1st Half 2022 | Brazil

Strategic Research Report
Distributed Generation

Photovoltaic (PV) Market

Greener

August/2022

v1

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From the Market to the Market

Every year we carry out our survey about the Distributed Generation solar PV sector. The objective of this survey is to show the reality of the market, in such a way that it can be a strategy guide for all the active companies in the sector.

To achieve this, we count on the collaboration of thousands of PV Integrators, who dedicate some of their precious time to respond to our questionnaire; on Distributors who take some time to provide us with reference prices of their PV kits; on all companies in general (Manufacturers, Distributors, Service providers) who use their time to distribute our questionnaire and incentivize the engagement of their customer bases and completion of the forms, as well as providing us with references and sharing their knowledge with us; and our Sponsors, who make the execution of all this work possible.

This is market research created by our market for our market. Our role is only to collect, concentrate and validate the information that the whole value chain supplies to us, with the best of intentions, since we all have the same objective: to help the solar PV market grow in a healthy direction.

Our Big Thanks to everyone!
Greener Team

Report Highlights

1. **The import of solar PV equipment to Brazil is accelerating.** The quantity demanded by the Brazilian market in the **first half of 2022** should generate **investments exceeding R$35 billion** to meet the needs of distributed generation and large-scale solar PV plants.

2. **The prices of solar PV systems showed an average decrease of 4.3%** in the first half of 2022. Lower sales prices of the equipment in the distribution chain and high competitiveness in the sector were factors that contributed to the reduction of prices to the end consumer.

3. A sharp rise in interest rates contributed to a **drop in the share of (bank) financing** in the sales of PV systems in the first half of 2022. Despite this development, the solar PV sector continues to attract **new financial backers to the market,** with the number of financial institutions providing credit to the PV sector **growing by 30%**.

4. In spite of the reduction in the value of energy to the final consumer as a result of **Complementary Law (LC) 194, which reduces ICMS**, investments in Distributed Generation solar power, in general, remain attractive.

STRATEGIC REPORT FOR THE DG SOLAR MARKET

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CHAPTER 1

Value Chain

Value Chain

Distributed Generation

- The **value chain** encompasses all activities carried out by a group of companies and organizations in order to deliver a **PV system** to the end consumer, taking into account the stages of manufacturing, distribution, integration, aquisition of the PV system and its deactivation at the end of its useful life. For each of these stages there are **market participants** directly related to the execution of those activities, as well as other companies that operate indirectly in the sector.

- A good understanding of the dynamics in the value chain is fundamental for all different market participants to obtain the **information needed to manage their processes and strategies**, such as **pricing**, amongst others, at the same time as trying to increase and improve their market presence and spread the use of DG solar technology.

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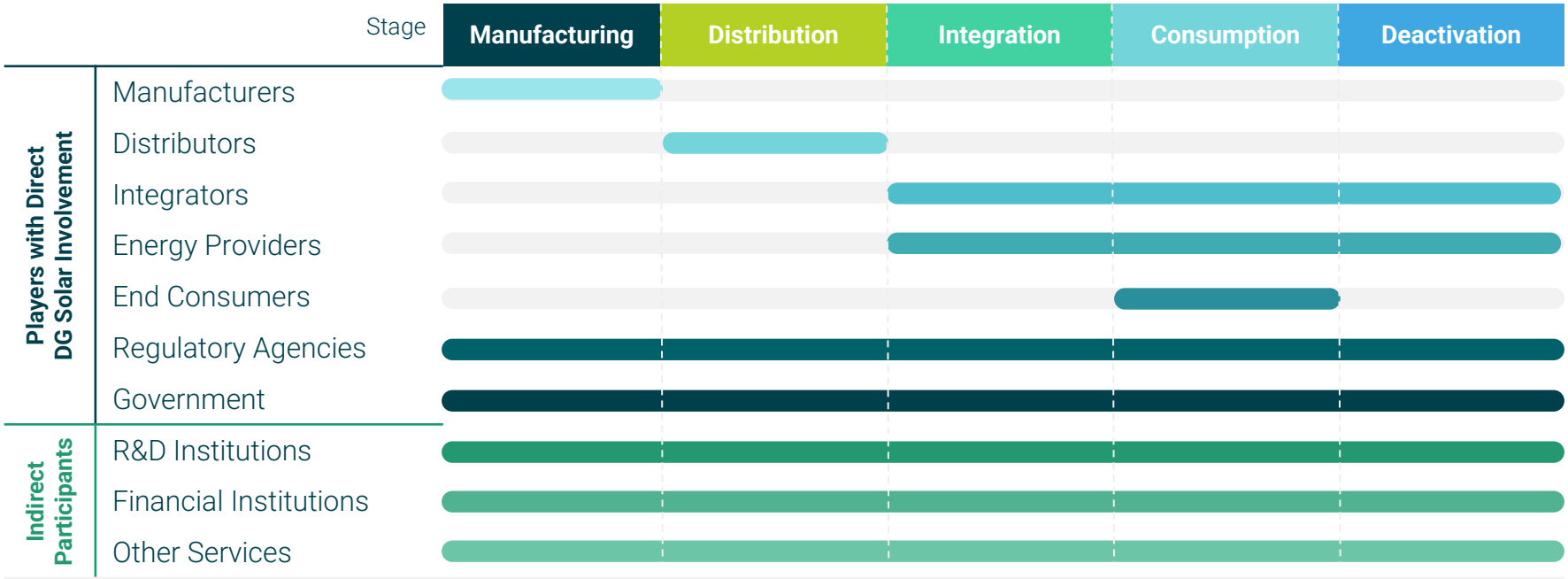
Value Chain



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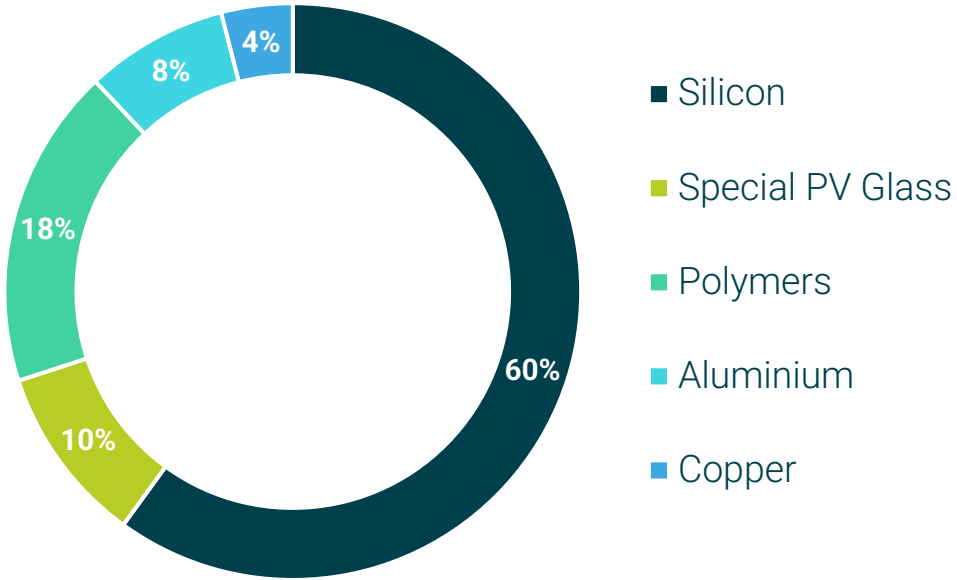
Manufacturing of PV System Components

PV Modules

Cost Structure



- The **PV modules** represent about 38% of the total cost of a PV system, thus an essential component for a detailed analysis of market pricing.
- Since the main input material for each module is metallic silicon (the raw material for the production of **polysilicon**), which makes up 60% of the total raw material cost, variations in the silicon price have a direct impact on the price of PV modules.

Source: Greener, 2022. Access here.

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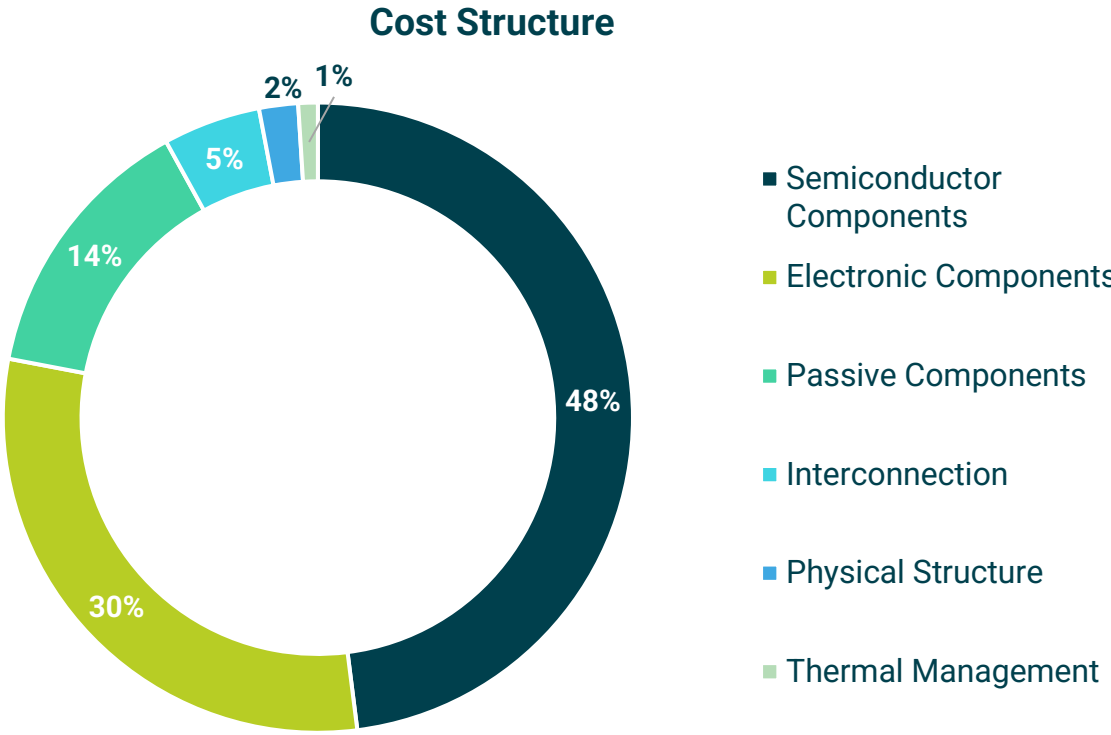
Manufacturing of PV System Components

PV Inverters



- The **semiconductors and electronic components** represent the bulk of the component costs for PV Inverters. In the past year, these components experienced a sharp increase in demand due to the ongoing digitalization process, which was accelerated by the pandemic. This scenario culminated in **global supply issues** for these components and consequent increases in **prices and shipping costs**, potentially influencing the future cost of inverters.

Source: Greener, 2022. Access here.

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Manufacturing of PV System Components

PV Mounting Structures, Installation Tools & Materials, Bidirectional Electricity Meters

- The **PV Mounting Structures** are basically made of **aluminum or steel** to guarantee the structural flexibility that is required of them and the maximum useful system lifetime. Even though aluminum is also produced in Brazil, its pricing structure is based on the value of the US $ and its quoted price on the London Metal Exchange (LME), meaning that currency movements can have a significant impact on the final cost of PV mounting structures.

- The **installation tools and materials** include cables/wiring, system protection, devices for energy conversion, as well as their raw materials such as **copper, aluminum, polymers, and steel.**

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Manufacturing the Components of a PV System

Impact from Commodity Price Rises

- After a sharp rise in 2021 because of a lack of supply, the **price of steel has shown a declining trend** in the last few months and is getting close to the price level of January 2021.
- The global steel price impacts the production cost of **mounting structures, especially for ground-based PV plants.**

Source: https://tradingeconomics.com/commodity/steel

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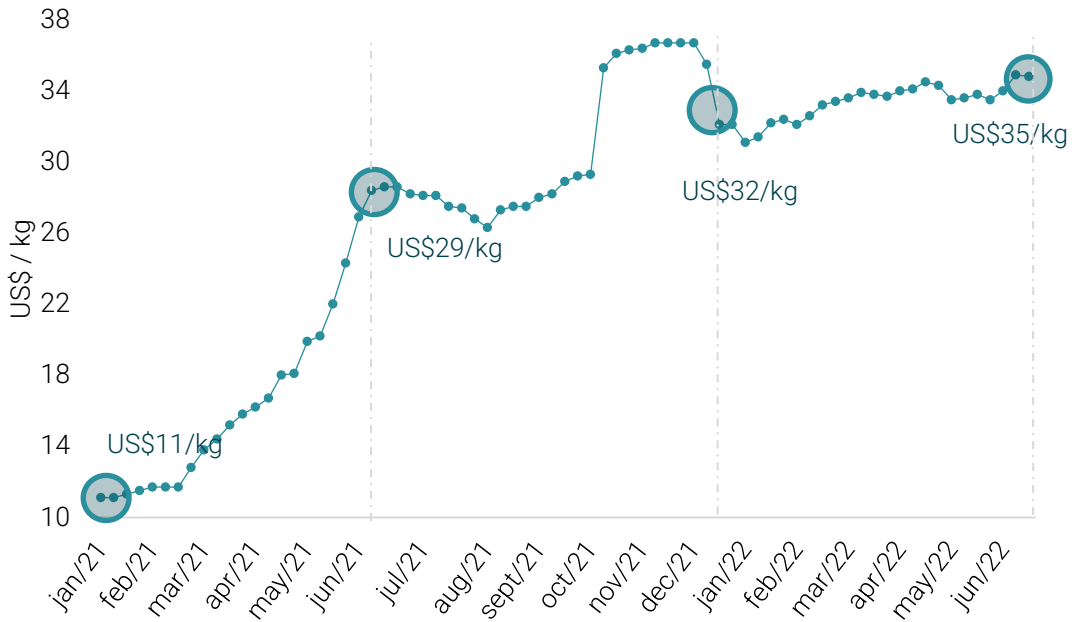
Manufacturing the Components of a PV System

