GENERATION EXPANSION

2nd RESERVE ENERGY AUCTION OF 2015

Solar Photovoltaic Projects: Overview

Empresa de Pesquisa Energética

Ministério de Minas e Energia

GOVERNO FEDERAL BRASIL PÁTRIA EDUCADORA

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FOREWORD

This report presents an overview of the participation of solar photovoltaic projects in the 2nd Reserve Energy Auction of 2015 – *2nd LER*/2015[1], held on November 13th, 2015.

The *2nd LER*/2015 was the third auction promoted by the Brazilian Ministry of Mines and Energy (MME) for contracting electricity from photovoltaic projects in the Regulated Trading Environment (ACR, or *Ambiente de Contratação Regulada*). In the first auction, held in October of 2014 (*LER/2014*), 31 photovoltaic projects were contracted and this result was the subject of report EPE-DEE-NT-150/2014-r0, published by EPE. Afterwards, in August of 2015, another 30 projects were contracted in the *1st LER/2015* and its results were discussed in the report EPE-DEE-127/2015-r0.

This report presents the results of the *2nd LER*/2015, exclusively regarding PV energy, presenting the main features of the contracted projects and the most relevant trends.

[1] Also named as "8º Leilão de Energia de Reserva (Edital ANEEL nº 09/2015)" by CCEE.

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SUMMARY

1. INTRODUCTION

Ordinance (*Portaria*) 70, dated 16 March 2015, issued by the Ministry of Mines and Energy (MME), established the guidelines for the 2nd Reserve Energy Auction of 2015, with the aim of contracting electricity from wind and PV power plants.

Among these guidelines, the following can be highlighted:

- Electricity supply of contracted projects must begin in November 1st, 2018 (it can be anticipated, as long as the transmission or distribution systems are available);
- 20-year Power purchase agreement (PPA);
- Contracted plants must be exclusively dedicated to the Reserve Energy Contract (*CER*);
- Projects under 5 MW of installed capacity not admitted; and
- Annual readjustment of the electricity price by the Brazilian Consumer Price Index – *IPCA*.

The energy production accounting methodology for each source, within the Reserve Energy Contract, was detailed in Technical Note EPE-DEE-NT-079/2014-r1, published by EPE on May 29th, 2014, and revised on August 18th, 2015, in accordance with the guidelines published by MME.

2. SUBMISSION AND TECHNICAL ACCEPTANCE

Submission

The submission and technical acceptance of projects for the auction must follow MME's guidelines, Ordinance MME 21/2008[2] and EPE's Instructions (*Instruções para Solicitação de Cadastramento e Habilitação Técnica com vistas à participação nos Leilões de Energia Elétrica*) published in the EPE website.

On July 22th, 2015, EPE published on its website a summary of the submission stage. Concerning photovoltaic projects, a total of 649 projects were submitted, representing 20.953 MWp of installed capacity (**Table 1**).

[2] And subsequent revisions.

Table 1 – Submitted PV projects for 2nd LER/2015

State	Number of Projects	Sum of Proposed Installed Capacity (MWp)
Bahia	192	6,049
Ceará	34	1,004
Goiás	4	67
Mato Grosso do Sul	1	22
Minas Gerais	61	1,974
Paraíba	29	903
Pernambuco	47	1,625
Piauí	89	2,909
Rio Grande do Norte	97	3,315
São Paulo	56	1,937
Tocantins	39	1,148
Total	**649**	**20,953**

Considering these 649 projects, it was possible to account:

- 22 PV modules manufacturers,
- 17 inverter manufacturers; and
- 16 independent certification companies for energy yield prediction.

Considering the last PV energy auctions, it's possible to notice a trend of increasing number of submitted projects, as well as increasing diversity of certification companies and module and inverter manufacturers.

Technical Acceptance

The analysis and technical acceptance by EPE process covers various aspects of a project and a number of submitted documents, aiming to select those projects that accomplish minimum requirements to demonstrate their technical feasibility and capacity to supply the amount of contracted electricity.

Concerning the 2nd *LER*/2015, EPE accepted 76% (493) of the submitted PV projects. **Table 2** shows a brief summary of accepted projects.

Table 2 – Technical accepted PV projects for 2nd *LER*/2015

State	Number of Projects	Sum of Installed Capacity (MW)
Bahia	140	3,717
Ceará	30	754
Goiás	4	60
Minas Gerais	43	1,225
Mato Grosso do Sul	1	20
Paraíba	17	430
Pernambuco	47	1,315
Piauí	79	2,047
Rio Grande do Norte	68	1,900
São Paulo	43	1,235
Tocantins	21	455
Total	**493**	**13,159**

As shown in **Figure 1**, among the 156 projects that were not accepted by EPE, there were:

- 44 dropouts, due to difficulties in fulfilling the technical and/or documentation requests or because previously contracted in the 1st *LER*/2015; and
- 112 technically disqualified projects that couldn't fulfill the minimum technical requirements.

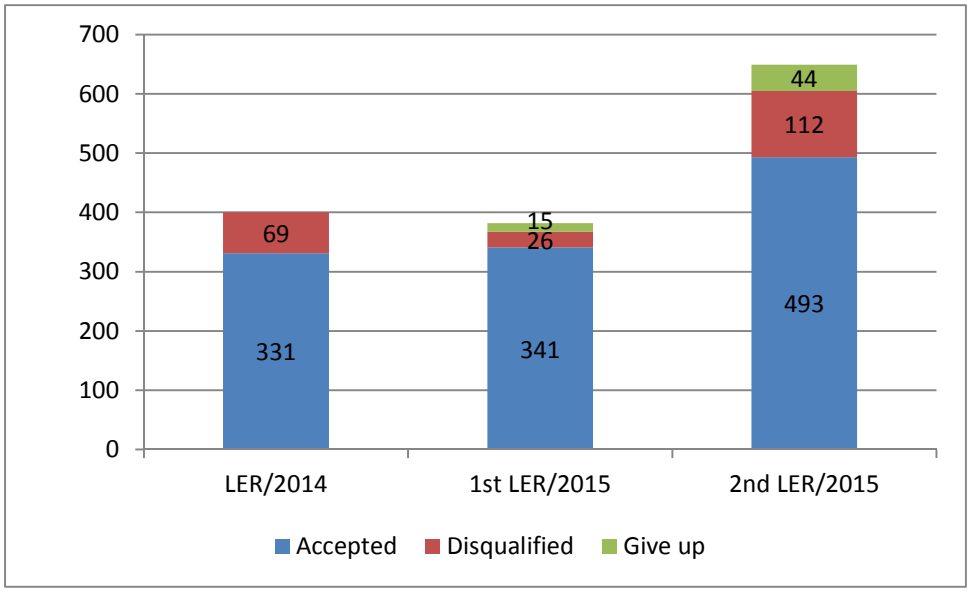


Figure 1 – Technical acceptance rates in LER/2014, 1st LER/2015 and 2nd LER/2015 – PV projects

Figure 2 shows a summary of technical disqualifying reasons in 2nd *LER*/2015.

