE

Table 7 Manufacturers of Subcomponents, Inputs and Internal Elements for Towers

Subcomponents, Inputs and Internal Elements	Manufacturer	Location	
		City	State
PLATFORM	ENGEBASA	CUBATÃO	SP
	ALUSTAR	SÃO BERNARDO DO CAMPO	SP
	AVANTI BRASIL	EUSÉBIO	CE
	BARGA	CABO DE SANTO AGOSTINHO	PE
	ATLANTA	SOROCABA	SP
	HAILO SISTEMAS	JAGUARIUNA	SP
SUPPORTS AND ACCESSORIES	ATLANTA	SOROCABA	SP
	HAILO SISTEMAS	JAGUARIUNA	SP
	NORTEL	CAMPINAS	SP
	BARGA	CABO DE SANTO AGOSTINHO	PE
	ENGEBASA	CUBATÃO	SP
FALL PROTECTION SYSTEMS	HAILO SISTEMAS	JAGUARIUNA	SP
	ARTAMA METALMECÂNICA	JARAGUÁ DO SUL	SC
	BARGA	CABO DE SANTO AGOSTINHO	PE
	ENGEBASA	CUBATÃO	SP
LIGHTING	NORTEL	CAMPINAS	SP
	PRYSMIAN	SOROCABA	SP
	PHELPS DODGE	POÇOS DE CALDAS	MG
	NEXANS	AMERICANA	SP
ELETRIC CABLES	PRYSMIAN	SOROCABA	SP
	PHELPS DODGE	POÇOS DE CALDAS	MG
	NEXANS	AMERICANA	SP

4.1.5.5 Manufacturers of Sub-Components and Rotor Supplies - Blades and Hub

Table 8 Manufacturers of Sub-Components and Rotor Supplies - Blades and Hub

Subcomponents for Hubs	Manufacturer	Location	
		City	State
CARENAGE	ANCEL	RIO CLARO	SP
	ATLANTA	SOROCABA	SP
	BFG BRASIL	JOINVILLE	SC
	MOLDE PLASTICOS REFORÇADOS	SÃO JOSÉ DOS CAMPOS	SP
	MVC	SÃO JOSÉ DOS PINHAIS	PR
HUB (FUSED)	FUNDIÇÃO MORENO	SERTÃOZINHO	SP
	GERDAU SUMMIT	PORTO ALEGRE	RS
	ROMI	SANTA BARBARA D'OESTE	SP
	VOITH HYDRO	SÃO PAULO	SP
LUBRICANTS	FUCHS DO BRASIL	BARUERI	SP
	KLUBER	BARUERI	SP
	MOBIL	RIO DE JANEIRO	RJ
	SKF	CAJAMAR	SP
CONTROL PANEL	SANMINA-SCI DO BRASIL	SÃO PAULO	SP
BOARDS (TORQUE AND STIFFENING PLATES)	BARDELLA	GUARULHOS	SP
	PAINCO	PORTO ALEGRE	RS
ROLAMENTO	GERDAU SUMMIT	PORTO ALEGRE	RS
	LIEBHERR BRASIL	GUARATINGUETÁ	SP
	SHILLA BRASIL	TIETÊ	SP
	SKF DO BRASIL	CAJAMAR	SP
	THYSSENKRUPP	SÃO PAULO	SP
SERVIÇOS DE PINTURA	GRIUPO GP	BARUERI	SP
MACHINING SERVICES	BARDELLA	GUARULHOS	SP
	EMALTO	TIMÓTEO	MG
	PAINCO	RIO DAS PEDRAS	SP
	ST METALS	JAGUARIUNA	SP
	STEPAN	CAMPINAS	SP
	USICAL	VARZEA PAULISTA	SP
LUBRICATION SYSTEM	EXIMPORT	SÃO PAULO	SP

Table 9 Manufacturers of Sub-Components and Rotor Supplies - Blades and Hub

Subcomponents for Blades	Manufacturer	Location	
		City	State
FIBERGLASS FABRICS	CPIC BRASIL	CAPIVARI	SP
	SAERTEX	INDAIATUBA	SP
	OWENS CORNING	RIO CLARO	SP
FIBER CARBON FABRICS	Imported from companies like Germany SAERTEX		
POLYESTER RESIN	REICHHOLD	MOGI DAS CRUZES	SP
	NOVAPOL	SERRA	ES
EPOXY RESIN	DOW	GUARUJÁ	SP
	HEXION	ITATIBA	SP
BALSA WOOD	IMPORTADO DO EQUADOR		
FIXERS AND NUTS	METALBRAX	GUARULHOS	SP
	METALTORK	DIADEMA	SP
	TECNOFIX	SOROCABA	SP
	ALGOLIX	SÃO PAULO	SP
FIXERS (STICKERS)	HENKEL	DIADEMA	SP
	SIKA	OSASCO	SP
ADHESIVES (OTHERS), FOAMS, SEALS AND INKS	IMPORTED FROM FOREIGN COMPANIES AS AITW, PLEXUS AND AKZO		
ANTI-RAY SYSTEM	LEHMOR	Importado	