Impact of the Price Rise of Polysilicon on the Prices of PV Modules

Evolution of the Price of Polysilicon



- The global price of polysilicon maintained its rising trend, recording an increase of **9.4% in the first half of 2022.**
- **In the year up to December 2021** the polysilicon price had already undergone an increase of **200%.**
- The price variation of this raw material **directly impacts the price of PV modules.**

Source: https://www.bernreuter.com/polysilicon/price-trend/

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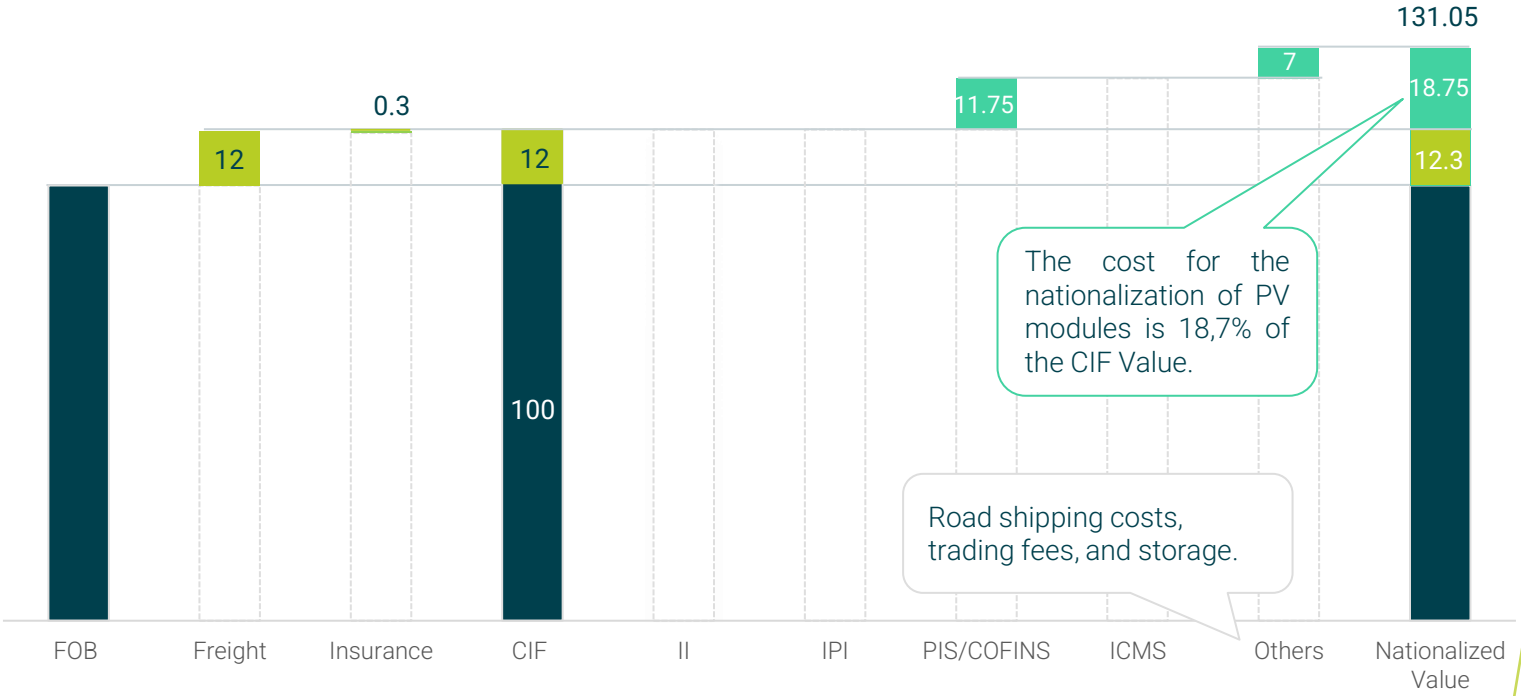
Solar PV Modules

Costs of importing and nationalization for use in Brazil

- International freight costs showed a reduction of around 30% compared to the end of 2021, impacting the cost of PV modules in Brazil positively.

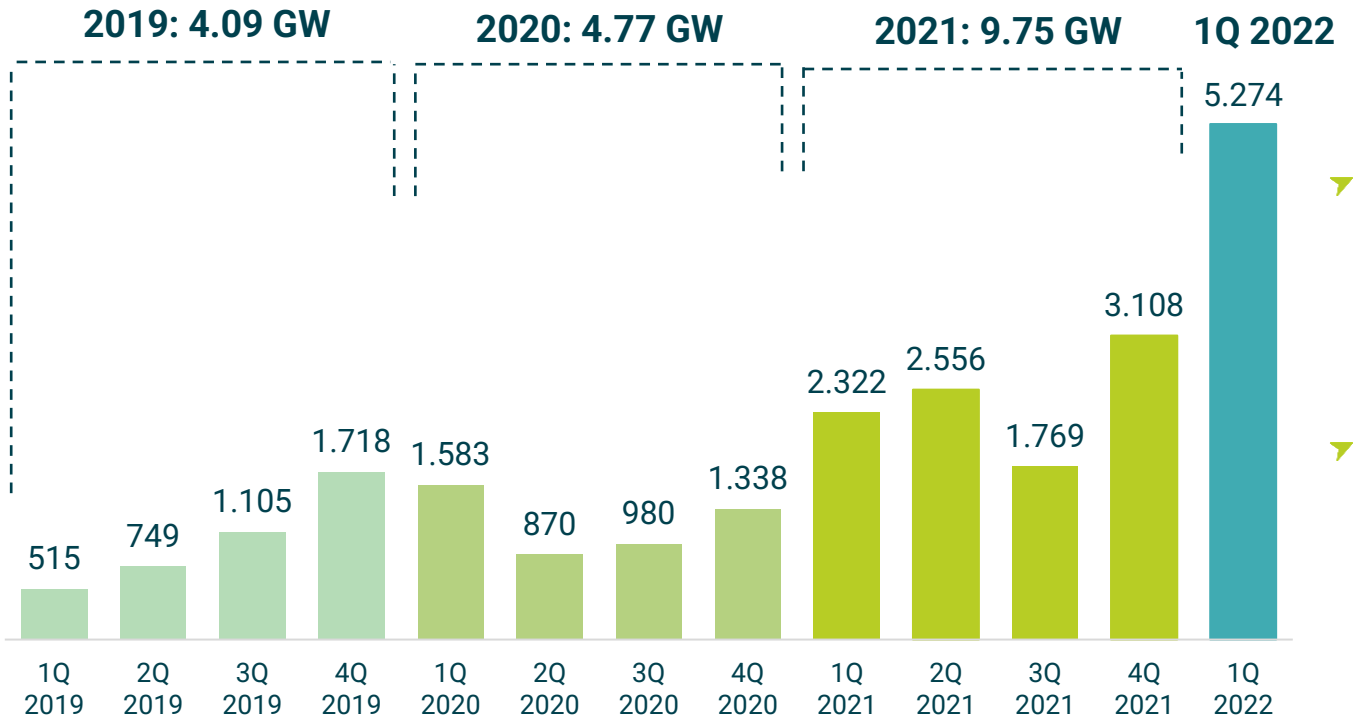


Freight Cost Brazil – China at USD10k per 40 ft container in Jul/2022

Cost / Rate	12%	0.3%	0%	0%	11.75%	0%	7%	31.05%

Solar PV Modules– Imported Volume [MWp]

Distributed Generation and Centralized Generation



- The first quarter of 2022 showed **volume growth of 127%** compared to the same period in 2021 (2,322 MW).
- The **regulatory changes** and high expectations for market growth in 2022 were the main drivers of these high volumes.

Source: Receita Federal / Federal Tax Authority (2021) and Greener

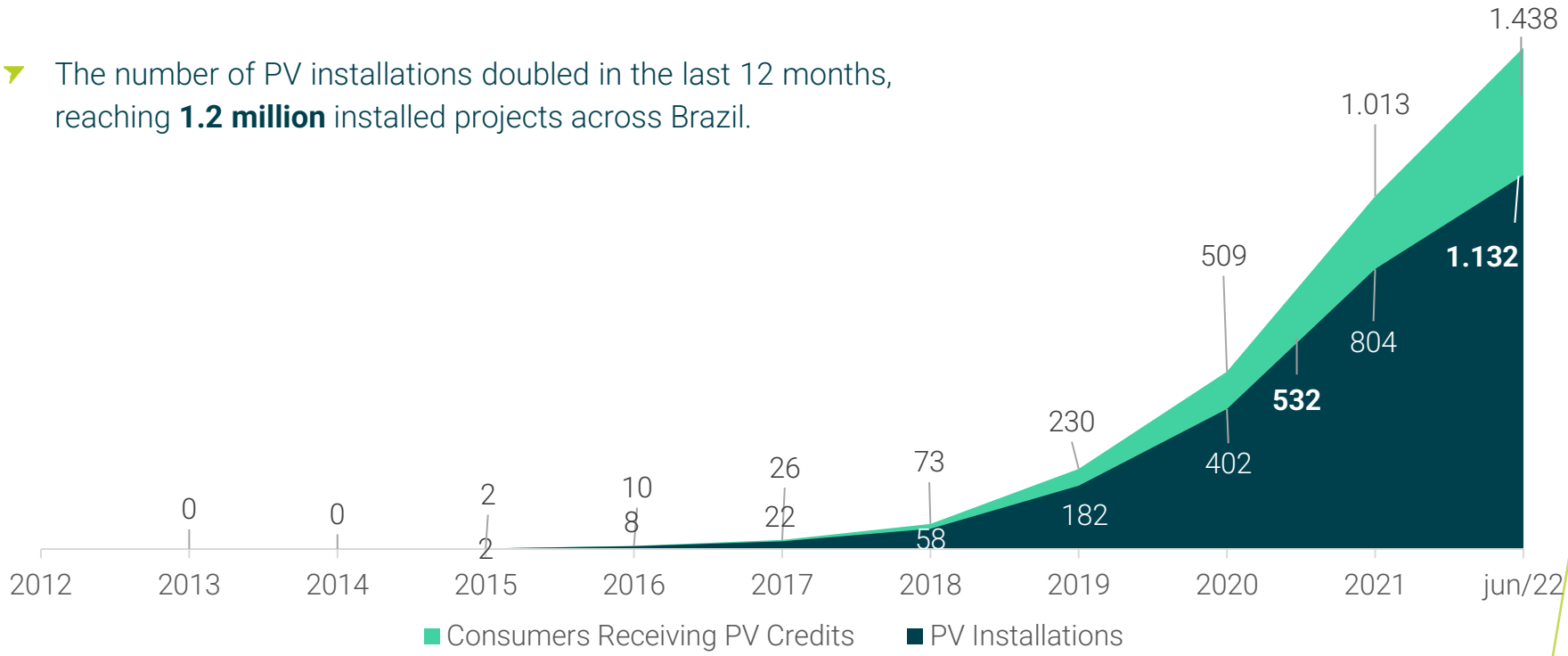
CHAPTER 2

DG Business Ventures

Cumulative Number of Solar PV Installations in Brazil

Nº Connected to Grid and Nº of Connected Customers Earning Energy Credits (Thousands)

- The number of PV installations doubled in the last 12 months, reaching **1.2 million** installed projects across Brazil.



Source: Aneel, 2022 (data downloaded on 12/08/2022).

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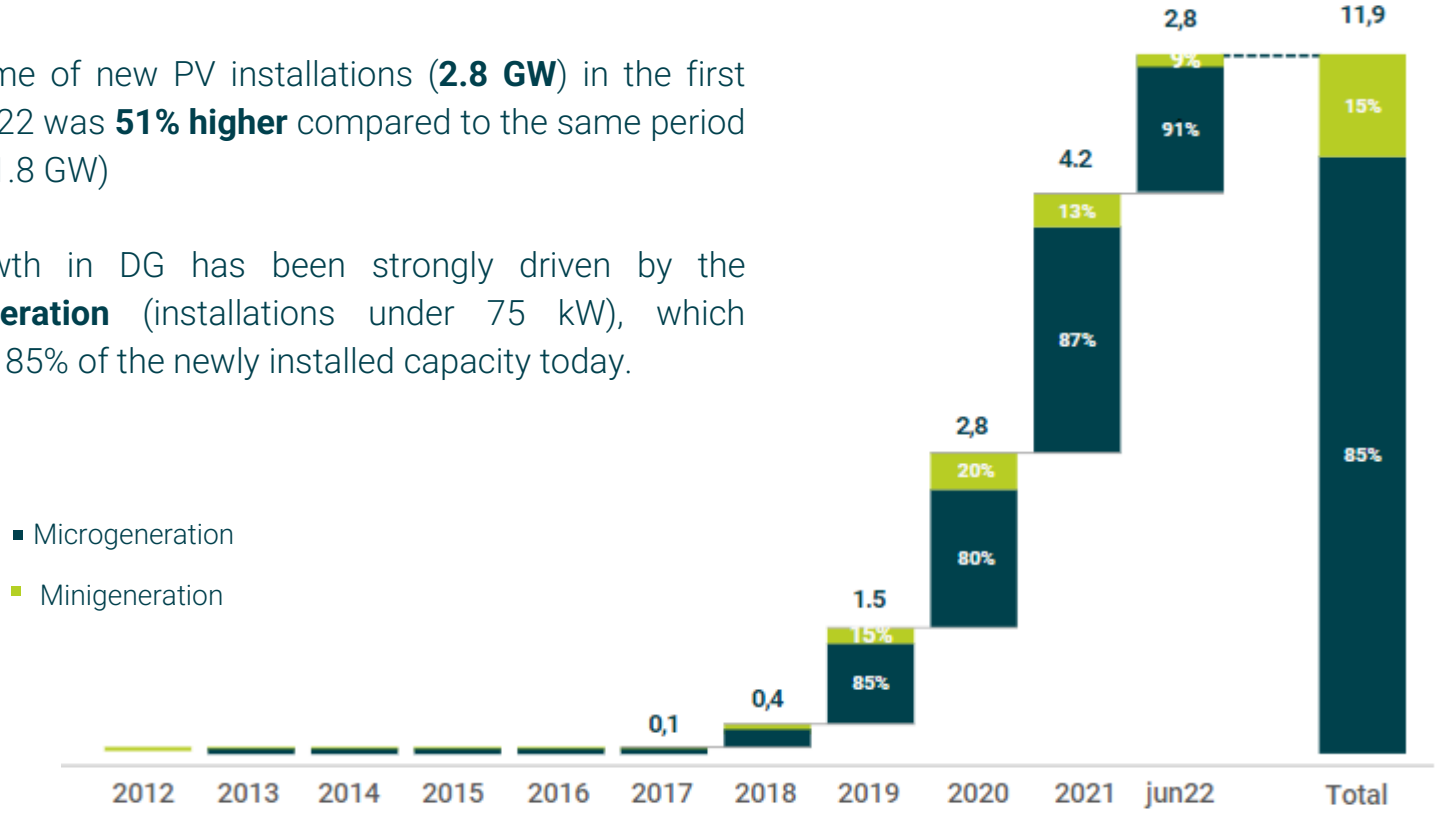
Additional and Cumulative PV Volume Connected to Grid [GW]