In the 2nd *LER*/2015 both the amount of qualified and disqualified projects increased, when compared to 1st *LER*/2015.

The main reason for disqualifying projects in 2nd *LER*/2015 is related to, either the lack of a valid connection report, in the case of projects intending to connect directly to the distribution grid, or insufficiency of transmission system capacity (71 projects), in the case of projects intending to connect to the transmission grid (National Interconnected System).

The transmission system capacity was evaluated by the National System Operator *(ONS)*, that published the Technical Note 0134/2015, with the amount of available capacity of each busbar of the transmission grid indicated as a connection point for the submitted projects.

As previously established by Ordinance MME 70/2015 and based on the results shown in the Technical Note 0134/2015, PV project developers were allowed to change their connection point, in order to avoid saturated spots, with lack of transmission system capacity.

Nevertheless, this change was conditioned to the availability of another suitable nearby busbar with enough capacity for new projects. Where this was not possible, the projects were disqualified due to lack of system capacity.

Regarding other reasons for disqualifying, they were mainly related to problems regarding the environmental licensing and land-use rights. Actually, there was a

considerable rise in the number of projects that did not accomplish these requirements.

There was a gap of only three months, approximately, between the submission dates for 1st LER/2015 and 2nd LER/2015. In spite of that, 2nd LER/2015 had extra 267 submitted projects. It can be noticed, however, that part of these new projects were incomplete or poorly developed, what explains the number of disqualified projects in this auction, as shown in **Figure 1** and **Figure 2**.

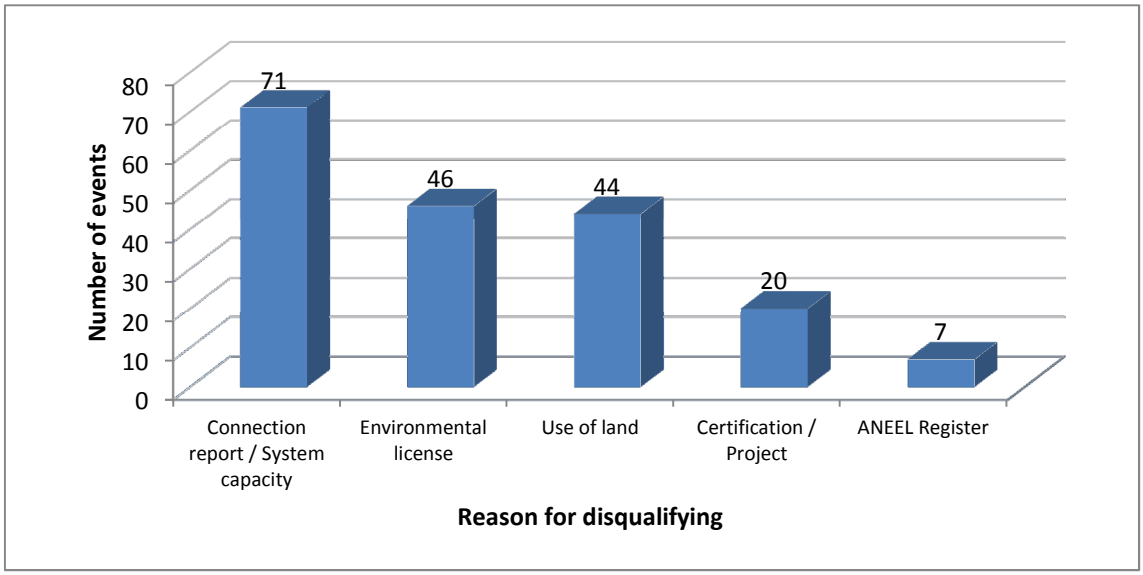


Figure 2 – Disqualifying reasons

3. RESULTS AND EVALUATIONS

The results of the 2nd *LER*/2015 were published by The Electric Energy Chamber of Commerce (*Câmara de Comercialização de Energia Elétrica*) in its website and a summary is shown in **Table 3**. 245,3 MWa[3] of electric energy were contracted, from 33 PV projects.

APPENDIX I describes the most relevant technical features of each contracted project. Note that these features reflect the submitted projects. Nevertheless, after the auction it's possible for developers to modify the features of their projects, if authorized by MME and in accordance with the applicable legislation.

[3] MWa (average megawatt) is an unit of energy and is equivalent to the energy produced by a 1 MW source during a certain period of time. Considering a 20-year supply agreement: 1 MWa = (8.766 hours x 20 years) = 175.320 MWh (megawatt-hour).

Table 3 - 2nd *LER*/2015 summary: contracted PV projects

State	DC[1] Power (MWp)	AC[2] Power (MW)	Qualified Power[3] (MW)	Physical Guarantee (MWa)	Contracted Energy (MWa and %)	
BA	197.3	169.3	169.3	47.6	47.6	18.2%
CE	145.8	120.0	120.0	34.8	34.8	12.1%
MG	331.5	270.0	270.0	75.6	75.6	27.3%
PB	36.8	30.0	30.0	7.1	7.1	3.0%
PE	130.1	105.0	105.0	22.1	22.1	12.1%
RN	168.6	140.0	140.0	41.3	40.6	15.2%
SP	6.0	5.0	5.0	1.3	1.3	3.0%
TO	99.8	90.0	90.0	16.2	16.2	9.1%
Total	**1,115.9**	**929.3**	**929.3**	**246.0**	**245.3**	**100.0%**

Notes:
1) The DC Power is the sum of the rated capacities of all PV modules.
2) The AC Power is the sum of the rated capacities of all inverters, considering possible power limitations.
3) The lower of either DC or AC Power for each generating unit.

For further details regarding the concepts of DC power, AC power and Qualified Power, see Technical Note EPE-DEE-NT-150/2014-r0, dated November 21st, 2014 ("*Leilão de Energia de Reserva de 2014 - Participação dos Empreendimentos Solares Fotovoltaicos: Visão Geral*"), available only in Portuguese.