Table 10 Manufacturers of Sub-Components and Rotor Supplies

Rotor Subcomponents	Manufacturer	Location	
		City	State
STEP DRIVE (MOTOR REDUCER)	GE POWER CONVERSION	SÃO PAULO	SP
	GLUAL HIDRAULICA	SOROCABA	SP
	HINE DO BRASIL	INDAIATUBA	SP
	JABIL DO BRASIL	BETIM	MG
HYDRAULIC STEP BLOCK	GLUAL HIDRAULICA	SOROCABA	SP
GEARS AND PLANETARY REDUCERS	TGM	SERTÃOZINHO	SP
MOTOR REDUCER	BONFIGLIOLI	SÃO BERNARDO DO CAMPO	SP
	SEW-EURODRIVE	INDAIATUBA	SP
STEP CONTROL PANEL	GLUAL HIDRAULICA	SOROCABA	SP
	HINE DO BRASIL	INDAIATUBA	SP
	INGETEAM	VALINHOS	SP
	MOOG DO BRASIL	JURUBATUBA	SP
	SANMINA-SCI DO BRASIL	SÃO PAULO	SP
	SAT	SOROCABA	SP

4.1.5.6 Nacele Subcomponent Manufacturers

Table 11 Manufacturers of Nacele components

Nacele components	Manufacturer	Location	
		City	State
BEATER	BARDELLA	GUARULHOS	SP
	BR METAIS	MATOZINHOS	SP
	LIEBHERR BRASIL	GUARATINGUETÁ	SP
	MAUSA	PIRACICABA	SP
	PAINCO	RIO DAS PEDRAS	SP
CHASE / GENERATOR SUPPORT	BARDELLA	GUARULHOS	SP
	HKM	SERRA	ES
	PAINCO	RIO DAS PEDRAS	SP
	WEG	JARAGUÁ DO SUL	SC
STRUCTURAL SCREWS	CISER	JOINVILLE	SC
	INDUSTRIAL REX	BRAÇO DO TROMBUDO	SC
MAIN FRAMEWORK	BR METALS	MATOZINHOS	MG
	ROMI	SANTA BARBARA D'OESTE	SP
REAR FRAME	BARDELLA	GUARULHOS	SP
	JUMBO	ASSAI	PR
	PAINCO	RIO DAS PEDRAS	SP
GEARS	TGM	SERTAOZINHO	SP
BRAKES	ANTEC EOLICA	CAMAÇARI	SP
FUSED TO YAW	ROMI	SANTA BARBARA D'OESTE	SP
MOTOR REDUCER	BREVINI	LIMEIRA	SP
	SEW-EURODRIVE	INDAIATUBA	SP
YAW CONTROL PANEL	GE POWER CONVERSION	SÃO PAULO	SP
	WEG	JARAGUÁ DO SUL	SC
REDUCER	BONFIGLIOLI	SÃO BERNARDO DO CAMPO	SP
	BREVINI	LIMEIRA	SP
	SEW-EURODRIVE	INDAIATUBA	SP
YAW BEARING	LIEBHERR BRASIL	GUARATINGUETÁ	SP
	SHILLA BRASIL	TIETÊ	SP
	SKF	CAJAMAR	SP
	THYSSENKRUPP	GUAIBA	RS
YAW DRIVE SYSTEM	BREVINI	LIMEIRA	SP
GENERATOR	ABB	BLUMENAU	SC
	ANDRITZ HYDRO	SÃO PAULO	SP
	GE POWER CONVERSION	SÃO PAULO	SP
	INDAR	CAMPINAS	SP

4.2 Solar Photovoltaic

The sun is the most abundant energy source in the world. Solar radiation reaches every corner of earth's surface and can generate enough electricity to meet current global demand 10,000 times continuously (United States, 2016). Solar energy can be used anywhere on the planet's surface and in space, without fuel costs, and is clean and sustainable, since its generation involves no greenhouse gases emissions and its source is renewable. The sun generates energy in the most demanding hours, enabling a proven technology, since it has been used for over 60 years, enabling distributed generation (GD), being easily installed in remote and diverse characteristics, with low complexity of implementation and plenty of materials that make up your equipment.

Photovoltaic solar energy is the widely used in the world for electricity generation and is the object of this study. Photovoltaic cells convert solar energy directly into electricity
by the process of converting light (photons) into electricity (electrons), the so-called photovoltaic effect, discovered in 1839.
The photovoltaic modules used today in homes and photovoltaic plants are made of cells
solar panels in modules or films, which may or may not be connected to the distribution network of electric power. As a practical example, a typical family residence uses between five and 10 photovoltaic modules to generate electricity for the entire house. The modules can be mounted at a fixed angle or over support structures that follow the sun (solar trackers or trackers), which make it possible to capture more irradiation and thus generate more electricity.

4.2.1 Indicators

According to data from ABSolar (Brazilian Association of Photovoltaic Solar Energy), Brazil had, by the end of 2018, 2,454 MW of total installed capacity originating from solar plants.
Most commercially available photovoltaic modules are made of crystalline silicon (> 85%). Although technology is widespread in the market, there are still barriers/obstacles to overcome in order to make it even more technologically and commercially viable.

According to the projections of Bloomberg New Energy Finance (2016), photovoltaic energy will represent around 32% of the Brazilian electric matrix, going from the source with the lowest representation in the matrix in 2016 to the source with the largest representation in 2040, with capacity installed between 110 and 126 GW.

According to data from the Brazilian Atlas of Solar Energy from the National Institute for Space Research (INPEs), Brazil has an excellent solar resource, which varies between 1,500 and 2,350 kWh / m2 / year. It is a resource well distributed around the country, superior to that seen in countries such as Germany (900 to 1,250 kWh / m2 / year), France (900 to 1,650 kWh / m2 / year) and even Spain (1,200 to 1,850 kWh / m2 / year). The states with the highest levels of solar radiation in Brazil are Bahia, Piauí, Paraíba, Rio Grande do Norte, Ceará, Tocantins, Goiás, Minas Gerais and São Paulo.

4.2.2 Technology

4.2.2.1 Advanced instrumentations, including robotics and cloud computing

We can identify as a lack of this sector technologies for the monitoring of panels mainly focused on levels of dirt, temperature, efficiency, generation predictability and solar tracking systems.