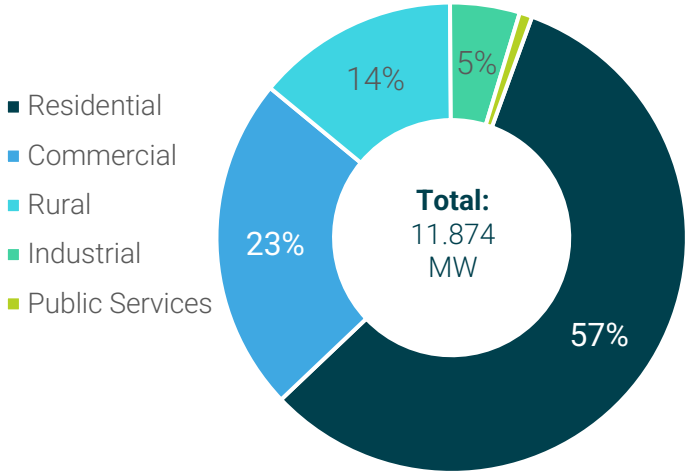
- The volume of new PV installations (**2.8 GW**) in the first half of 2022 was **51% higher** compared to the same period of 2021 (1.8 GW)
- The growth in DG has been strongly driven by the **microgeneration** (installations under 75 kW), which represent 85% of the newly installed capacity today.

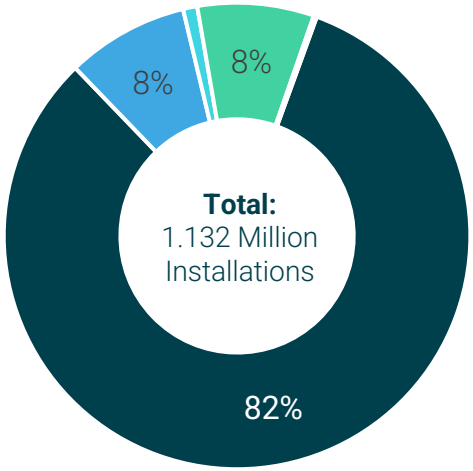


Source: Aneel, 2022 (data downloaded on 12/08/2022)

Cumulative Volume / Installations per Customer Type

Cumulative Capacity (MW) and PV Installations (in thousands)





- **Residential Customers** continue to represent a majority share in DG solar, both in the number of installations and the installed generating capacity.
- Larger-sized PV systems, such as those for **Commercial and Industrial Customers,** currently represent **37%** of installed capacity and **16%** of the number of installations in the country.

Source: Aneel, 2022 (data downloaded on 12/08/2022)

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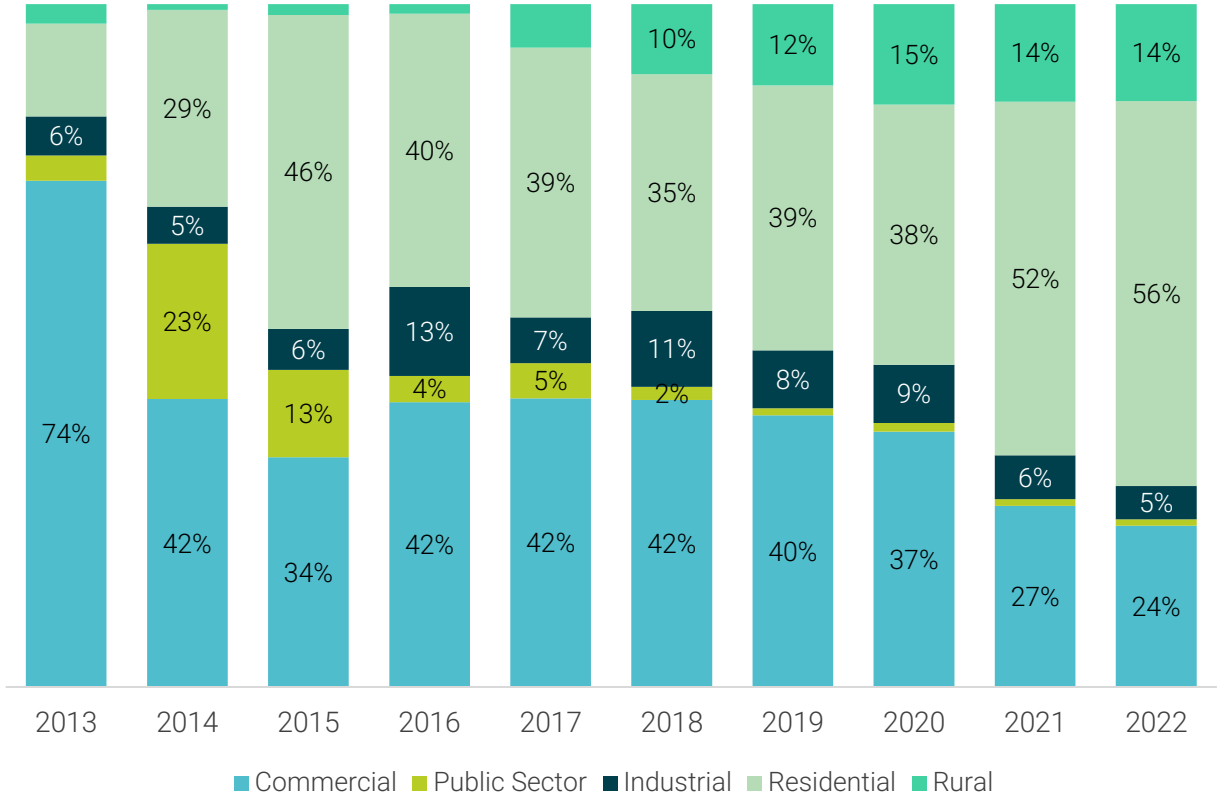
Additional Volume per Customer Type



- The **residential customer group** continues to increase its share of additional PV volume each quarter, and now represents **56% of newly installed PV volume**
- **71%** of PV volume **comes from natural persons**, while **29%** are legal persons
- The relative share of **commercial and industrial customers** has been decreasing, while that of rural and public sector customers has remained stable.

Source: Aneel, 2022 (data downloaded on 12/08/2022)

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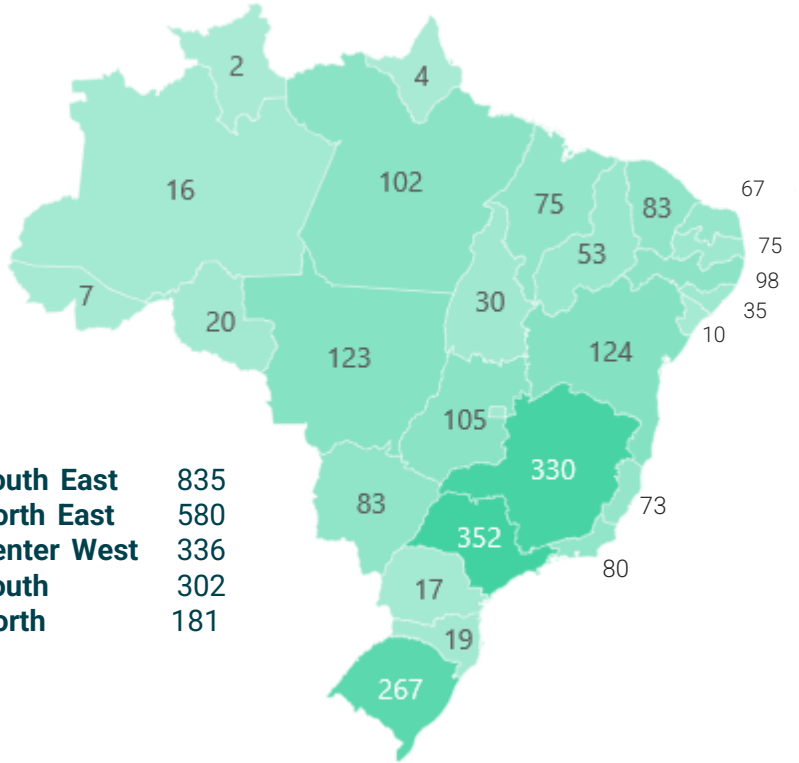
Additional PV Capacity per State [MW]

Cumulative Total PV Volume from January to June 2022 (in thousands)



South East	835
North East	580
Center West	336
South	302
North	181

- **São Paulo** was the State that **invested the most in solar PV energy** in the first half of the year, followed by Minas Gerais and Rio Grande do Sul, forming the top 3 investors
- The **top 5 States** invested a total of **R$ 7.6 Billion** in the first half of 2022.

TOP 5 States 1H/2022		
State	Additional Capacity (MW)	Investment (R$ Billions)
São Paulo	352	2.2
Minas Gerais	330	2.1
Rio Grande do Sul	267	1.7
Bahia	124	0.8
Mato Grosso	123	0.8

Source: Aneel, 2022 (data downloaded on 12/08/2022)

CHAPTER 3

PV Integrators

The GREENER Survey

Introduction

- Greener once again carried out its market survey of the Brazilian PV market, interviewing **1.579 Integrator companies** in the period between the **6th of June and 20th of July 2022**. The survey included a representative sample of companies from all over the country, of all sizes and years of experience, therefore creating a heterogenous and reliable view of the market for solar integration in Brazil.

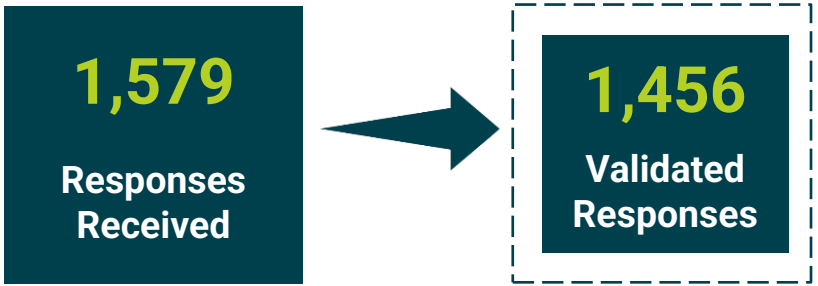
The Survey

Year of start of commercial activities of surveyed companies:

2017 Or before	2018	2019	2020	2021	2022
23%	12%	14%	16%	21%	14%

1st Half Year

Data Validation:



92% of Responses utilized

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The Survey

Estimated Total Number of Integrator Companies in Brazil

- **The total number of active Integrator Companies** is estimated based on a cross-reference between Greener's survey data and information obtained through Entities and Companies that represent and supply the PV sector.

26,050 **№ of Active PV Integrators***

* Companies that completed at least one transaction in 2022. This is a conservative estimate made by Greener, however, the real number of companies active in the market could be higher.