The terminologies and concepts described by ANEEL in Resolution 676, dated August 25th 2015, should also be noted (free translation):

> *Art. 3º For the purposes and effects of this Resolution, the following terminology and concepts defined are adopted:*
>
> *(...)*
>
> *III – Generating Unit: set of photovoltaic modules associated to an inverter, so that the number of generating units of the project is equal to the number of inverters that will operate;*
>
> *IV – Installed Power of a Generating Unit: electric rated power, in kW, at the inverter output, subject to the power limitations from the modules, inverter power control or other technical restrictions; and*
>
> *V – Power of the Array: electric power, in kWp, obtained from the photovoltaic effect in modules grouped in arrays.*

It should be noted that when designing a PV project, it is usual to have higher DC Power than AC Power, like many of the submitted projects for the auction. This is due to the fact that real irradiation and temperature conditions in the field rarely reflect reference lab conditions. Consequently, PV modules will not achieve, most of the time,

its rated power. Therefore, "oversizing" PV modules allows a more efficient operation of the inverter, which will be working closer to its rated conditions. Most of the qualified projects in the auction have Qualified Power equal to AC Power.

3.1 Capacity factor

The capacity factor of a power plant is defined as the ratio, over a certain period of time, of the actual energy yield to the energy that could potentially be generated if it operated continuously at its rated power.

For the purpose of this document, and considering the rules of Brazilian Regulated Market *(ACR)*, the capacity factor of a project is calculated as the ratio of the expected energy yield[4] of the power plant, in MWa, to its installed power, in MW.

In order to provide a comprehensive comparison with international data and reports (either DC or AC-based), APPENDIX I shows the capacity factors in terms of both Qualified Power and DC Power. As AC Power and Qualified Power are usually lower than DC Power, AC-based capacity factors will normally be higher than DC-based.

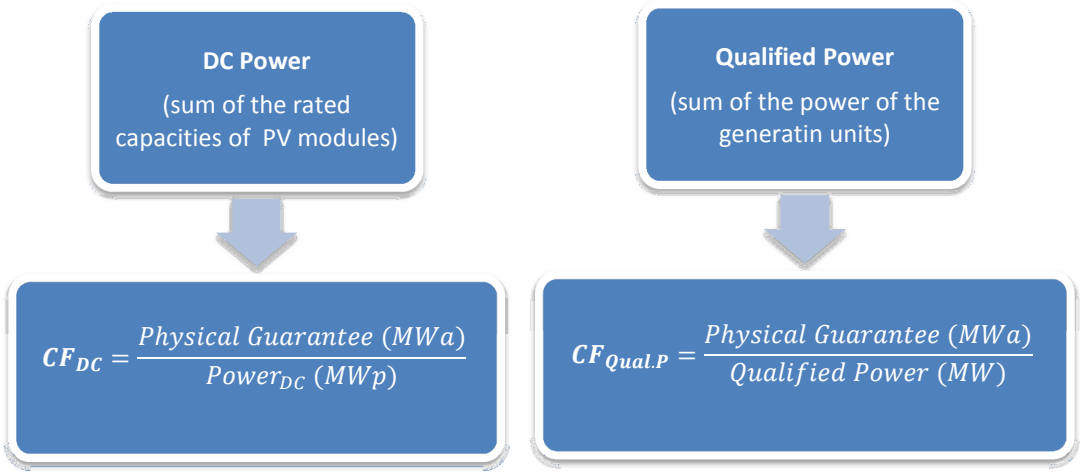


Figure 3 – Capacity Factor (CF): in terms of DC or Qualified Power

Regarding Qualified Power, among contracted projects in the 2nd *LER*/2015, capacity factors were in the range from 18.0% and 31.5%. On the other hand, regarding DC Power, capacity factors were between 15.4% and 25.7%.

Note that higher capacity factors are associated with the choice of the project developer for making use of sun-tracking systems, what contributes to increasing energy production of the plant.

[4] In accordance with Ordinance MME 258/2008, the physical guarantee of PV projects corresponds to their expected energy yield.

From the total of 33 PV contracted projects, 24 (73%) intend to install mounting structures with one-axis tracking system (east-west direction), showing the predominance of tracking systems over fixed installations.

Regarding the group of contracted projects in the 2nd *LER*/2015, the capacity factor of those with tracking systems range from 23.3% to 31.5% (AC-based) / 20.6% to 25.7% (DC-based). On the other hand, those with fixed mounting structures range from 18.0% to 25.0% (AC-based) / 15.4% a 19.6% (DC-based).

3.2 Solar Resource

Ordinance MME 21/2008 (article 6º-B[5], item II) determines that from 2016 on PV projects applying for the energy auctions will be required a continuous record of Global Horizontal Irradiation (GHI) measurements at project site, for at least 12 consecutive months.

Thus, for technical acceptance in the 2nd *LER*/2015, projects were still allowed to have their Annual Energy Yield Prediction Certificates exclusively based on secondary irradiation data, mainly from numerical models, using satellite-derived data, on-ground data (from third party) interpolation, among others. For this reason, in the 2nd *LER*/2015 only a few projects had ground-measured GHI data from a station at the project site. In fact, only one of the 33 PV contracted projects had its own solarimetric station for resource assessment.

GHI data presented in the Energy Yield Prediction Certificates in the 2nd *LER*/2015 ranges from 1,888 to 2,446 kWh/m² per year. Additionally, uncertainty in the solar resource estimate, for these projects, ranges from 4.5% to 9.0%, as informed by the independent certification companies.

Comparing the certified GHI values to the Brazilian Atlas of Solar Energy (INPE, 2006), deviation goes from -3% to +22%, regarding only the contracted projects. It can be noted that such deviations are directly related to the applied methodology by each certification company. A reduction in this uncertainty is expected in 2016, due to the better knowledge of the local solar resource provided by on-site measurements.

Figure 4 shows the distribution of certified annual GHI values for these projects, with a predominance of values around 2,000 and 2,300 kWh/m² per year.

[5] This article was included by Ordinance MME 226/2013.