4.2.2.2 Electronics

No clear opportunity has been identified for this sector at this time.

4.2.2.3 Embedded systems, including artificial intelligence and big data

According to data obtained from the Brazilian Solar Energy Association (ABSolar), the opportunities in this area of technology apply to solar tracking and the use of photovoltaic systems management software.

4.2.2.4 High tech materials

Regarding the new materials, researches on the development of organic cells, dye-sensitized oxide cells, multijunction photovoltaic modules and other nanostructured materials are observed.

Organic cells are made of materials that have intermediate electrical conductivity between the conductors and the insulators. Usually the materials used in commercial photovoltaic cells are inorganic and made from gallium or silicon as mentioned. More recently, a class of materials has emerged from applied research and is based on organic components capable of combining the electrical conductivity properties of radical materials with the virtues of plastic (moldability). In this way, it is possible to obtain lighter, flexible devices with greater use of solar energy.

Dye-sensitized oxide cells may use titanium dioxide ($TiO2$), tin oxide ($SnO2$) or zinc oxide ($ZnO2$) to replace traditional silicon.

Oxides are inexpensive compared to traditional materials and, in Brazil, titanium dioxide can be found in mineral reserves.

The technological evolution of dye-sensitized cells, from the point of view of different areas such as physics, chemistry and materials engineering, has significantly increased the efficiency of these devices, depending on the active area. Currently, average oxide cell efficiency can range from 9.9% to 11%, up to amaximum of 15% for some commercial modules made of silicon. In laboratory scale surveys, the efficiency of oxide cells reached 12.3%.

Multijunction photovoltaic modules consist of multiple thin films composed of different conductors. This configuration allows the module to more efficiently absorb solar electromagnetic energy, as its conductors have the function of absorbing the different levels

of solar radiation observed throughout the day. In this case, the goal of R&D is to increase energy absorption capacity based on the different configurations and materials that make up the photovoltaic module (National Renewable Energy Laboratory (2015).
As mentioned, the use of these technologies on the market will depend on the deployment and operating costs of the modules. Considered an advance in this issue, it is possible to infer that the application of multijunction modules, crystalline silicon and thin films will be responsible for a significant portion of the energy generated via photovoltaic systems, in the horizon 2050.

For the use of photovoltaic technology, inverter technology also needs to achieve a high level of maturity in parallel with promising modules. Inverters have the function of converting the direct current (DC) generated by the modules into alternating current (AC) to be made available to the grid. The equipment is manufactured in different configurations to meet the demands of applicability such as the type of network connection and the size of the module. Therefore, R&D focuses on reducing the energy losses observed in the process of converting direct current to alternating current, as well as allowing greater variability in the use of these modules in more sophisticated photovoltaic cell systems.

4.2.2.5 Nanotechnology

No clear opportunity has been identified for this sector at this time.

4.2.2.6 Printing

A good example of using printing technologies is the process used by the company Sunew for the production of its photovoltaic films, where organic photovoltaic cells are "printed" on rolls of film.

4.2.2.7 Semiconductor equipment

This branch of technology is underdeveloped in Brazil because the cost of importing materials is more advantageous than local manufacture.

4.2.3 Manufacturing process

According to data obtained from the Brazilian Solar Energy Association (ABSolar), the manufacturing process for solar panels and inverters basically consists of assembling equipment from imported raw material. The largest volume of equipment, about 80 to 90% comes from imports.

4.2.4 Challenges

The main challenges for the photovoltaic sector are listed below:

- Development of national technology that is competitive in terms of costs with imported materials, mainly from China;
- Development of national technology for the manufacture of bifacial panels;
- Integration of technologies such as artificial intelligence, machine learning with photovoltaic generation systems;
- Use of management and monitoring software;
- Use of technology for solar tracking.
- Due to the lack of evidence of the use of some of the technologies researched in this sector, we understand as an opportunity the development of feasibility studies for the application of the technologies listed below:

  - Electronics;
  - Nanotechnology;
  - Printing;

4.2.5 Players

In the Brazilian solar photovoltaic energy market we have the predominance of using imported equipment, mainly related to solar panels from China.

Companies that produce panels in Brazil only assemble the equipment using much of the imported raw material.

In 2006, CSEM Brazil was created, the result of a joint venture between FIR Capital and CSEM (Swiss Center for Electronics and Microtechnology) Switzerland, focused on the creation of new products and the development of innovative research.

In 2010 CSEM Brazil started research and development of Organic Photovoltaic Film (OPV) technology and in 2015 Sunew was born, responsible for the manufacture and large-scale commercialization of Organic Photovoltaic Film (OPV), with the largest and most modern production structure of the world according to the company.

The manufacturing and inverter market has some domestic companies among the main manufacturers, below is a list with the main players of this market.