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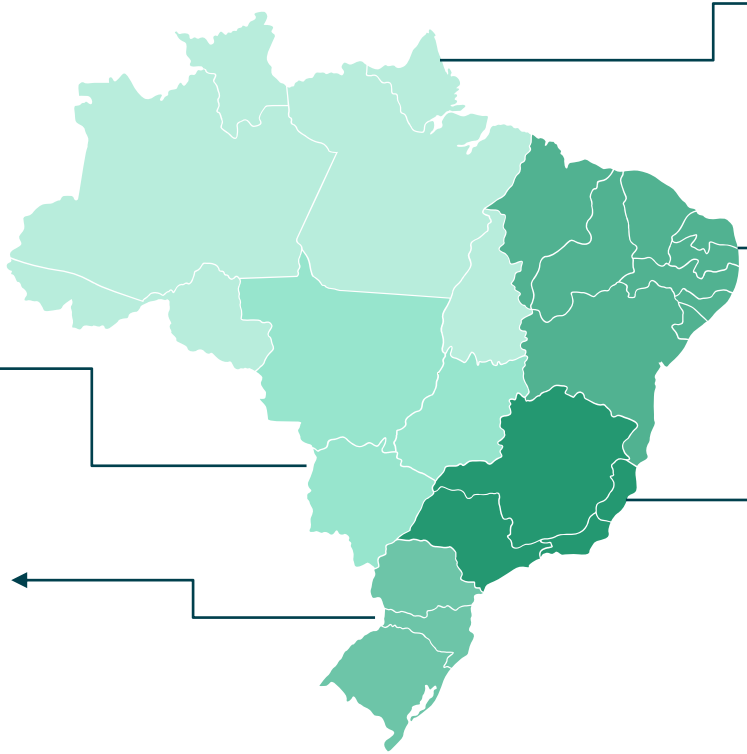
Location of Headquarters (HQ) of Companies that Responded

Share of Company HQs per Region



North 4%

North East 22%

Center West 9%

South East 45%

South 18%

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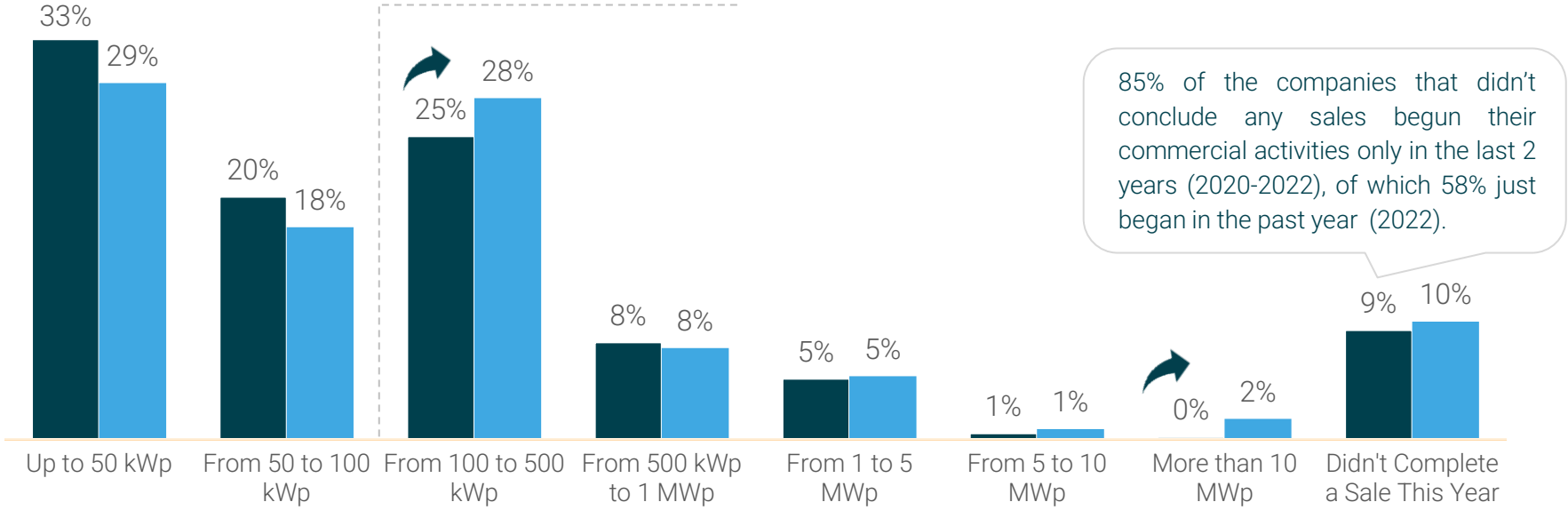
Sales Volume of PV Integrators in 2022

- There was an **increase** in the percentage of companies **in the upper sales bands (more than 100 kWp)** in the first half of 2022 compared to the same period in 2021;
- **44%** of integrators achieved sales of at least **R$ 500 thousand** no primeiro semestre;
- At least **8%** of companies made revenues above **R$ 4 million** in the first half of the year.

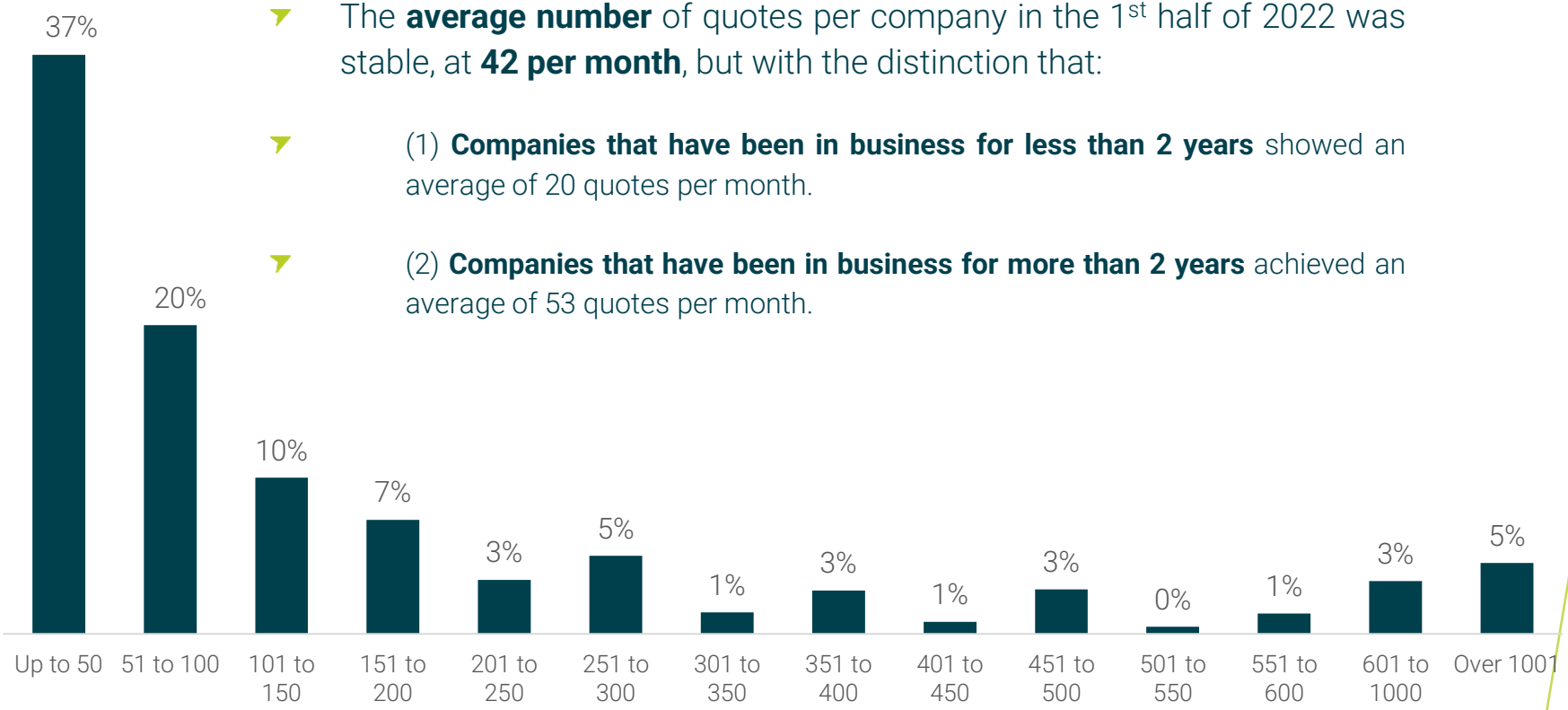


85% of the companies that didn't conclude any sales begun their commercial activities only in the last 2 years (2020-2022), of which 58% just began in the past year (2022).

Source: Greener, 2022

How many Commercial Quotes were Prepared in 1H/2022?

- The **average number** of quotes per company in the 1st half of 2022 was stable, at **42 per month**, but with the distinction that:
  - (1) **Companies that have been in business for less than 2 years** showed an average of 20 quotes per month.
  - (2) **Companies that have been in business for more than 2 years** achieved an average of 53 quotes per month.



Source: Greener, 2022. Access here.

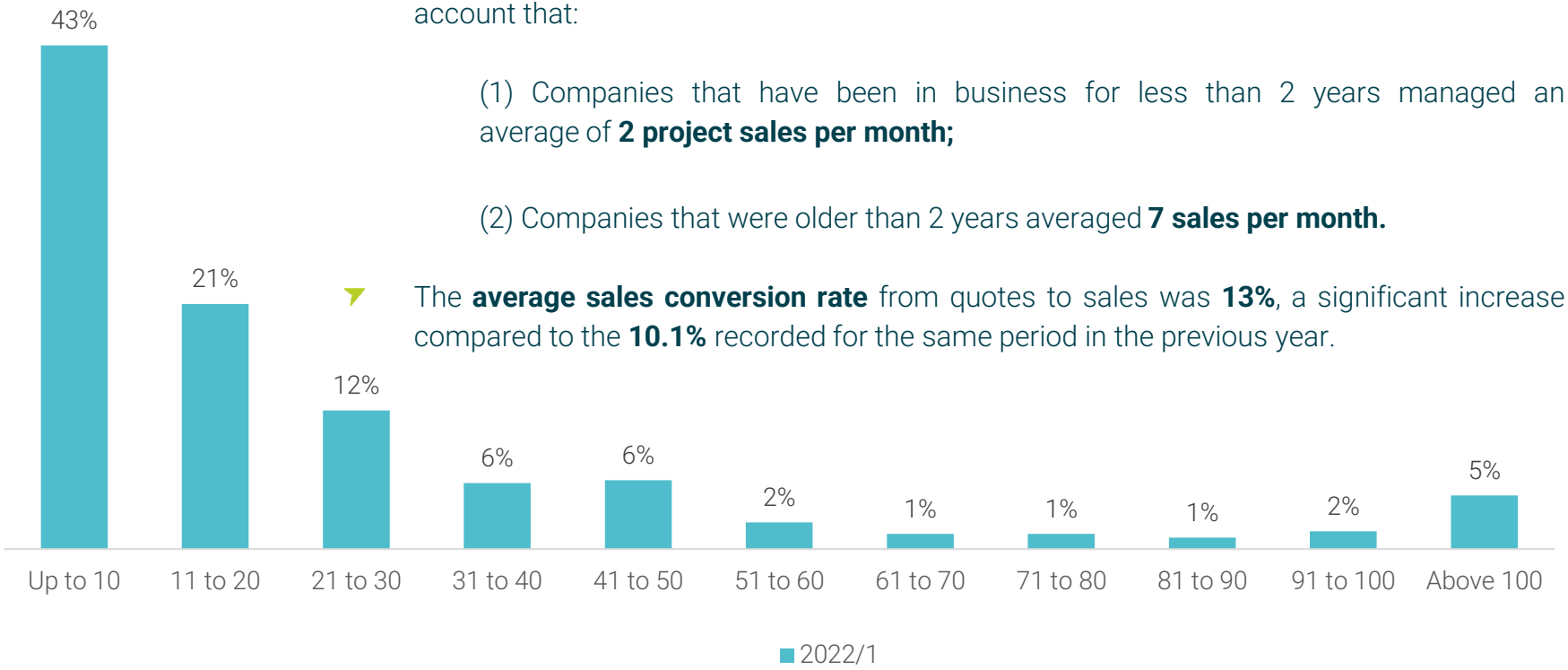
How Many PV Systems were Sold in 2022?

- The **average number** of projects sold per company in 1H2002 was **5** per month, taking into account that:

  (1) Companies that have been in business for less than 2 years managed an average of **2 project sales per month;**

  (2) Companies that were older than 2 years averaged **7 sales per month.**

- The **average sales conversion rate** from quotes to sales was **13%**, a significant increase compared to the **10.1%** recorded for the same period in the previous year.



Data related to those companies that prepared at least 1 commercial proposal in 2021.

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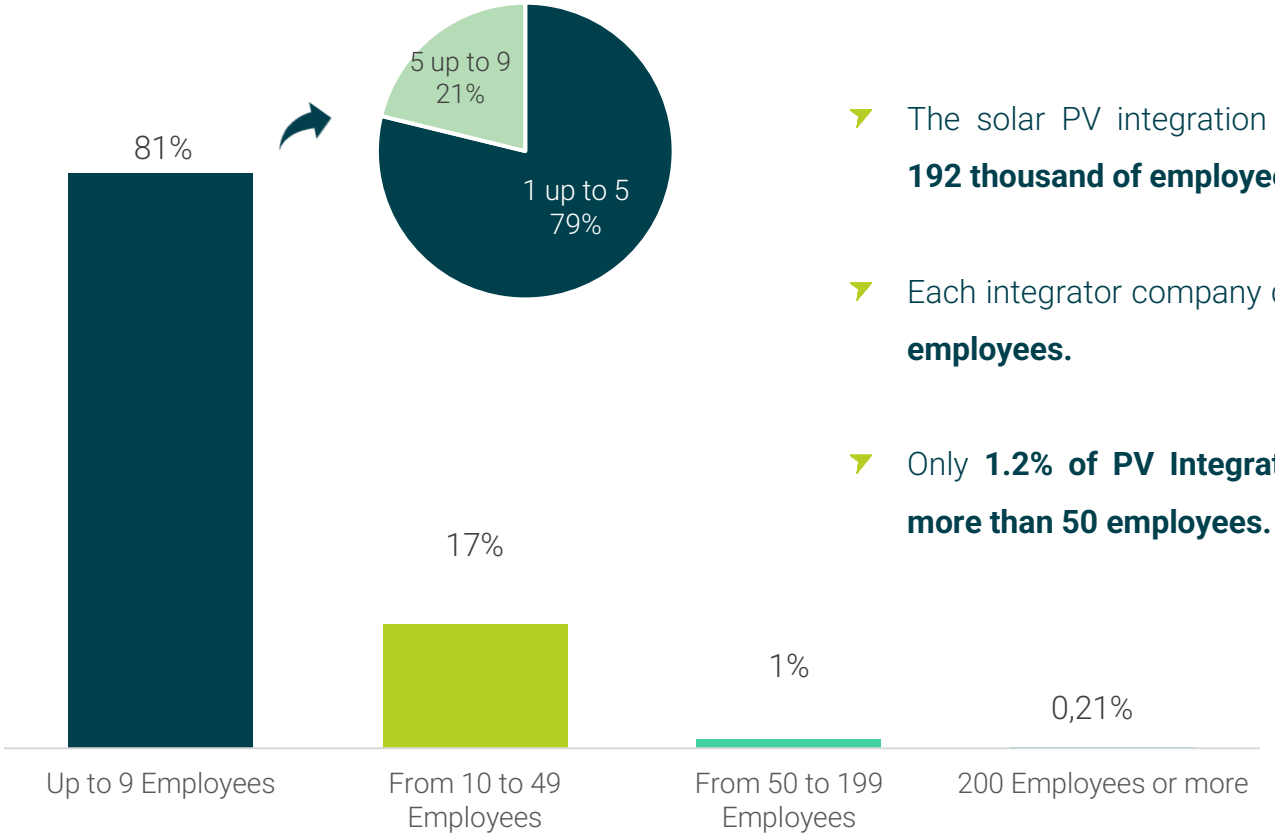
Number of Employees per Company