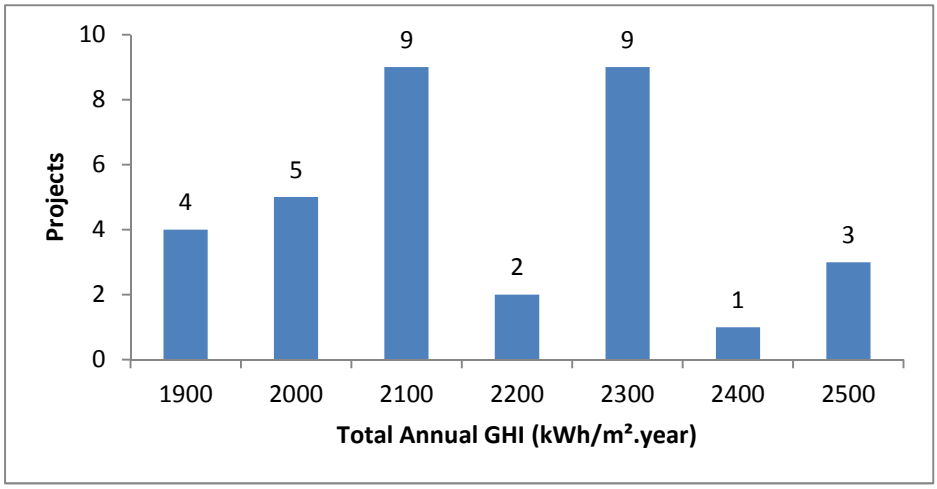


Figure 4 – Annual GHI histogram

Regarding the seasonal GHI profile, Figure 5 shows a graph with the certified values for the group of contracted projects.

In this graph, the red curve draws attention by presenting an irradiation pattern different from the others, with higher irradiation values observed during winter. In this case, it should be noted that the certification of solarimetric data for this project was obtained from a radiometric model based on satellite images of low resolution in terms of time and space. Based on the Brazilian Atlas of Solar Energy, we would expect, for this location, a profile more like the other ones shown in Figure 5, but data from nearby projects show a GHI profile that is similar to the red curve. Such discrepancy reinforces the importance of on-site measurements, in order to provide more accurate solar resource assessment.

Also with respect to the graph, the green curve indicate, for June and July, irradiation values that are lower than average, even when comparing to projects located relatively nearby.

The two abovementioned examples give us clues on how different methodologies and models can affect the resource assessment and lead to discrepancies that only on-site GHI measurement will help to reduce.

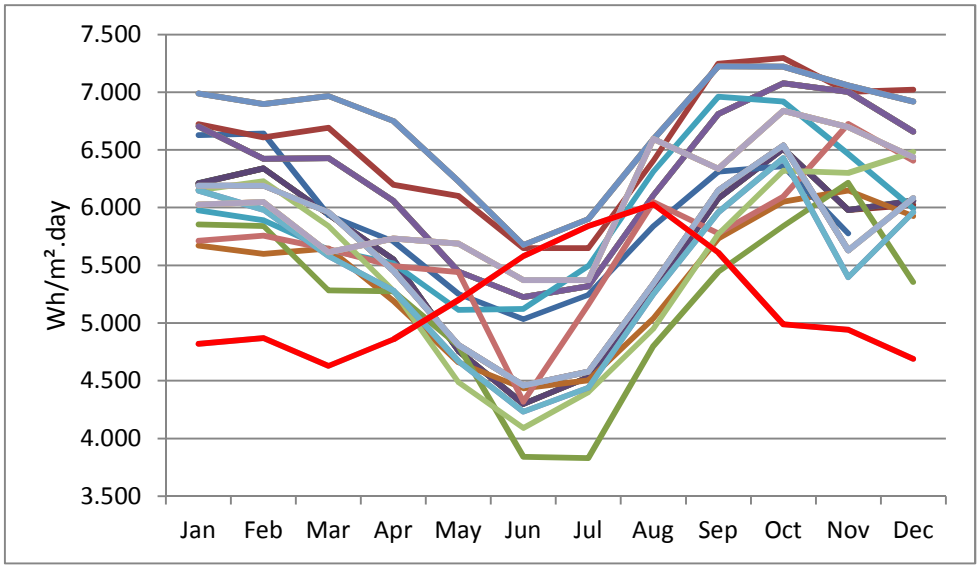


Figure 5 - Seasonal GHI profile

3.3 Other aspects

3.3.1 Photovoltaic modules

From the group of contracted projects in the 2nd LER/2015, 25 have chosen polycrystalline silicon modules, 5 monocrystalline silicon and only 3 thin-film (**Figure 6**). Among those intending to use crystalline silicon technology, the rated power of PV modules ranges from 295 to 335 Wp, while efficiency varies from 15.2% to 20.3%. In the case of thin-films, the rated power of the modules is 140 Wp, with efficiency of 12.9%.

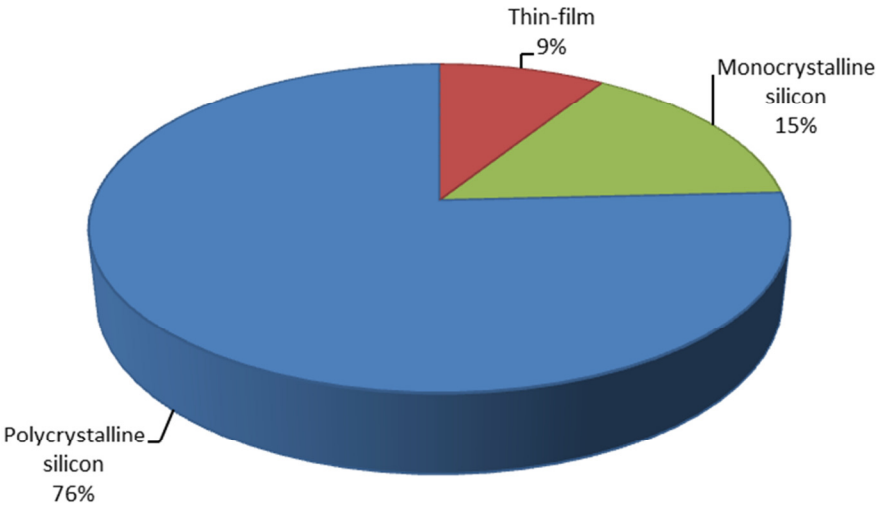


Figure 6 – PV modules technology: relative share among contracted projects on 2nd LER/2015

3.3.2 Inverters

The contracted projects in the 2nd *LER*/2015 intend to have inverters between 100 kW and 2.000 kW.

As already described, it usual for project developers to undersize the inverter power regarding the PV modules rated power, i.e. design the power plant with DC power higher than AC power.

The Inverter Sizing Factor (ISF) is a design criterion that corresponds to the ratio of AC to DC power. The adopted ISF depends on cost-benefit analysis, since it can result, on one hand, in lower investment cost and more efficient inverter operation and, on the other hand, in a reduction in the supplied energy due to inverter power limitation[6]. The ISF of contracted projects ranges from 74.7% to 90.2%, as shown in **APPENDIX I**.