Table 12 Manufacturers of Inverters

Company	Origin	Factory in Brazil
ABB	Switzerland	Yes
APSystems	USA	No
ECOSOLYS	Brazil	Yes
FRONIUS	Austria	Yes
INGETEAM	Spain	Yes
KACO	Germany	Yes
OUTBACK	USA	Yes
PHB	Brazil	Yes
REFUSol	Germany	No
SCHNEIDER	France	Yes
SMA	Germany	No
SUNGROW	China	No
WEG Solar	Brazil	Yes

According to data from FINAME, the financing program of the National Bank for Social Development (BNDES), we have 102 companies registered as manufacturers of equipment for the photovoltaic solar sector, distributed according to the table below:

Table 13 Companies of solar systems

Equipment	Number of companies
Photovoltaic solar system (Kit)	70
Photovoltaic inverter	10
Solar Tracker	11
Photovoltaic module	8
Batteries	1
String Box	2

Table 14 Manufacturers of photovoltaic panels

Manufacturer	Location	
	City	State
BALFAR SOLAR	Paranavaí	PR
BYD	Campinas	SP
CANADIAN SOLAR	Sorocaba	SP
GLOBO BRASIL	Valinhos	SP
INTELBRAS	São José	SC
MINASOL	Araguari	MG
RENOVIGI	Chapecó	SC
SUNEW	Belo Horizonte	MG

4.3 Bioenergy

Bioenergy is the name given to energy from biomass, ie organic matter of plant and animal origin. This type of energy can be used to produce fuels, electricity and heat, being considered an alternative to conventional energy sources, which are in force in the world energy matrix.

Biogas is obtained through the anaerobic digestion process, defined as the conversion of organic material, through bacteria, into methane, carbon dioxide, some inert gases and sulfur compounds, in an environment with no oxygen. Different substrates can be used for their production and the amount of biogas obtained depends mainly on the technology used in digestion and the substrate.

4.3.1 Indicators

The generation of energy through the use of biomass represents 9.1% of the total energy generated in Brazil.
There are several types of biomass and the main ones used are:
- Sugar cane juice;
- Molasses;
- Sugar cane bagasse;
- Black liquor;

In Brazil, the greatest potential for biogas is found in the agricultural sector (agricultural residues and confined livestock), which includes straws and tips, as well as vinasse and filter cake from the sugar-energy sector. A considerable amount is added, which can be obtained through solid urban waste and sewage. Despite this considerable potential, its presence in the national energy matrix is still modest. The projections for ethanol and sugar production indicate a high amount of waste from this sector that can be destined for the production of biogas. Thus, considering that all the resulting vinasse and filter cake will be destined for biodigestion, the biogas potential reaches 7.2 billion Nm^3 in 2029, representing 3.9 billion Nm^3 of biomethane.

According to data from the International Center for Renewable Energies - Biogas (CIBiogás) it is estimated that 71 million cubic meters of biomethane are wasted in Brazil, 50 million m3 in the sugar-energy sector, 15 million m3 in the food sector and 6 million m3 in the sanitation area. This is equivalent to the consumption of 44% of diesel or 73% of natural gas consumed in the country.

4.3.2 Technology

4.3.2.1 Advanced instrumentations, including robotics and cloud computing

Some plants are using virtual assistants so that users can obtain data from all stages of the generation process.
For this, the use of data collection systems to feed the database arises as an opportunity.
To this end, it is increasingly necessary to increase and improve the sensing equipment.

4.3.2.2 Electronics

No clear opportunity has been identified for this sector at this time.

4.3.2.3 Embedded systems, including artificial intelligence and big data

As mentioned in item 4.3.2.1, the use of artificial intelligence can and has been applied in the use of virtual assistants to assist users.

4.3.2.4 High tech materials

No clear opportunity has been identified for this sector at this time.

4.3.2.5 Nanotechnology

Use of nanotechnology to accelerate the biodigestion process.

4.3.2.6 Printing

No clear opportunity has been identified for this sector at this time.

4.3.2.7 *Semiconductor equipment*

No clear opportunity has been identified for this sector at this time.

4.3.3 Manufacturing process

The manufacturing process for photovoltaic system equipment basically consists of assembling imported equipment.

4.3.4 Challenges

- Due to the lack of evidence of the use of some of the technologies researched in this sector, we understand as an opportunity the development of feasibility studies for the application of the technologies listed below:

  - Electronics;
  - High Tech Materials;
  - Nanotechnology;
  - Printing;
  - Semiconductor Equipments;

4.3.5 Players

Table 15 Boiler Manufacturers

Manufacturer	Location	
	City	State
Steam Master	Varginha	MG
Aalborg	São Paulo	SP
Sathel	Cotia	SP

Table 16 Turbine Manufacturers

Manufacturer	Location	
	City	State
TGM	Sertãozinho	SP
Siemens	Jundiai	SP

Table 17 Gas Generator Manufacturers

Manufacturer	Location	
	City	State
CHP Brasil	Jacaré	RJ
WEG	Jaraguá do Sul	SC
HEIMER	Paulista	PE

Table 18 Biodigester Manufacturers

Manufacturer	Location	
	City	State
Sansuy	Embu	SP
Recolast	Guarulhos	SP
Michelon	Caxias do Sul	RS
TMR	Pinhais	PR
BGS	Curitiba	PR

4.4 Smart grid

Smart Grids (SG) can be considered an infrastructure investment in the electricity sector, where new technologies converge to contribute to the entire industry chain, directly affecting generation, transmission, distribution and consumption. In this context the end consumer is no longer supporting and now occupies a prominent role within the electrical system. From a technical standpoint, Smart Grid combines automation, information and communication technologies, and Internet of Things (IoT) or Internet of Things, enabling real-time communication, processing, and historical data storage between consumer and the system operator.

Beginning with the Lula administration, Brazil set ambitious goals for its national smart grid deployment, but the market has been slow to develop and the smart grid regulatory and business environment has fallen short of expectations. So far, investment in smart meters in Brazil is mainly restricted to pilot smart grid projects undertaken by power distribution companies.