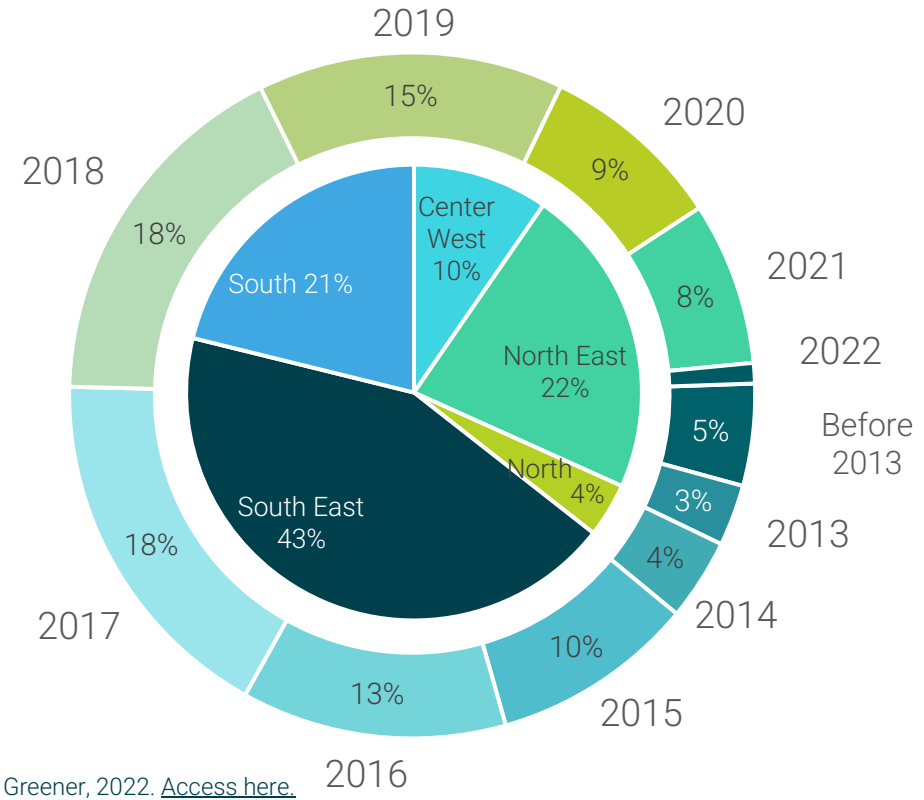


- The solar PV integration sector directly employs about **192 thousand of employees**.
- Each integrator company directly employs on average **7.4 employees.**
- Only **1.2% of PV Integrator companies** have a staff of **more than 50 employees.**

Source: Greener, 2022. Access here.

Profile of the top 100 selling companies

Founding year and location of the top-selling companies in 1H/2022



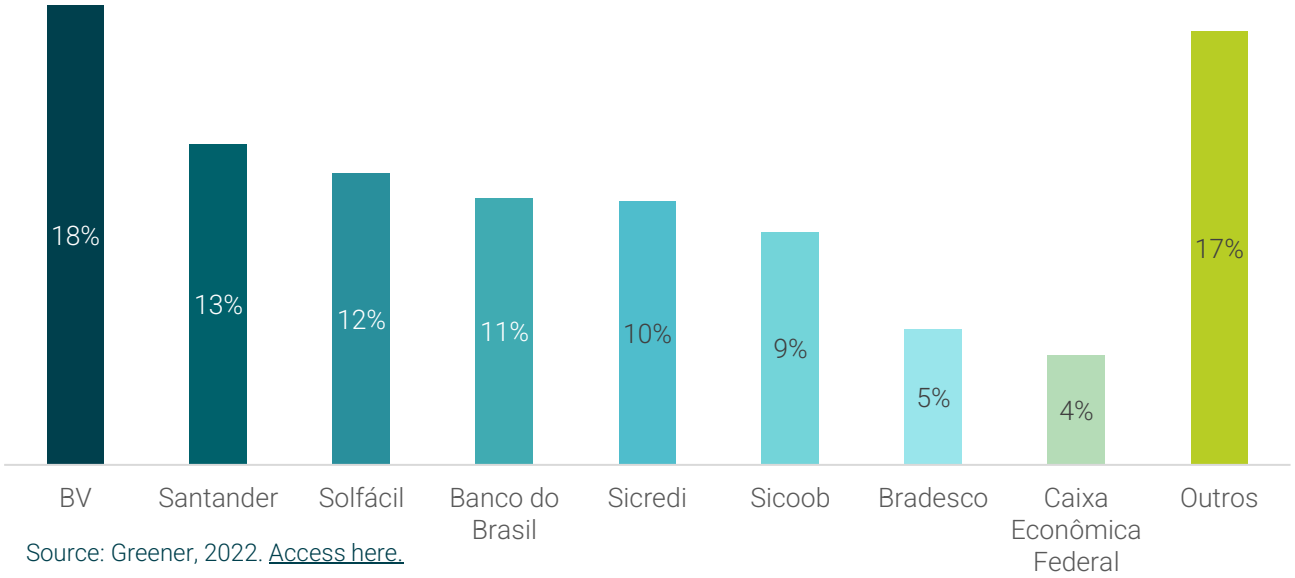
Source: Greener, 2022. Access here.

- Out of the top 100 companies, **70%** have been in business for more than 4 years.
- The average number of employees at the **top 100 integrator companies** is **23**, compared to the general average of **7** employees per company.

Solar Energy Financing

For the Sales Concluded in 1H2022 using Bank Financing, which Banks/financing lines were used?

Click here to access the complete list of banks.



Source: Greener, 2022. Access here.

52 financial institutions were mentioned in 2022, compared to 40 in the previous survey, showing an increase of **30%** in the **number of financing solutions** for the solar market.

However, as a consequence of rising interest rates, the **share of PV projects using bank financing fell,** now financially supporting around **54% of the project sales completed** in 1H2022, while this figure was 57% for the year 2021.

These data give an indication of the distribution of business among financial agents, but, do **not show market share**.
They indicate the percentage of companies that had at least one financing transaction completed through a particular bank.
The same company/integrator might have closed different projects with different banks/financing methods.

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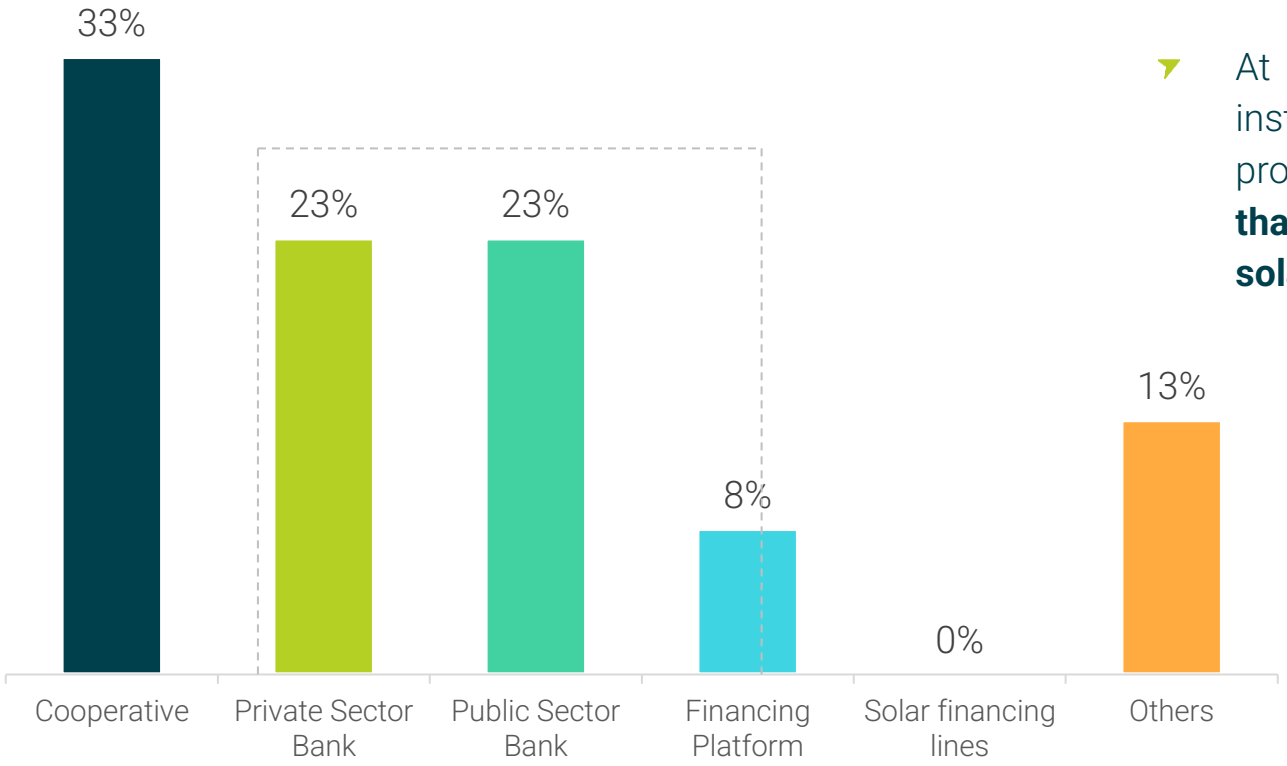
What is the Profile of Lenders / Financial Backers?



- At least **46%** of financial institutions used for PV projects are **traditional banks that provide financing for the solar PV sector.**

Source: Greener, 2022. Acesse aqui.

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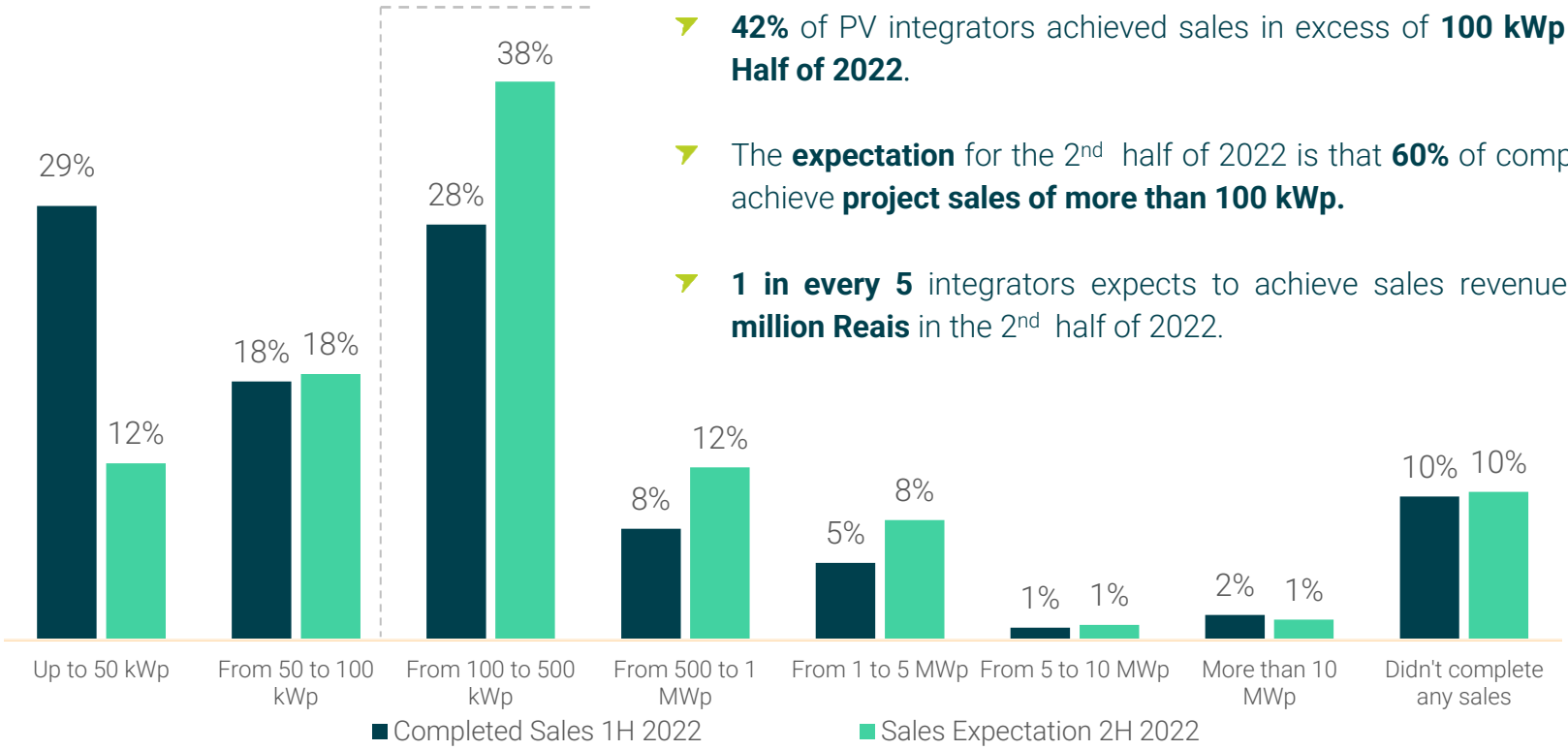
Sales Expectations for 2H/2022



- **42%** of PV integrators achieved sales in excess of **100 kWp** in the **1st Half of 2022**.
- The **expectation** for the 2nd half of 2022 is that **60%** of companies will achieve **project sales of more than 100 kWp.**
- **1 in every 5** integrators expects to achieve sales revenues of **2.4 million Reais** in the 2nd half of 2022.