3.3.3 Connection to the grid

The auction results indicate, among the contracted projects, the predominance of connections at "Basic Grid"[7] (transmission grid and facilities) over the distribution grid,

[6] Under certain conditions, the inverter can operate above its rated power.
[7] All transmission facilities equal or over 230 kV.

as shown on Table 4 and Figure 7. From a total of 33 projects, only 6 (18%) intend to be connected directly to the distribution grid.

Table 4 – Connection to the grid: number of projects and power

Installation Type	Installed Capacity (MW)	Projects
Basic Grid	699.3	24
OTF [1]	75.0	3
Distribution	155.0	6
Total	**929.3**	**33**

[1] Other transmission facilities (OTF).

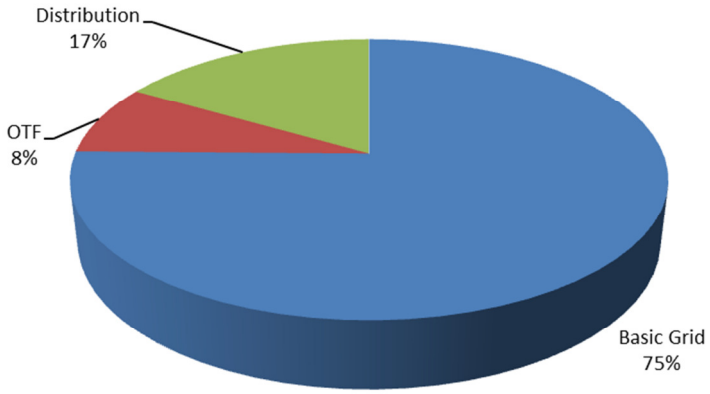


Figure 7 – Connection points: percentage share

3.3.4 Construction times

According to the submitted schedules of the contracted projects in the 2nd *LER*/2015, the construction times of the plants may vary between 6 and 24 months, with an average time of 11 months.

3.3.5 Investment costs

Investment costs estimates of the contracted PV plants in the 2nd *LER*/2015, as declared by the project developers, range from R$ 3,117 to R$ 6,122/kWp[8]. In average

[8] In terms of US$/kWp, these prices correspond to US$ 825 and US$ 1,620/kWp, considering an exchange rate of R$ 3.78 per US dollar (see note 10)

terms, these costs are similar to the ones verified for the contracted projects in the 1st *LER*/2015.

There was not a clear distinction in investment costs between projects with fixed structures and one-axis tracking systems. However, it's reasonable to expect higher costs for the latter ones.

It should be noted that such costs do not include financing interest during construction and are referenced to December 2014, therefore may not reflect the recent rise of US dollar[9] value against Brazilian Real.

3.3.6 Operation and maintenance fixed costs

The operation and maintenance (O&M) annual fixed cost of a project is usually represented by a percentage of the total investment cost of a power plant. Among the contracted projects in the 2nd *LER*/2015, the average declared annual O&M cost is around 1.0% of total investment cost for projects with fixed structure, and 1.6% for those with one-axis tracking systems. These numbers are similar to those seen in previous PV auctions.

3.3.7 Energy price

The average selling price of PV energy in the 2nd *LER*/2015 was R$ 297.75/MWh, ranging from R$ 290.00/MWh to R$ 302.90/MWh, representing an average discount of 21.9% over to the price cap of R$ 381.00/MWh. In terms of US$/MWh, these prices correspond to US$ 77 and US$ 80/MWh, considering an exchange rate of R$ 3.78 per US dollar[10].

Despite the higher exchange rate in November/2015 when compared to August/2015, when 1st *LER*/2015 was held, there was a slight reduction in the average selling price of PV energy in the 2nd *LER*/2015, of around 1% compared to the 1st *LER*/2015. In US$/MWh, this reduction corresponds to around 8%.

It's worth mentioning that, even though the higher price cap for PV energy (mainly to accommodate the rise of the US dollar), the large number of competing projects has led to a reduction in the selling price. Furthermore, part of the contracted projects in

[9] The variation of the average monthly exchange rate of the commercial US dollar, in Brazil, was around 43% from December/2014 to November/2015.
[10] Average exchange rate for US commercial dollar in November/2015.

the 2nd *LER*/2015 belongs to companies with already contracted projects in the previous PV auctions, with expected synergistic benefits.

APPENDIX I – Contracted projects in the 2nd LER/2015: main technical features

PV Project	State	DC Power (MWp)	AC Power (MW)	Qualified Power (MW)	Physical Guarantee (MWa)	Capacity Factor (%)		Mounting system	Connection	Contracted Energy (MWa)	Inverter Sizing Factor (%)
						ref.: Qual.Pow	**ref.: DC.Pow**				
Sol Steelcons Miracema 1	TO	33.3	30.0	30.0	5.4	18.0%	16.2%	Fixed	Basic Grid	5.4	90.2%
Sol Steelcons Miracema 2	TO	33.3	30.0	30.0	5.4	18.0%	16.2%	Fixed	Basic Grid	5.4	90.2%
Sol Steelcons Miracema 3	TO	33.3	30.0	30.0	5.4	18.0%	16.2%	Fixed	Basic Grid	5.4	90.2%
Fazenda Esmeralda	PE	40.1	30.0	30.0	6.2	20.7%	15.4%	Fixed	Distribution	6.2	74.7%
Boa Hora 1	PE	30.0	25.0	25.0	5.3	21.2%	17.7%	Fixed	OTF	5.3	83.3%
Boa Hora 2	PE	30.0	25.0	25.0	5.3	21.2%	17.7%	Fixed	OTF	5.3	83.3%
Boa Hora 3	PE	30.0	25.0	25.0	5.3	21.2%	17.7%	Fixed	OTF	5.3	83.3%
NOVA CRUZ	RN	34.0	30.0	30.0	7.0	23.3%	20.6%	1 axis tracking	Distribution	6.3	88.2%
COREMAS III	PB	36.8	30.0	30.0	7.1	23.7%	19.3%	Fixed	Basic Grid	7.1	81.6%
BJL 4	BA	25.5	20.0	20.0	5.0	25.0%	19.6%	Fixed	Basic Grid	5.0	78.4%
Sobrado1	BA	34.2	30.0	30.0	7.8	26.0%	22.8%	1 axis tracking	Distribution	7.8	87.7%
BRISAS SUAVES	SP	6.0	5.0	5.0	1.3	26.0%	21.8%	1 axis tracking	Distribution	1.3	84.0%
GUIMARANIA 1	MG	36.8	30.0	30.0	8.2	27.3%	22.3%	1 axis tracking	Distribution	8.2	81.5%
GUIMARANIA 2	MG	36.8	30.0	30.0	8.2	27.3%	22.3%	1 axis tracking	Distribution	8.2	81.5%
PIRAPORA 2	MG	36.8	30.0	30.0	8.4	28.0%	22.8%	1 axis tracking	Basic Grid	8.4	81.5%
PIRAPORA 3	MG	36.8	30.0	30.0	8.4	28.0%	22.8%	1 axis tracking	Basic Grid	8.4	81.5%
PIRAPORA 4	MG	36.8	30.0	30.0	8.4	28.0%	22.8%	1 axis tracking	Basic Grid	8.4	81.5%
PARACATU 1	MG	36.8	30.0	30.0	8.5	28.3%	23.1%	1 axis tracking	Basic Grid	8.5	81.5%
PARACATU 2	MG	36.8	30.0	30.0	8.5	28.3%	23.1%	1 axis tracking	Basic Grid	8.5	81.5%
PARACATU 3	MG	36.8	30.0	30.0	8.5	28.3%	23.1%	1 axis tracking	Basic Grid	8.5	81.5%
PARACATU 4	MG	36.8	30.0	30.0	8.5	28.3%	23.1%	1 axis tracking	Basic Grid	8.5	81.5%