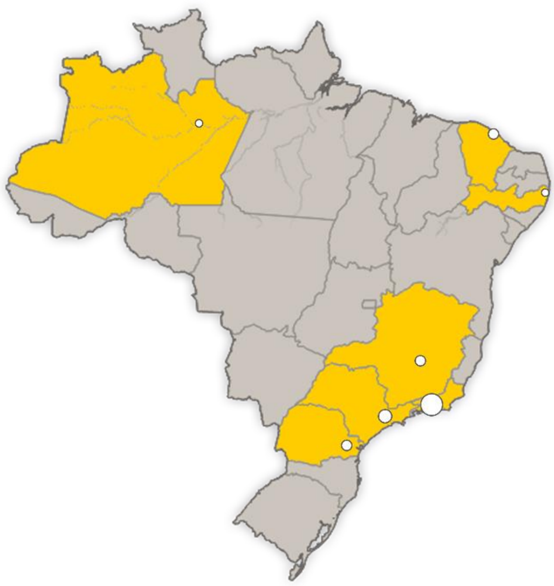
The projects are being financed with research and development ((R&D) compulsory investment budgets under the National Electricity Agency's program, which establishes that all public service power distribution companies must invest approximately 1% of their operating revenues in R&D programs.

Growth opportunities for the smart grid market are in the transmission to connect growth areas of the energy supply - particularly wind and solar sources and at some of the larger, urban utilities that bet on the smart distribution solutions to solve the problem of electricity theft and for a range of power management challenges, although there is not a mandate for power distribution companies to install smart meters in Brazil.

4.4.1 Indicators

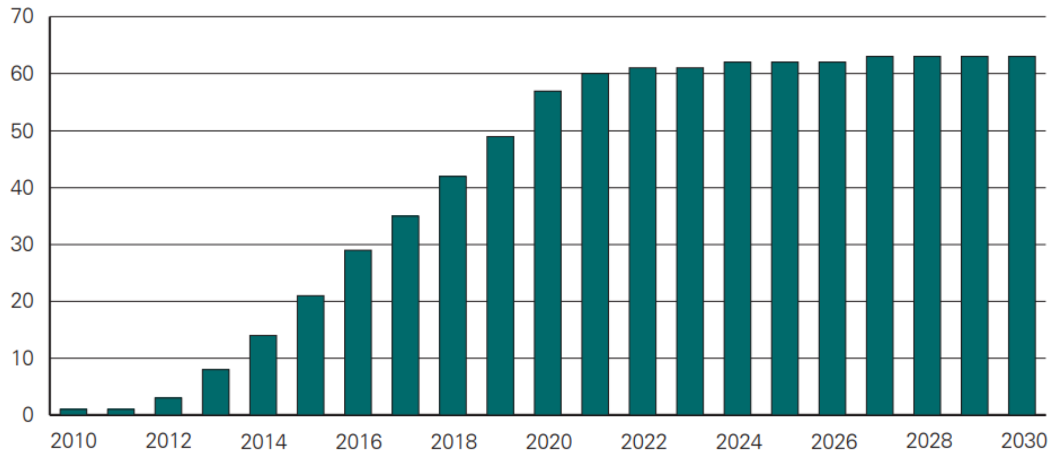
A mapping of the Smart Grids project, financed by the National Electric Energy Agency, identified 9 smart city initiatives investing in smart grid since 2012, in municipalities of São Paulo, Minas Gerais, Rio de Janeiro, Paraná, Amazonas, Ceará and Pernambuco. One of the pilots takes place in Barueri, in the state of São Paulo.

Figure 1 Pilot smart grid projects location Source: Energy Research Company(EPE)



1. Smart Grid Light (Light) - Rio de Janeiro / RJ: 400,000 consumers.
2. Smart Grid (AES Eletropaulo) - Barueri and other locations / SP: 84,000 consumers.
3. Cidade Inteligente Aquiraz (Coelce) - Fortaleza / CE: 19,000 consumers.
4. Paraná Smart Grid (Copel) - Curitiba / PR: 10,000 consumers.
5. Cities of the Future (Cemig) - Sete Lagoas / MG: 8,000 consumers.
6. Parintins (Eletrobras Amazonas Energia) - Parintins / AM: 5000 consumers.
7. Fernando de Noronha Archipelago (CELPE) - Fernando de Noronha Island / PE: 1,000 consumers.

Chart 4 Growth forecast for the smart meter base in brazil. (millions) Source: Energy Research Company (EPE)



Renewable energy projects in Brazil – particularly locally sourced projects – receive favorable financing in Brazil and electricity produced from renewable sources with capacity less than or equal to 30 megawatts (MW) receives a 50% reduction in T&D tariffs. Brazil's first "solar only" energy auction attracted bids among the lowest in the world, bringing Brazil closer to achieving the world's cheapest solar contract prices – without subsidies.

4.4.2 Technology

From a technological perspective of its components, we can characterize a Smart Grid in five different vectors:

1. Advanced electrical network components;
2. Sensors and smart meters;
3. Advanced control and automation systems;
4. Decision support systems and advanced interfaces;
5. Communication technologies.

Advanced electrical network components are components aimed at improving energy supply efficiency, reliability and availability, such as conductive and superconducting materials, energy storage, renewable energy generators operated by the consumer (solar, hydraulic and wind power).

4.4.2.1 Advanced instrumentations, including robotics and cloud computing

Sensors and smart meters are devices that are distributed throughout the entire electrical network, from transformers and substations to homes and are intended, in the case of sensors, to monitor network conditions such as, for example, temperature monitoring, detection of faults and disturbances in the network, cut / restart of network segments and, in the case of user meters, the measurement of energy consumption and storage of information related to consumption.

In addition, the meters can be used for telemetering - that is, the sending of information collected in the user environment - and which enables demand-side management (DSM) and the exploration of new businesses.