Source: Greener, 2022. Access here.

CHAPTER 4

Digital Tools

Digital Tools

Introduction

- The **efficient management of integrator companies** is vital for the sustainable growth of the solar PV sector. Tools available for automation, like online platforms, programmes and software, can be used to optimize and streamline the complete operational workload of the company, all the way from customer acquisition through the sales process to installation and monitoring of PV systems.

- Through the DG Integrator Survey*, Greener tried to **understand the behaviour of the PV integration market** in the face of the **acceleration of digitalization and automation** in the post-pandemic world**,** learning some **valuable** insights for the whole solar PV value chain.

* Survey carried out in accordance with the information provided in the chapter about PV Integrators (chapter 3)

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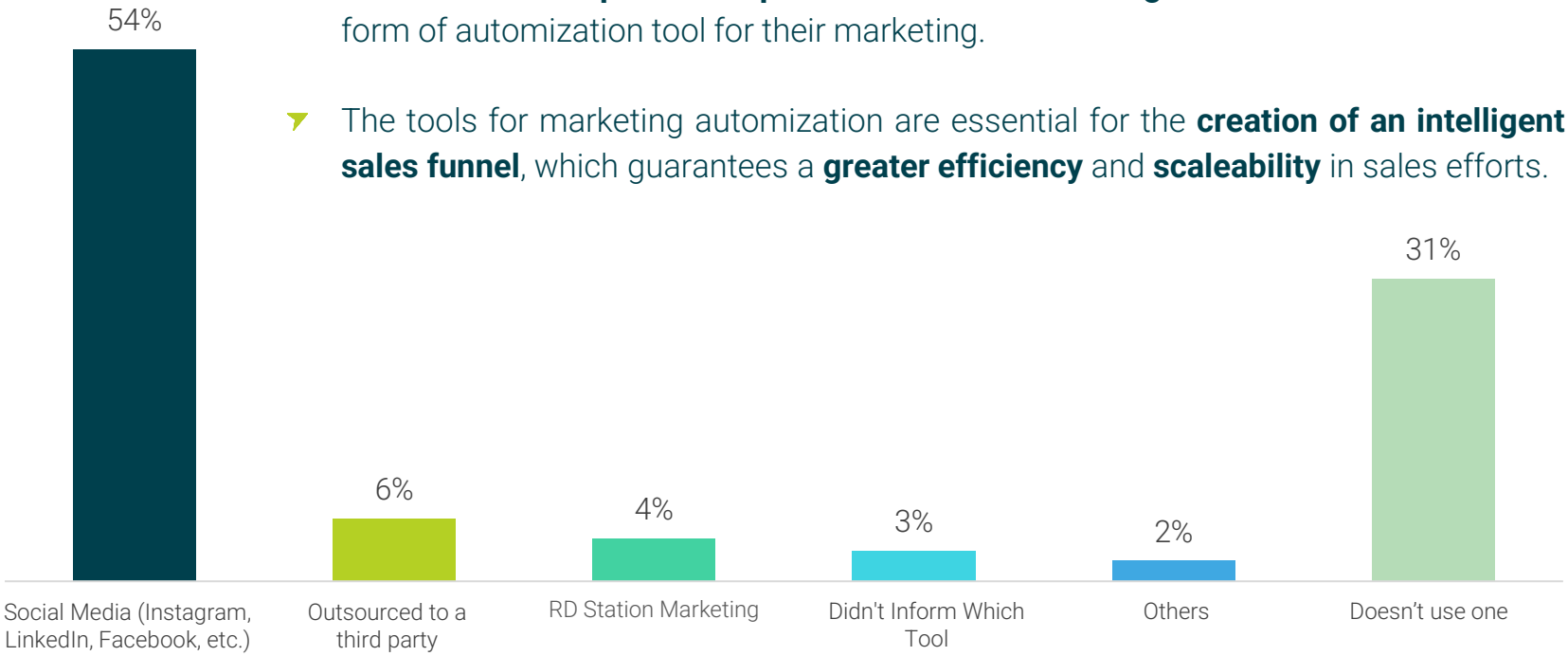
Which Marketing Automation Tool does your Company use?

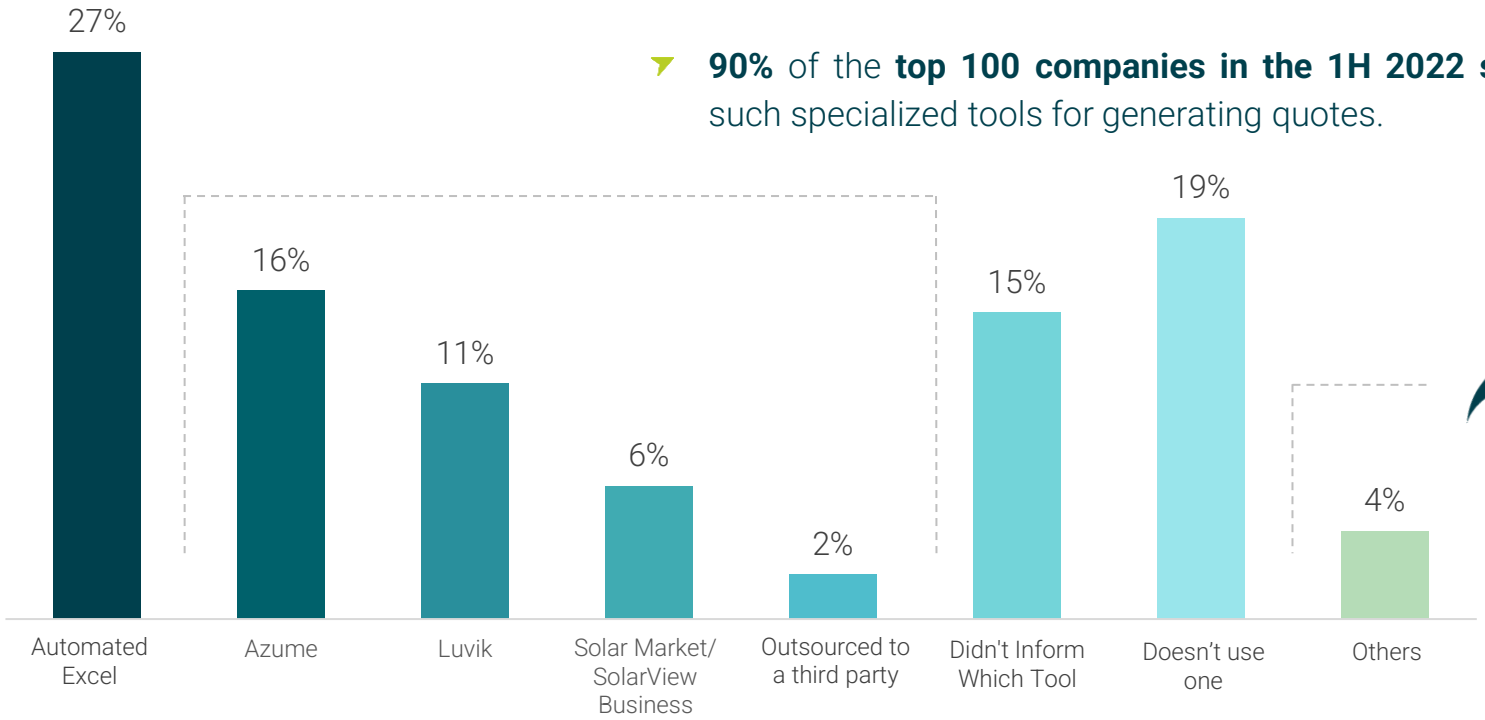
- **87% our of the top 100 companies in the sales ranking** in the 1H / 2022 use some form of automization tool for their marketing.
- The tools for marketing automization are essential for the **creation of an intelligent sales funnel**, which guarantees a **greater efficiency** and **scaleability** in sales efforts.



Source: Greener, 2022. Access here.

Which Commercial Quote Automation Tool does your Company use?

- **39%** of companies **use specialized tools** for the creation of commercial proposals / quotes for PV systems.
- **90%** of the **top 100 companies in the 1H 2022 sales ranking** use such specialized tools for generating quotes.



Source: Greener, 2022. Access here.

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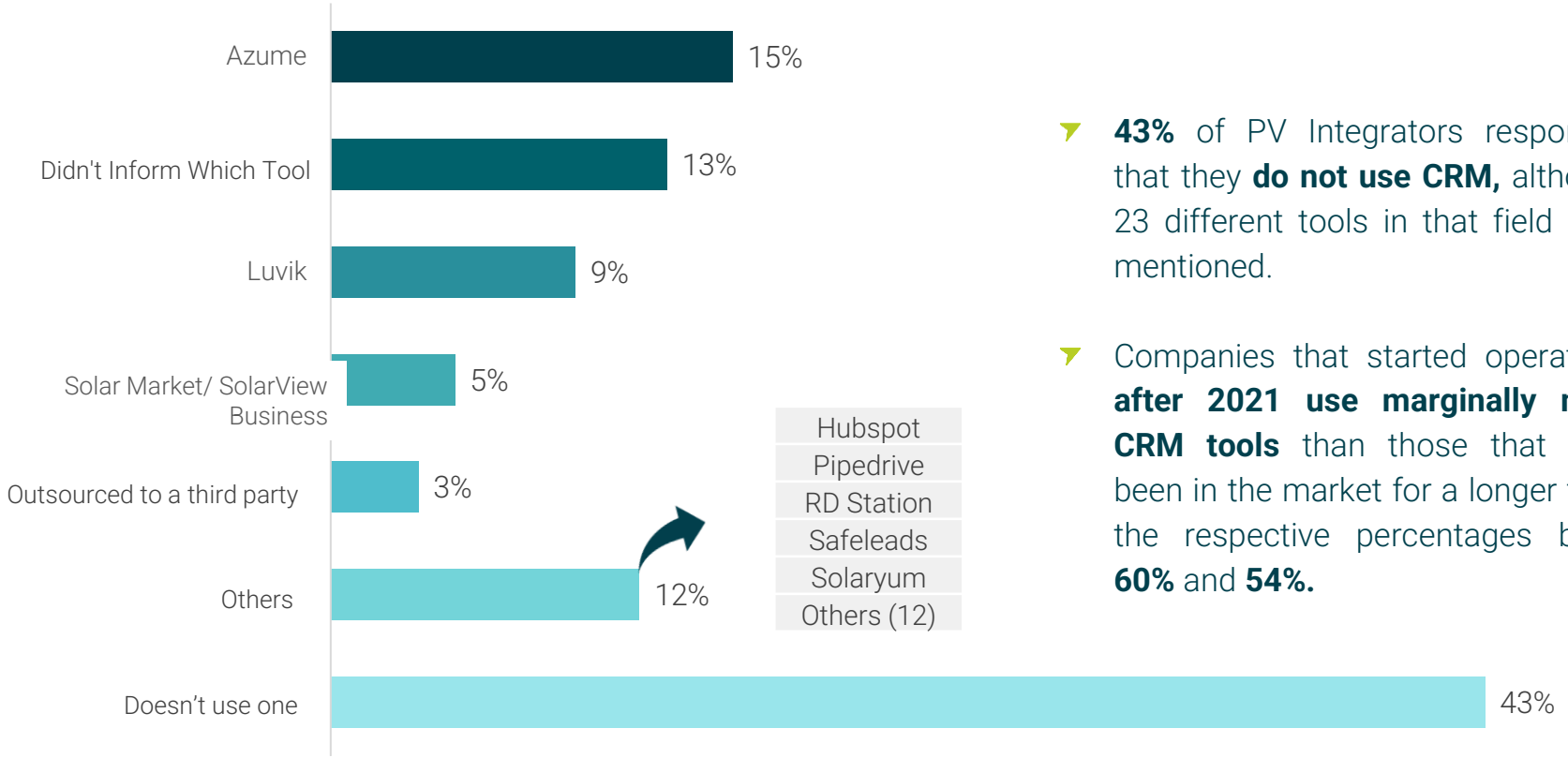
Which Client Management Tool (CRM) does your Company use?