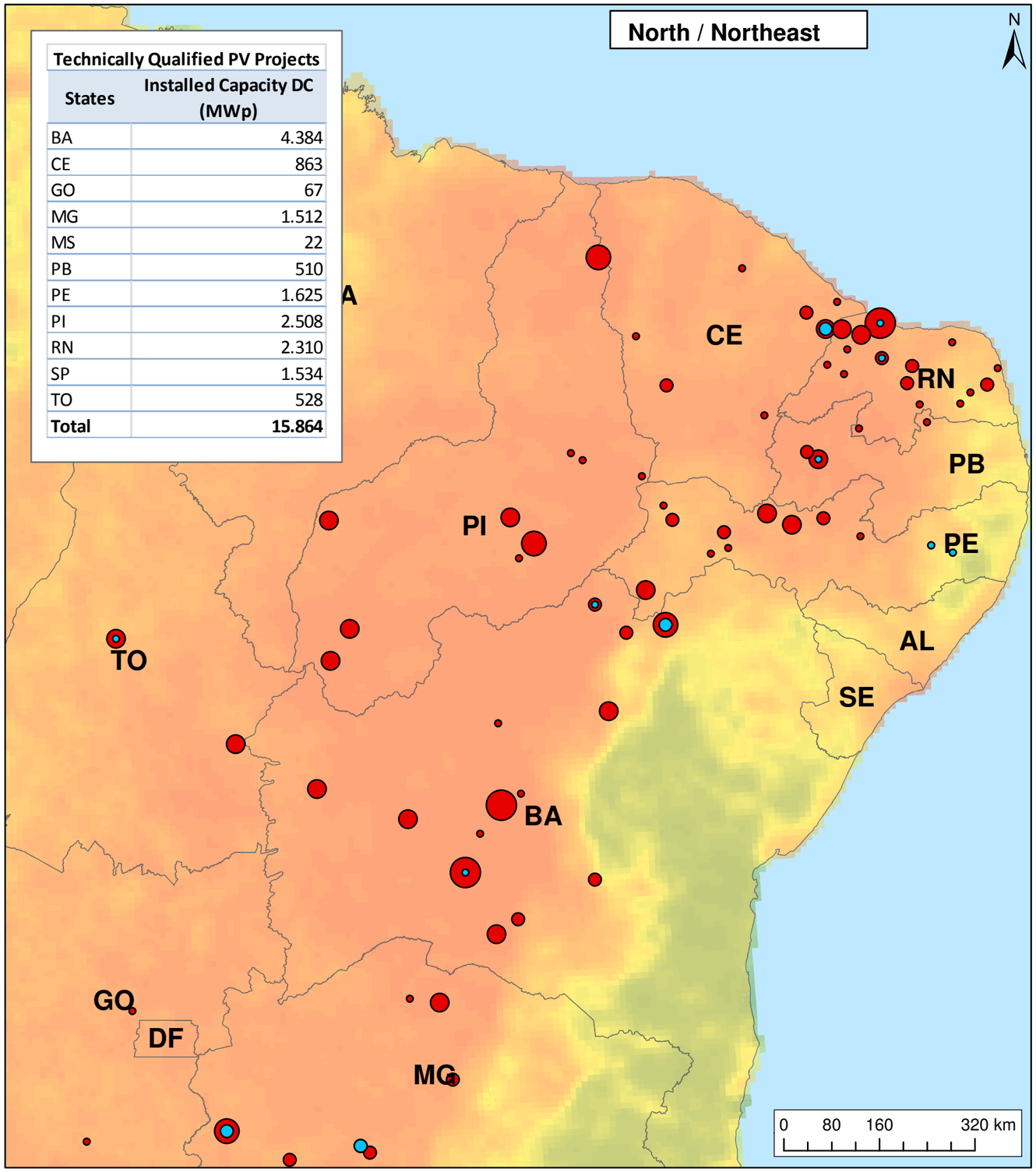
PV Project	State	DC Power (MWp)	AC Power (MW)	Qualified Power (MW)	Physical Guarantee (MWa)	Capacity Factor (%)		Mounting system	Connection	Contracted Energy (MWa)	Inverter Sizing Factor (%)
						ref.: Qual.Pow	**ref.: DC.Pow**				
APODI I	CE	36.5	30.0	30.0	8.7	29.0%	23.9%	1 axis tracking	Basic Grid	8.7	82.3%
APODI II	CE	36.5	30.0	30.0	8.7	29.0%	23.9%	1 axis tracking	Basic Grid	8.7	82.3%
APODI III	CE	36.5	30.0	30.0	8.7	29.0%	23.9%	1 axis tracking	Basic Grid	8.7	82.3%
APODI IV	CE	36.5	30.0	30.0	8.7	29.0%	23.9%	1 axis tracking	Basic Grid	8.7	82.3%
JUAZEIRO SOLAR II	BA	34.4	29.8	29.8	8.7	29.2%	25.3%	1 axis tracking	Basic Grid	8.7	86.7%
JUAZEIRO SOLAR I	BA	34.4	29.8	29.8	8.7	29.2%	25.3%	1 axis tracking	Basic Grid	8.7	86.7%
JUAZEIRO SOLAR III	BA	34.4	29.8	29.8	8.7	29.2%	25.3%	1 axis tracking	Basic Grid	8.7	86.7%
JUAZEIRO SOLAR IV	BA	34.4	29.8	29.8	8.7	29.2%	25.3%	1 axis tracking	Basic Grid	8.7	86.7%
Assú V	RN	36.7	30.0	30.0	9.2	30.7%	25.1%	1 axis tracking	Basic Grid	9.2	81.7%
Floresta I	RN	36.7	30.0	30.0	9.4	31.3%	25.6%	1 axis tracking	Basic Grid	9.4	81.7%
Floresta II	RN	36.7	30.0	30.0	9.4	31.3%	25.6%	1 axis tracking	Basic Grid	9.4	81.7%
Floresta III	RN	24.5	20.0	20.0	6.3	31.5%	25.7%	1 axis tracking	Basic Grid	6.3	81.7%
Total		**1,115.9**	**929.3**	**929.3**	**246.0**					**245.3**	