4.4.2.2 Electronics

In relation to communication technologies, technological evolution will take place in order to adapt the communication platforms, common to the telecommunications sector, to all sorts of interactions and interventions necessary throughout the electric energy supply chain. In general, the necessary infrastructure must allow bidirectional communication between the different elements of the electrical network, constituting a communication access network; between the elements and their centralization points (measurement and control), constituting a backhaul network; and between these points and the company's Data Center, which can be shared by different municipalities or even states, constituting a backbone network. provide information on network status and quality of service through easy viewing

4.4.2.3 Embedded systems, including artificial intelligence and big data

The advanced control and automation systems are mainly composed of computational algorithms that allow the analysis of the information collected throughout the entire network and the rapid diagnosis for all sorts of events. Also known as Operations Support Systems (OSS) they provide commands for human or automatic interventions on the elements of the electrical network and are suitable for the most diverse operational applications. For example, new automation systems for distribution substations have been developed to allow local information to be obtained in order to monitor them remotely. With this, it is possible to detect and locate faults more quickly, isolate network segments and restore service (FLISR - Fault Location, Isolation and Supply Restoration), reducing interruption times.
Therefore, decision support systems are computational algorithms that allow the management and planning of relationships with customers, based on information obtained about their consumption profile. Also known as Business Support Systems (BSS), these systems lend themselves to expand the capacity of human decision and are based on the use of Artificial Intelligence and Autonomous Agents, technologies of geolocation and virtualization etc. Advanced interfaces allow the integration of data from different sources in order to provide information about the status of the network and quality of service through easy visualization.

4.4.2.4 High tech materials

No clear opportunity has been identified for this sector at this time.

4.4.2.5 Nanotechnology

No clear opportunity has been identified for this sector at this time.

4.4.2.6 Printing

No clear opportunity has been identified for this sector at this time.

4.4.2.7 Semiconductor equipment

No clear opportunity has been identified for this sector at this time.

4.4.3 Manufacturing process

The equipment used in the Smart Grid systems in Brazil consists entirely of imported equipment and there is no manufacture of them in the national market.

4.4.4 Challenges

Despite the long-standing goal of nationwide deployment, Brazil's smart meter market has experienced a number of false starts and the regulatory environment has not developed favorably to drive deployment. In 2012, ANEEL approved a long-awaited resolution establishing requirements for smart meters, but the regulator limited the classes of consumers for the roll-out. The smart grid market is still eagerly awaiting additional technical regulations from both ANEEL and Brazil's lead standards body, INMETRO, that will finally kick-off deployment.
Brazil's Energy Efficiency Program (EEP) mandates distribution utility spending in energy efficiency, requiring about $250m to be invested annually. However, restrictive program requirements have limited the effectiveness of spending and the wider energy efficiency market in Brazil has been stifled by a high cost of capital for financing deals.

- Due to the lack of evidence of the use of some of the technologies researched in this sector, we understand as an opportunity the development of feasibility studies for the application of the technologies listed below:

  - High Tech;
  - Nanotechnology;
  - Printing;
  - Semiconductor Equipments;

4.4.5 Players

Currently, the Brazilian Smart Grid market is dominated by international companies whose market share, for all segments listed in 2.1.1, is around 73%. [8] From information obtained through consultation with electricity distribution companies and specialized media, it is possible to identify the universe of equipment suppliers, whose portfolios present products aimed at Smart Grid. The main suppliers of electronic meters for Smart Grid are: ABB, Aclara, COMPLANT, Ecil, Eletra, ELO Electronic Systems, ELSTER, GE, ITRON, LANDIS + GYR, NANSEN and SIEMENS.

Hence, those with a portfolio focused on control and automation including equipment such as, for example, automatic switches / reclosers, digital relays, automatic meters for substations and networks and SCADA systems (Supervisory Control and Data Acquisition) are:

- ABB
- ALTUS
- EFACEC
- Elipse
- NOJA
- Whipp & Bourne
- SCHNEIDER
- SEL
- SIEMENS

Encouraged by the prospect of growth in the Brazilian Smart Grid market, companies have varied strategies, due to their current participation in the segment.

Some of these manufacturers already present in Brazil foresee significant investments to increase their market share, among them: ABB, GE, IBM and ITRON. Others seek to differentiate themselves by introducing innovations in the market, such as Landis + Gyr, with the introduction of its Loss Management + Measurement system (SGP + M), with the possibility of providing two-way communication between meters of consumers and back-end systems

4.5 Energy Storage

There is no history available of installations of Energy Storage Systems in Brazil. However, the world's first reversible hydroelectric was built in the country, in the state of São Paulo, and is operated by EMAE - Metropolitan Water and Energy Company.

Pedreira Elevatory Plant was inaugurated in 1939, with the operation of unit 4 (the first reversible unit in commercial operation in the world) and the possibility of functioning both as an energy generator and as a pump. Posteriorly, the other units were installed, reaching a total of eight - seven of which are reversible, and one works only as a pump. All have turbines equipped with rotor Francis type, powered by synchronous motors.(Brandão, n.d.)