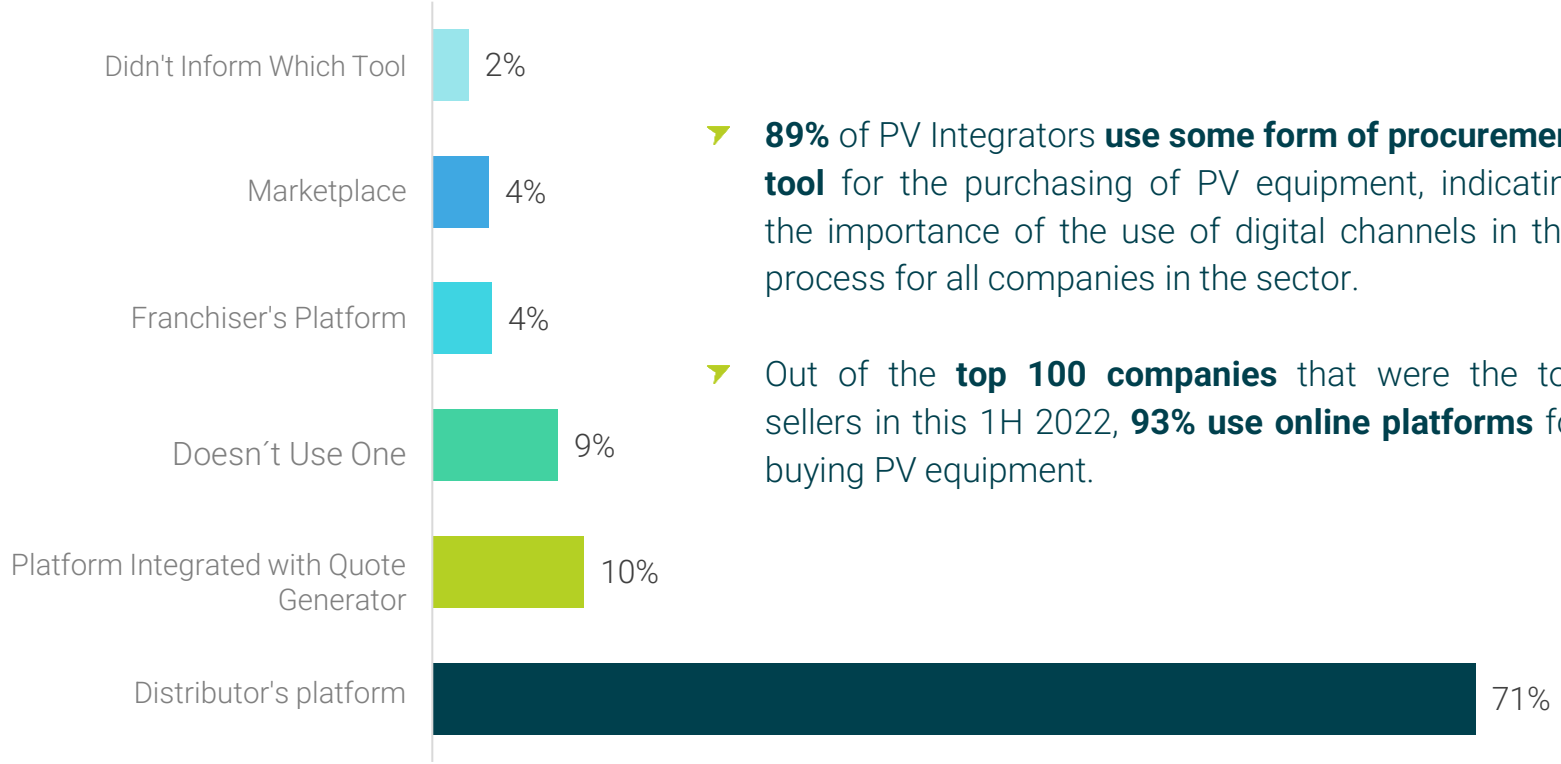


- **43%** of PV Integrators responded that they **do not use CRM,** although 23 different tools in that field were mentioned.
- Companies that started operations **after 2021 use marginally more CRM tools** than those that have been in the market for a longer time, the respective percentages being **60%** and **54%.**

CRM - Customer Relationship Management

Source: Greener, 2022. Access here.

Which Equipment Procurement Tools does your Company use?



- **89%** of PV Integrators **use some form of procurement tool** for the purchasing of PV equipment, indicating the importance of the use of digital channels in this process for all companies in the sector.
- Out of the **top 100 companies** that were the top sellers in this 1H 2022, **93% use online platforms** for buying PV equipment.

Source: Greener, 2022. Access here.

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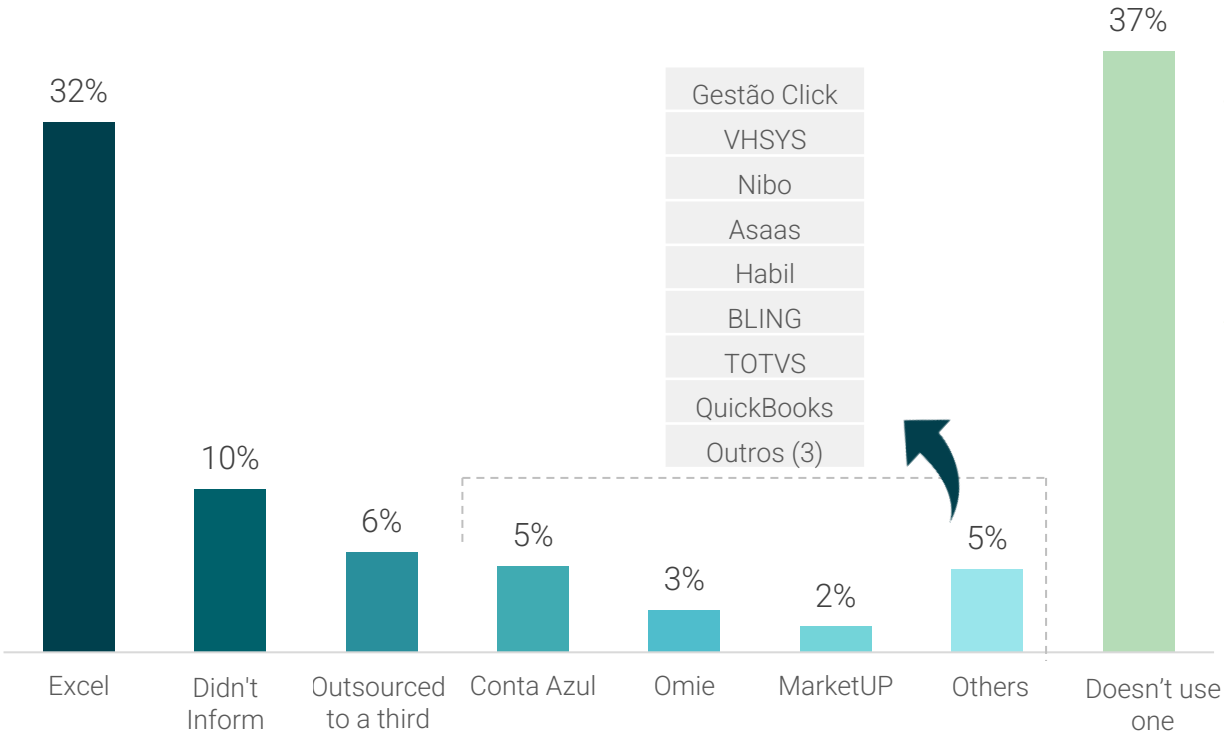
Which Financial Management Tools does your Company use?

Referring to payables and receivables processes, cash flow management, bank reconciliation, issuance of invoices, (electronic) billing, etc.



- **15%** of PV Integrators use **specialized tools** in financial management, while **32%** use Microsoft Excel.
- Out of the **top 100** companies by sales revenue this past half year, **91% use financial management tools.**

Source: Greener, 2022. Access here.

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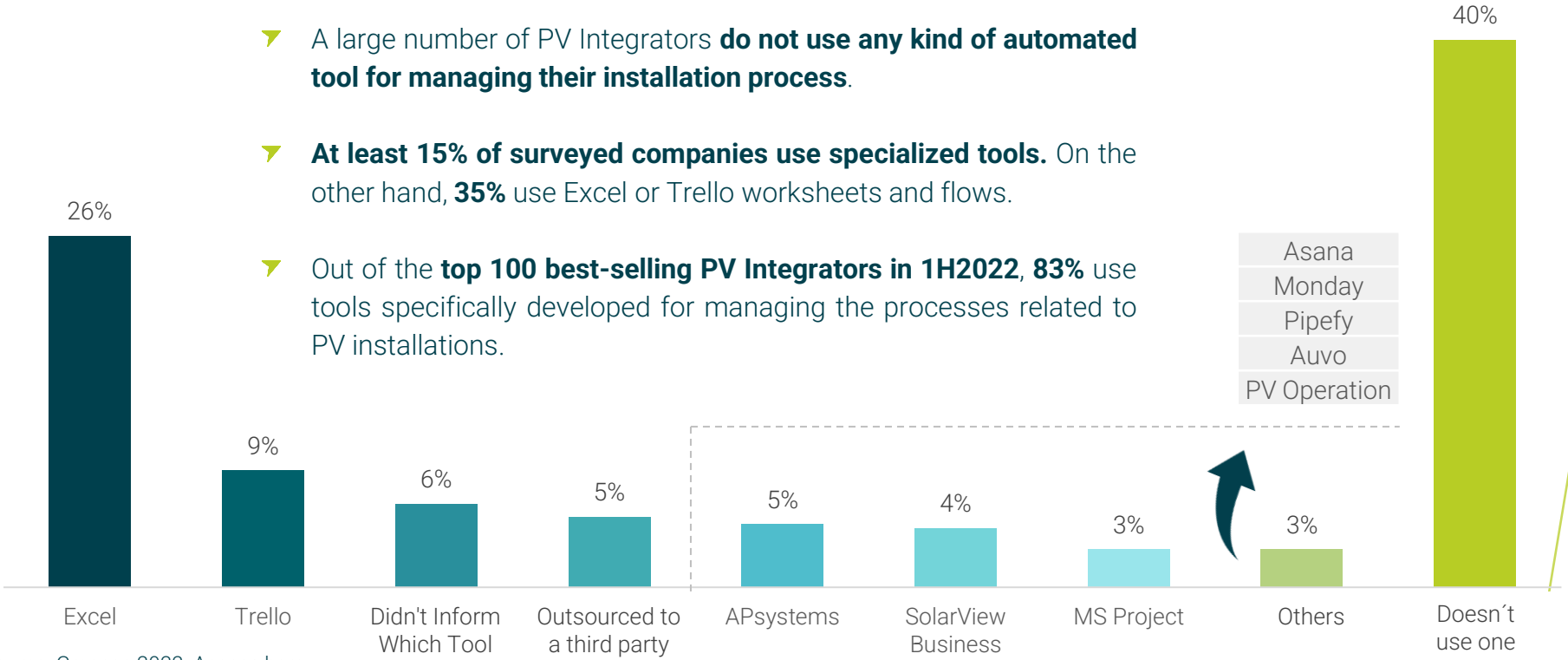
Which PV Installation Process Management Tool does your Company use?

- A large number of PV Integrators **do not use any kind of automated tool for managing their installation process**.
- **At least 15% of surveyed companies use specialized tools.** On the other hand, **35%** use Excel or Trello worksheets and flows.
- Out of the **top 100 best-selling PV Integrators in 1H2022**, **83%** use tools specifically developed for managing the processes related to PV installations.

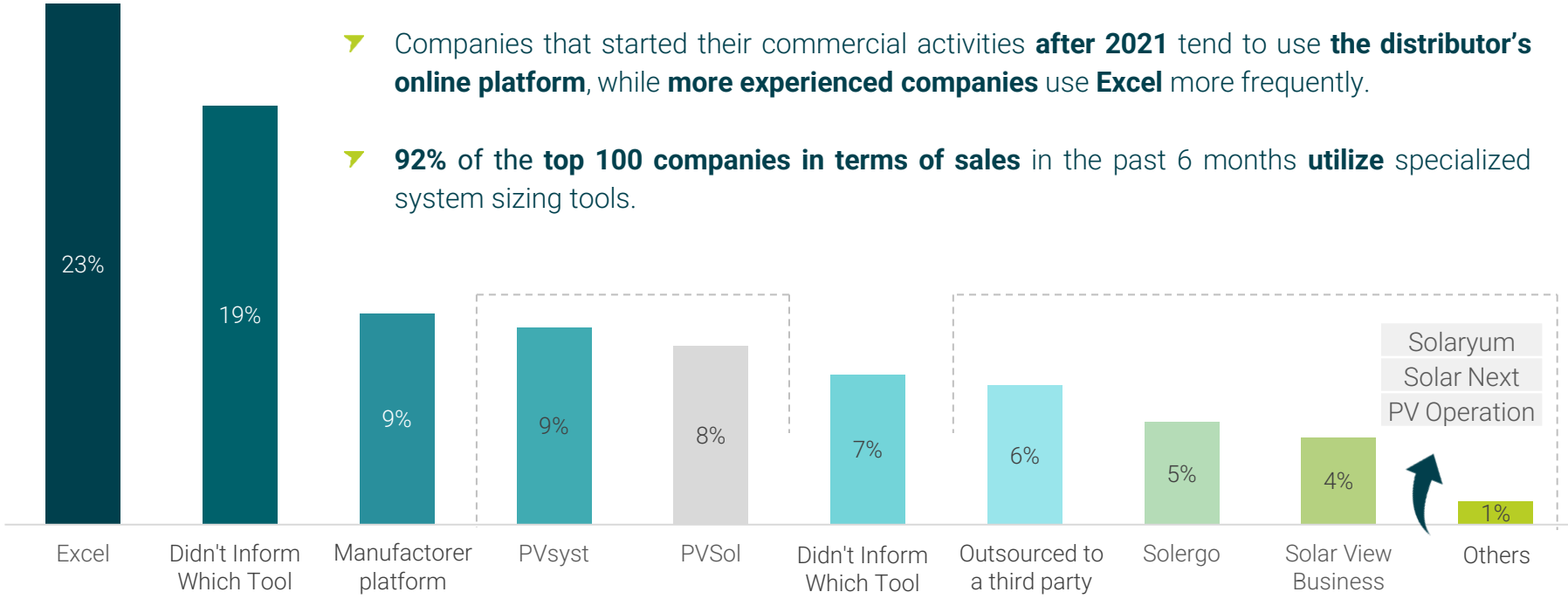


Source: Greener, 2022. Access here.

Which PV System Dimensioning Tool does your Company use?