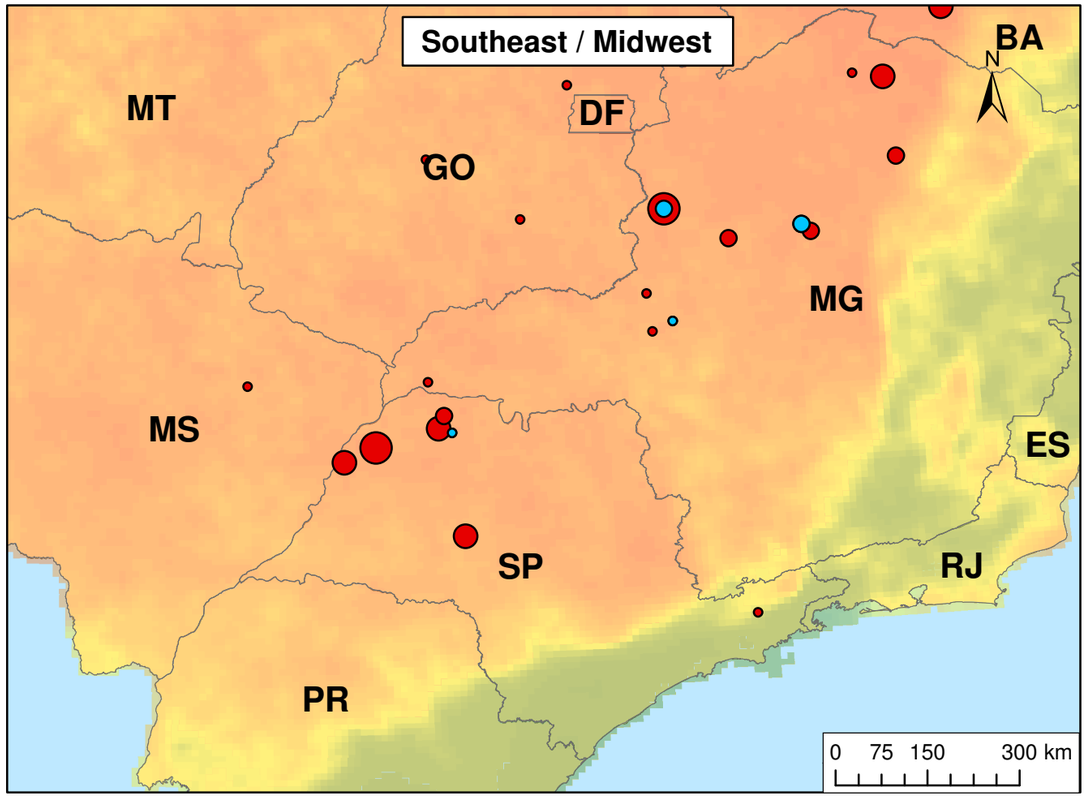
EPE-DEE-NT-023/2016
APPENDIX II

2nd LER/2015
Technically Qualified PV Projects
(Sum of Installed Capacity by city)

Empresa de Pesquisa Energética

Technically Qualified PV Projects	
States	**Installed Capacity DC (MWp)**
BA	4.384
CE	863
GO	67
MG	1.512
MS	22
PB	510
PE	1.625
PI	2.508
RN	2.310
SP	1.534
TO	528
Total	**15.864**





Conventions Adopted

Technically Qualified Sum of Installed Capacity by city (MWp)

- Up to 100 MW
- 101 to 200 MW
- 201 to 400 MW
- 401 to 800 MW
- Above 800 MW

Contracted Projects Sum of Installed Capacity by city (MWp)

- Up to 100 MW
- 101 to 200 MW
- 201 to 400 MW
- 401 to 800 MW
- Above 800 MW

Back Ground: Global Horizontal Irradiation (kWh/m².ano)

Color Grade: 1600 1800 1900 2150

Source: Atlas Brasileiro de Energia Solar (INPE, 2006)