4.5.1 Indicators

According to data from the Brazilian Energy Storage and Quality Association, Brazilian Electric System has some important differential factors:

a. Great market for any type of storage technology - currently, the installed capacity in the country exceeds 133 GW;
b. Great knowledge and mastery of hydroelectric generation technology and a large park installed. Studies carried out by Eletrobrás, still in the decade 1990, indicated a usable hydroelectric potential of 250 GW;
c. Brazil has a strong and very well-structured Regulatory Agency (Aneel);
d. Distributed Generation, especially photovoltaic, has been growing quickly, stimulated by regulation and tax policy favorable;
e. Likewise, wind generation has been growing at a faster pace than world growth, the result of a stimulus policy developed during the first decade of this century;
f. Brazil has a large domestic market (more than 77 million units consumers) and a privileged position on the continent;
g. South America holds more than 60% of all known lithium reserves of the world;
h. Brazil can rapidly develop the logistics chain for Energy Storage Systems;
i. There are demands related to energy storage technologies, since the use of electric cars is expected to increase and, also, Distributed Generation, Intermittent Generation, and Smart Grids;
j. The National Interconnected System (SIN) requires technologies to control load tip, rotating reserve and frequency control, among others;
k. There is an ongoing policy to universalize the electricity service. Supply to remote locations can be done with isolated installations of the National Interconnected System, through renewable generation integrated with SAE, postponing investments in transmission lines;
l. It is expected a strong growth of intermittent generation in the coming years, reaching values between 20% to 25% of the installed capacity by the year 2023.

It is important to note the specific characteristic of the Brazilian electrical system. The large volume of reservoirs in hydroelectric plants works as a "lung" capable of absorbing the short-term (hourly and daily) and medium-term (seasonal or annual) variations of intermittent generation, operating as a storage system large-sized.

There is a wide market for the application of energy storage systems in consumer facilities in Brazil. In this potential market, we highlight the main applications:

1. Load tip reduction: Store energy at times of increased availability to use in times of greater restriction. In this case, cytase, for example, the reduction in contracted demand for consumers with short-term consumption spikes (a few hours);

2. Arbitration: Storing energy at lower cost to use at times of higher cost. Typically, this use is associated with previous. In this case, mention is made, for example, of the reduction in contracted demand in the peak hours, when energy costs are high, or even the replacement of Motor-Generator Groups for customers who replace hiring demand at the tip by own generation. Shopping malls are the best examples of this application;

3. Consumption displacement: Storing energy in moments of greater production (supply) to use at a time of greater demand (consumption).
   This alternative is especially used in isolated systems. For example: energy is produced during the sunny hours of the day for consumption during in the evening;

4. Reliability: Energy storage in times of availability for use in times of unavailability - for example, UPS used in data processing centers, security centers etc. There are applications of this type where storage systems are a
   customer requirement or even a legal requirement;

5. Reliability in hospitals and surgical centers: In compliance with Ordinance No. 400 of the Ministry of Health, which determines the obligation of hospitals to maintain an emergency power source to ensure the continuity of the functioning of vital equipment used in patient care, when the energy supply is interrupted;

6. Supply to peak power demand: More common in electric traction systems or in industries with high inertia loads, load starts require high peak power. Batteries can supply these short-term peaks, reducing the dimensioning of the supply system;
7. Smoothing power fluctuations: Applied when a power source is unable to provide a constant power output. For example, a solar plant, subject to moments of greater or lesser sunshine, or a wind generator, subject to moments of greater or lesser intensity of wind.

8. Continuous power supply in isolated systems: Isolated systems are those not connected to the National Interconnected System (SIN) and normally located in remote areas, where interconnection to the SIN is uneconomical.
   In these applications, the use of Energy Storage Systems is essential to ensure continuity of supply, given the intermittent characteristic of the main sources of energy (solar, wind or even diesel generation).

9. Additional quality for sensitive industrial processes: Some industrial processes with a high level of automation can be quite sensitive to fluctuations and fundamentals of voltage, resulting from natural disturbances in the electrical system. For example, a short circuit followed by an “automatic reclosing”, a very common practice in the operation of power distribution systems, can result in short-term voltage sags (from

fractions of seconds to a few seconds), which can lead to loss of several hours of production in sensitive processes, in addition to massive product losses.

4.5.2 Technology

Despite the great potential for the application of energy storage systems in the Brazilian market, there is still a great void regarding the use of technologies in production processes and equipment.
We understand this void as the greatest opportunity in this segment since the main players in this market are importing equipment and technologies.

4.5.3 Challenges

- Use of new materials for the production of batteries;
- Development of systems for monitoring and control;
- Development of new technologies to reduce the costs of storage systems;

4.5.4 Players

The main player in this market is a joint venture composed by AES Corporation and Siemens called Fluence, focused on developing energy storage solutions on a global level.
Acting in partnership with this joint venture is Parker, responsible for the supply of high performance frequency inverters.

4.6 Events

1 - WORLD FORUM FOR WOMEN IN SCIENCE - BRAZIL 2020

Date: 02/10/2020 to 02/14/2020

Promoter: Brazilian Academy of Sciences

Location: Rio de Janeiro - RJ

Contact: (21) 3907-8100

Email: wfws2020@abc.org.br

2 - ABRINSTAL - 9th Energy Management and Economy Forum

Date : 02/12/2020

Location: FIESP

Address: Av. Paulista, 1313 - 4th floor auditorium - São Paulo / SP

More information by e-mail: comunicacao@abrinstal.org.br

3 - SECTORAL SCHEDULE 2020

Date: 04/ 01/2020

Promoter: Informa Markets, CanalEnergia Group

Location: Sulamérica Convention Center - Rio de Janeiro - RJ

Contact: (21) 3154-9436

Email: agenda.setorial@informa.com

4 - ECOENERGY - INTERNATIONAL FAIR AND CONGRESS ON CLEAN AND RENEWABLE TECHNOLOGIES FOR ENERGY GENERATION

Date: 04/14/2020 to 04/16/2020

Promoter: Cipa Fiera Milano

Location: São Paulo Expo Exhibition and Convention Center - São Paulo - SP

Contact: (11) 5585-4355

Email: comercial@fieramilano.com.br

5 - 360 SOLAR: CONNECTING PHOTOVOLTAIC ENERGY WITH THE FUTURE

Date: 05/15/20 to 05/15/2020

Promoter: ElektSolar

Location: Costão do Santinho - Florianópolis - SC

Contact: (48) 99656-6673

Email: 360solar@elektsolar.com.br

6 - BRAZIL WINDPOWER 2020

Date: 02/06/2020 to 06/04/2020

Promoter: Group CanalEnergia - Informa Markets, ABEEólica, GWEC

Location: Transamerica Expo Center - São Paulo - SP

Contact: (11) 4632-0373 / (11) 4632-0230

Email: atendimento.bwp@informa.com

7 - ENERGY SOLUTIONS SHOW - 2020

Date: 06/02/20 to 06/03/2020

Promoter: Group CanalEnergia - Informa Markets, ABEEólica, GWEC

Location: Transamerica Expo Center - São Paulo - SP

Contact: (11) 4632-0230

Email: atendimento.energysolutions@informa.com

8 - XV SEMINAR ON THE ENVIRONMENT AND RENEWABLE ENERGIES

Date: 06/03/20 to 06/04/2020

Promoter : CERPCH

Location: Auditorium of the Center of Excellence in Energy Efficiency - Itajubá - MG

Email: cerpch@gmail.com

9 - 2020 ENVIRONMENTAL CONGRESS

Date: 06/16/20 to 06/19/2020

Promoter: Viex-Americas

Location: São Paulo - SP

Contact: (11) 5051-6535

Email: info@viex-americas.com

10 - ENASE 2020 - 17th NATIONAL MEETING OF AGENTS IN THE ELECTRIC SECTOR

Date: 08/26/2020 to 08/27/2020

Promoter: Group CanalEnergia, Informa Markets

Location: SulAmérica Convention Center - Rio de Janeiro - RJ

Contact: (11) 4632-0237

Email: atendimento.enase@informa.com

11 - BW EXPO E SUMMIT 2020 – 3ª BIOSPHERE WORLD

Date: 10/06/2020 to 10/08/2020

Location: São Paulo Expo Exhibition & Convention Center

Contact: (11) 2501-2688

Email: info@bwexpo.com.br

12 - 12th ANNUAL FREE MARKET MEETING

Date: 11/26/2020 to 11/28/2020

Promoter: Group CanalEnergia, Informa Markets

Location: Tivoli Ecoresort Praia do Forte - Salvador - BA

Contact: (21) 3154-9436

Email: atendimento.eaml@informa.com

13 – FEIMEC – Feira Internacional de Máquinas e Equipamentos

Date: 05/05/2020 to 05/09/2020

Location: São Paulo Expo Exhibition & Convention Center

Contact: 11 4632-0230

Email: atendimento.feimec@informa.com

14 – Intersolar South America

Date: 08/25/2020 to 08/27/2020

Location: Expo Center Norte – São Paulo - SP

15 – FENASUCRO

Date: 08/18/2020 to 08/21/2020

Location: Zanini expo center – Setãozinho - SP

Contact: 11 3060 4717

Email: visitante@reedalcantara.com.br

5 Policies, Regulation and Funding

5.1 Policies and regulation impact

The values for taxation of taxes on the import of equipment in the energy area are governed by Decree 8950/2019.

For the production, distribution and sale of products in the electric sector, Brazilian law requires the company to be registered in the National Register of Legal Persons (CNPJ). All equipment produced and sold must first be certified by the National Institute of Metrology, Quality and Technology (INMETRO).

5.2 Funding opportunities/programmes

Law 11,196 / 05, which came to be known as the "Lei do Bem", creates the granting of tax incentives to legal entities that carry out research and development of technological innovation.

It is known that the growth of countries involves investment in research, development and innovation. The federal government, through the Ministry of Science, Technology, Innovations and Communications (MCTIC), uses this mechanism to encourage investment in innovation by the private sector. In addition, it seeks to bring companies closer to universities and research institutes, enhancing results in R&D.

Prerequisites of the Law of Good
There are some prerequisites to obtain the tax incentives of the Lei do Bem, they are:

- Real Profit regime companies,
- Companies with Tax Profit,
- Companies that invest in Research and Development.
- Companies with fiscal regularity (issuance of CND or CPD-EN),

The definition of R&D is subdivided into three groups:

- Basic or fundamental research:
  It consists of experimental or theoretical works carried out mainly with the objective of acquiring new knowledge on the fundamentals of observable phenomena and facts, without considering a particular application or use.
- Applied research:
  It consists of carrying out original works for the purpose of acquiring new knowledge; mainly aimed at an objective or a particular practical purpose.
- Experimental development:
  It consists of carrying out systematic work, based on pre-existing knowledge, obtained through research and / or practical experience, with a view to the manufacture of new materials, products or devices, processes, systems and services or to considerably improve the existing ones.

  Support Program for Technological Development of the Semiconductor and Display Industry (PADIS) is a set of federal tax incentives established in order to contribute to attracting investments and expanding those already existing in the areas of semiconductors and displays (information displays), including cells and photovoltaic modules / panels and strategic inputs for the chain productive, such as silicon ingot and purified silicon.

  The Program allows interested companies to exempt certain taxes and federal contributions levied on industrial implantation, production and commercialization of the benefited equipment. In return, companies are required to make minimal investments in R&D activities annually.

  Reductions to 0% of the II, IPI, PIS-COFINS and PIS-COFINS-Import rates are granted for specific machines / equipment / inputs / software intended for the production of those products, as per regulation. In addition, there is an incentive from the IPI and PIS-COFINS to commercialize production, as well as IRPJ and CIDE. The reductions are valid until 01/22/2022, or for 12 or 16 years from the approval of the project, depending on the tax and the local aggregation level.

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