Date: 02/03/2016

Source: AEGE/EPE System
Citys: IBGE 2010

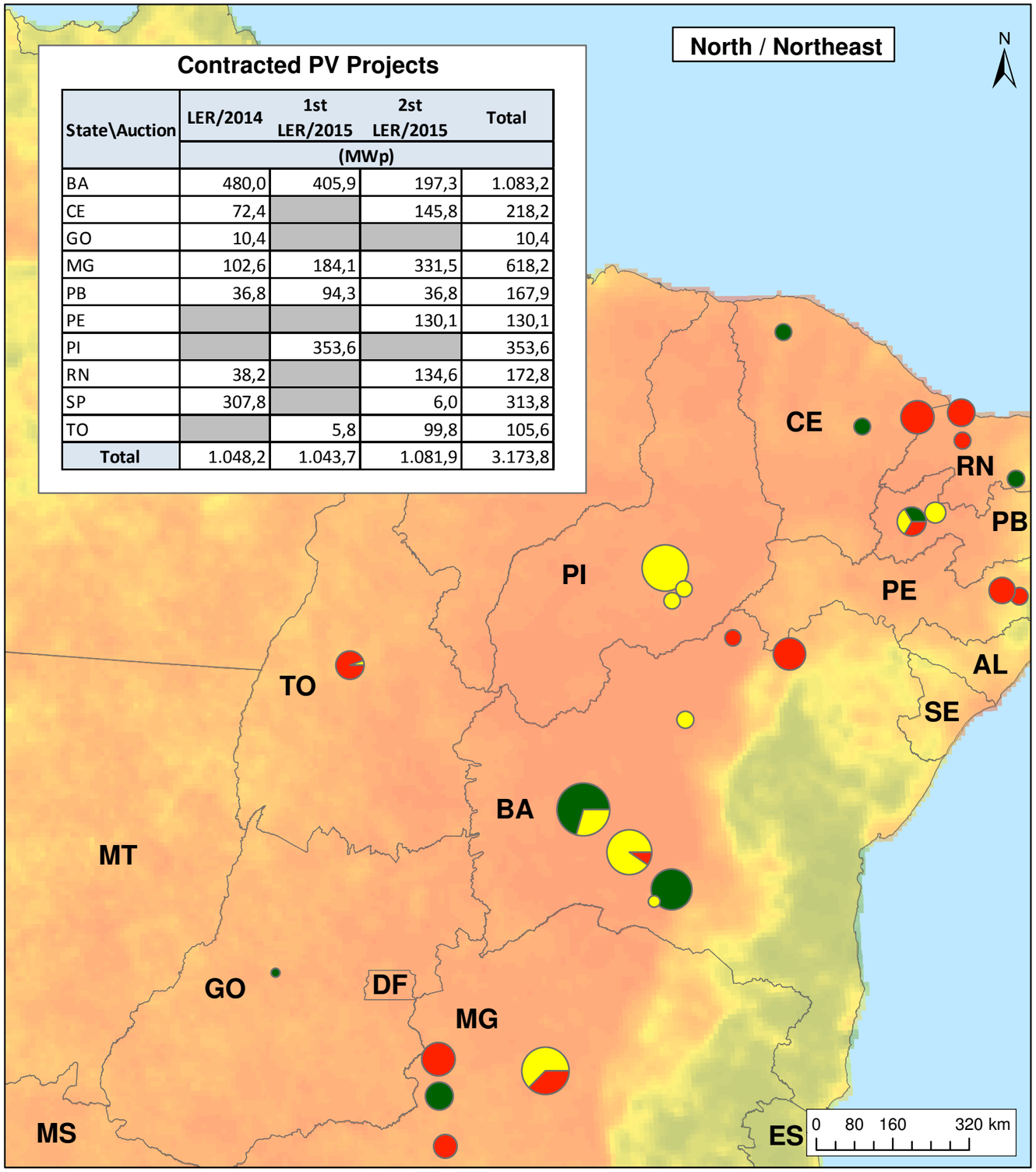
EPE-DEE-NT-023/2016
APPENDIX III

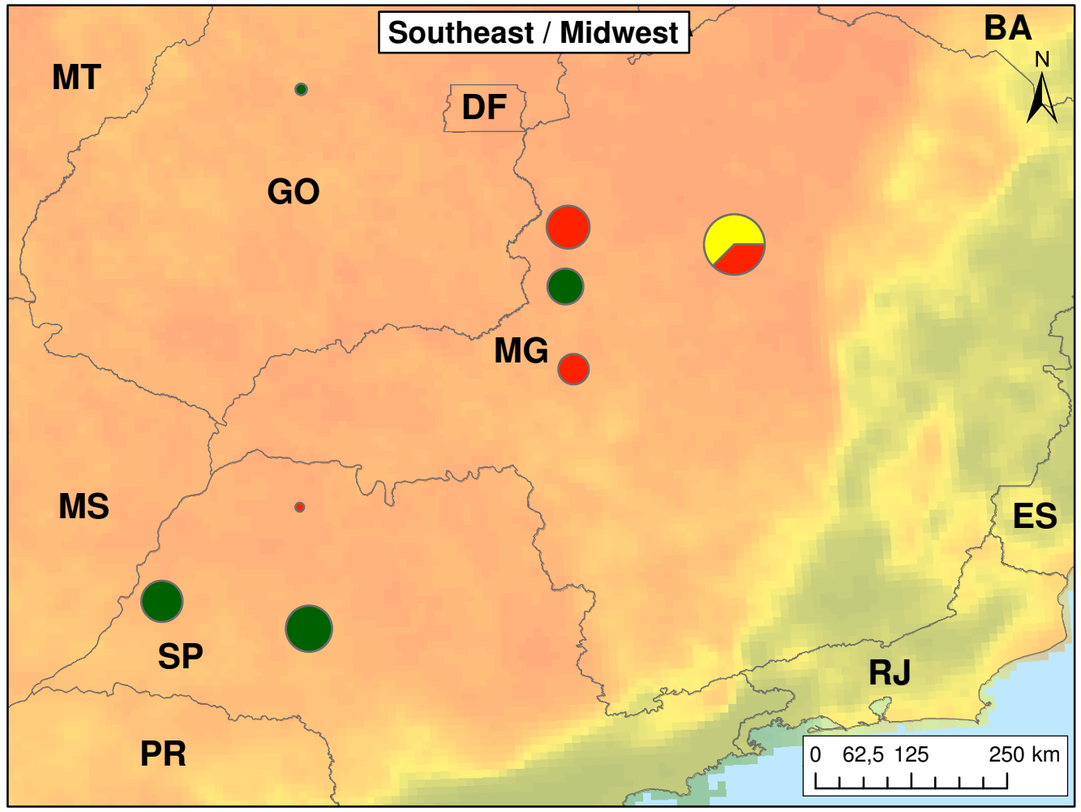
LER/2014, 1st LER/2015 e 2nd LER/2015
Contracted PV Projects
(Sum of Installed Capacity by City)

Empresa de Pesquisa Energética

Contracted PV Projects

State\Auction	LER/2014	1st LER/2015	2st LER/2015	Total
	(MWp)			
BA	480,0	405,9	197,3	1.083,2
CE	72,4		145,8	218,2
GO	10,4			10,4
MG	102,6	184,1	331,5	618,2
PB	36,8	94,3	36,8	167,9
PE			130,1	130,1
PI		353,6		353,6
RN	38,2		134,6	172,8
SP	307,8		6,0	313,8
TO		5,8	99,8	105,6
Total	1.048,2	1.043,7	1.081,9	3.173,8





Conventions Adopted

Contracted Projects Sum of Installed Capacity by City (MWp)

- LER/2014
- 1º LER/2015
- 2º LER/2015

Back Ground: Global Horizontal Irradiation (kWh/m².ano)

Color Grade:

- 1600
- 1800
- 1900
- 2150

Source: Atlas Brasileiro de Energia Solar (INPE, 2006)

Date: 02/03/2016

Source: AEGE/EPE System
Citys: IBGE 2010