Referring to dimensioning the system size for the engineering/installation team

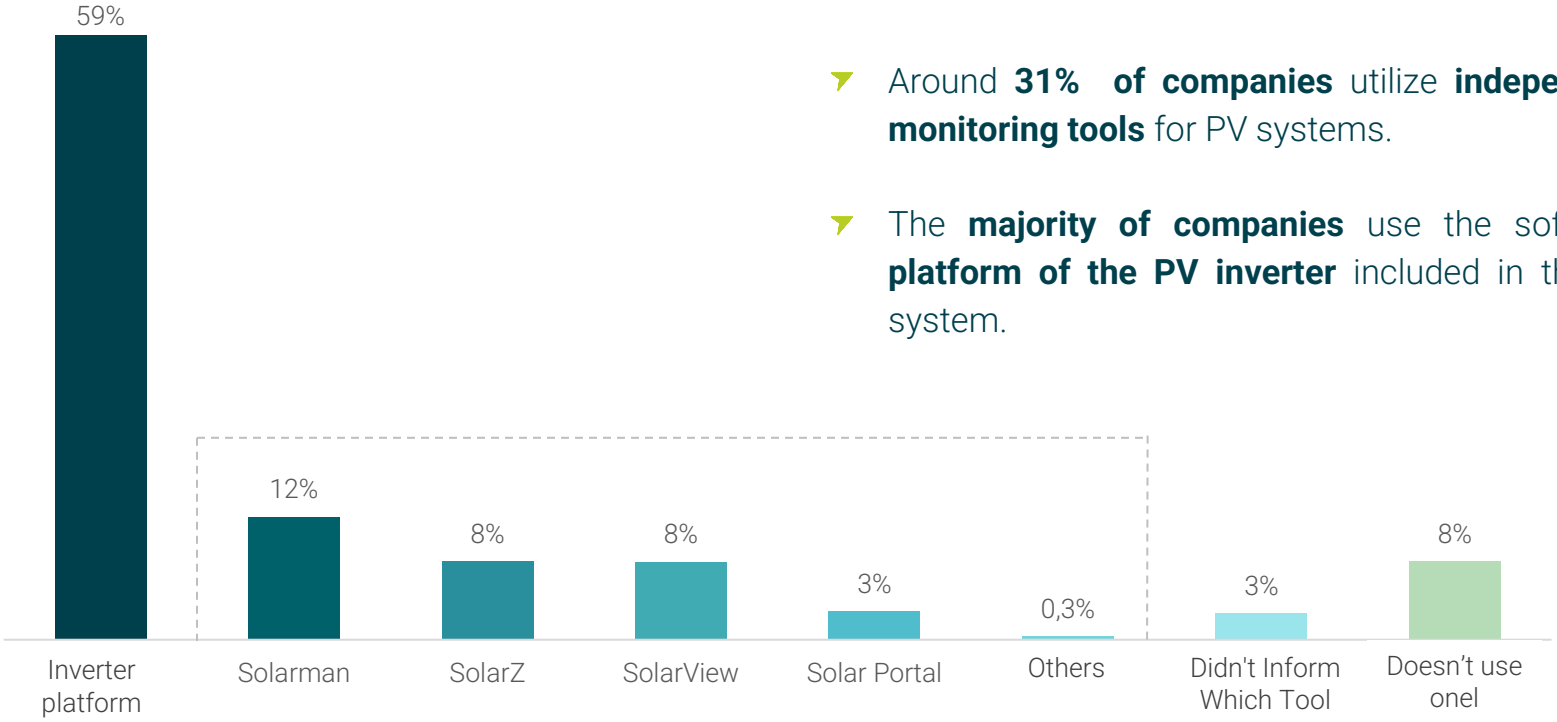
- **33%** of PV Integrators **use specialized software tools** to perform the PV system sizing.
- Companies that started their commercial activities **after 2021** tend to use **the distributor's online platform**, while **more experienced companies** use **Excel** more frequently.
- **92%** of the **top 100 companies in terms of sales** in the past 6 months **utilize** specialized system sizing tools.



Source: Greener, 2022. Access here.

Which PV System monitoring tool does your Company use?

Referring to remote monitoring of the PV System installed for the client



- Around **31% of companies** utilize **independent monitoring tools** for PV systems.
- The **majority of companies** use the software **platform of the PV inverter** included in the PV system.

Source: Greener, 2022. Access here.

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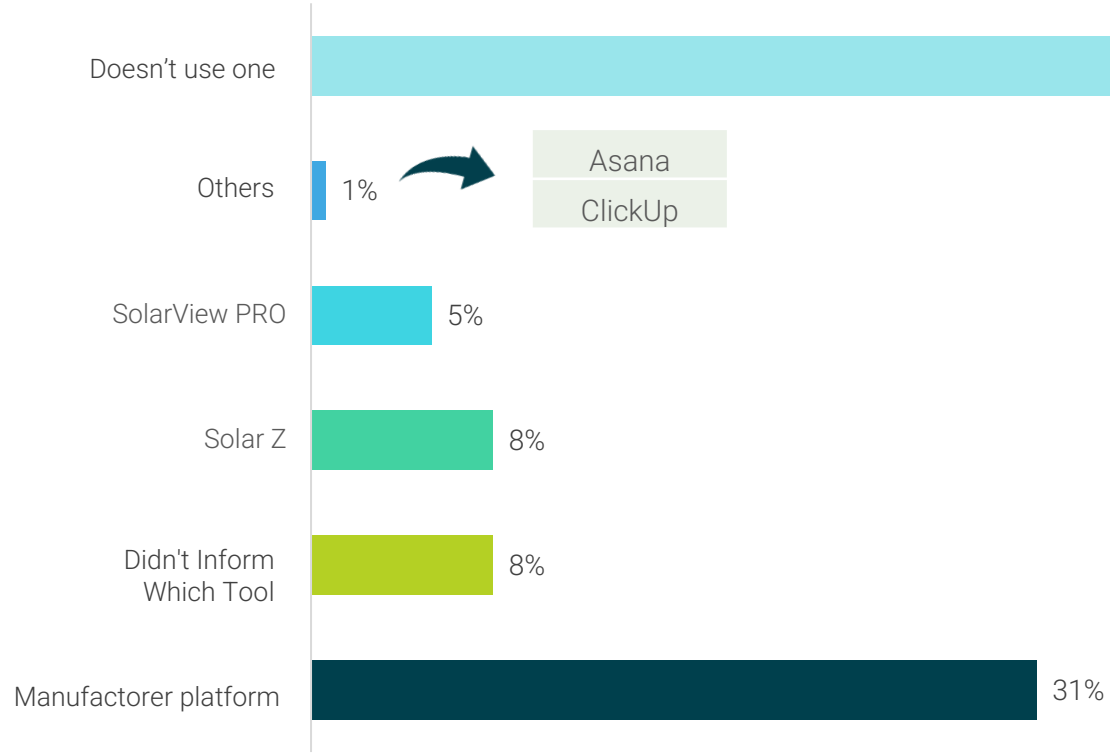
Which Software for Automation of After Sales Service do you use?

Referring to the after-sales process intended to manage customer support

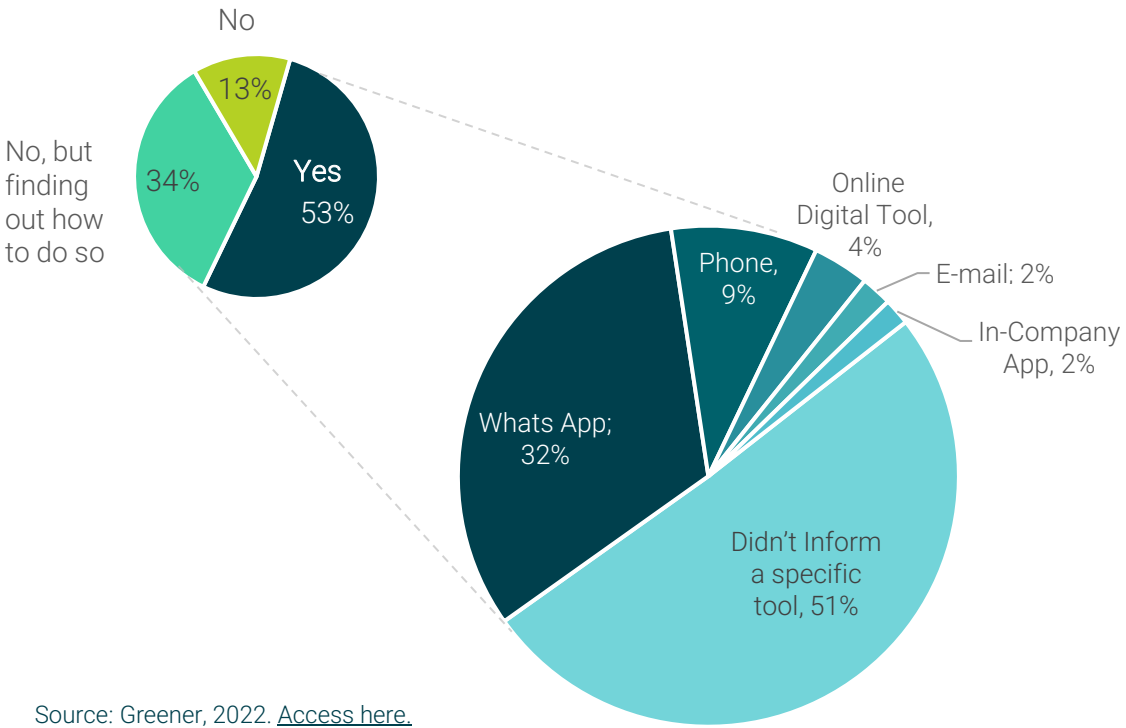


- **52%** of integrators **use some kind of automated tool** for after-sales service, including **31%** through the **manufacturer's own platform**, and **21% through independent customer support platforms**
- A total of **48%** of companies **still do not use any tool** for after-sales support.

Source: Greener, 2022. Access here.

Does your Company measure After-Sales Client Satisfaction?

How does your company evaluate customer satisfaction?

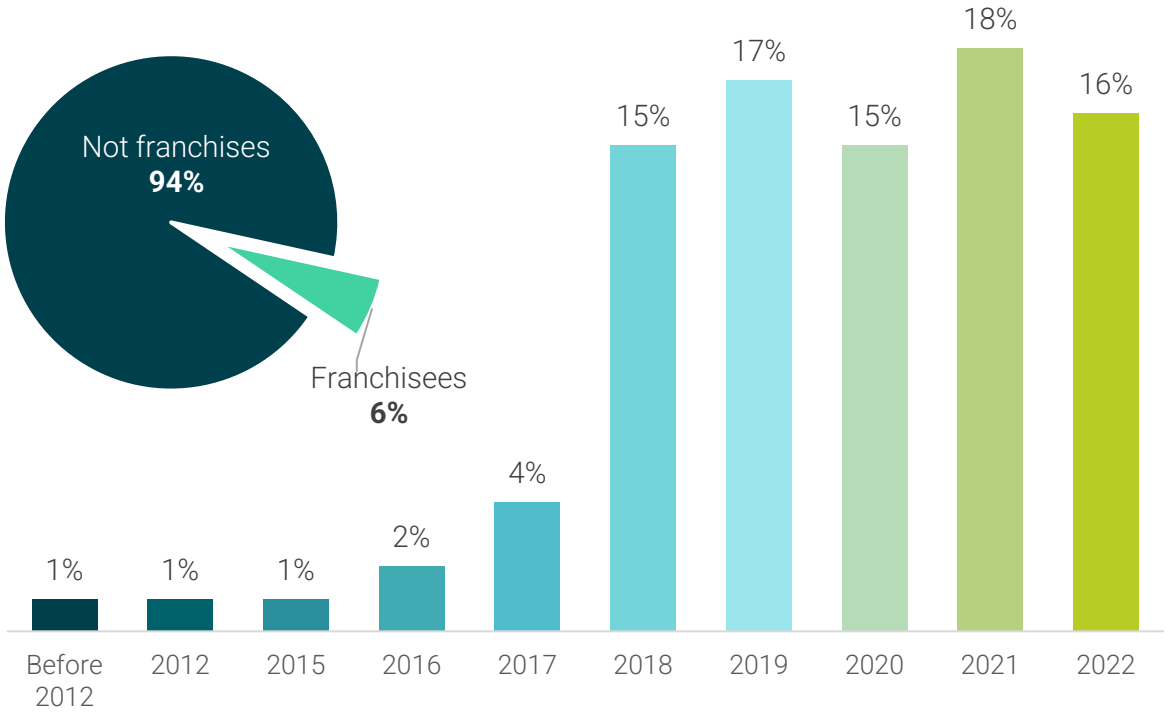


Source: Greener, 2022. Access here.

- **More than half** of companies evaluate after-sales client satisfaction, with the most common method being through **WhatsApp.**
- Even though 47% of companies informed that they don't measure after-sales customer satisfaction, **34% of them are actively looking for tools** to do so.

Is your Company part of some form of Franchise?

In which year did you start commercial activities?



- Out of the responding companies, **6%** are **associated with franchises**.
- **34%** of franchisees only **recently started** their activities **(2021-2022),** while **66%** have already been active since **before 2021.**
- **73%** of them are located in the **South East (53%)** and **North East (20%) regions.**

Source: Greener, 2022. Access here.

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CHAPTER 5

PRICES

The Survey

Introduction

- Greener once again carried out its market survey of the Brazilian PV market, interviewing **1,579 solar integrators** in the period between **6th of June 2022 until 20th of July 2022**. The survey included a representative sample of companies from all over the country, of all sizes and years of experience, therefore creating a heterogenous and reliable view of the market for solar integration in Brazil.

- The survey counted on the **cooperation of companies through a data partnership**, meaning greater accuracy and assertiveness of our indicators so the market receives realistic and reliable parameters. **Find out about our data partners here.**

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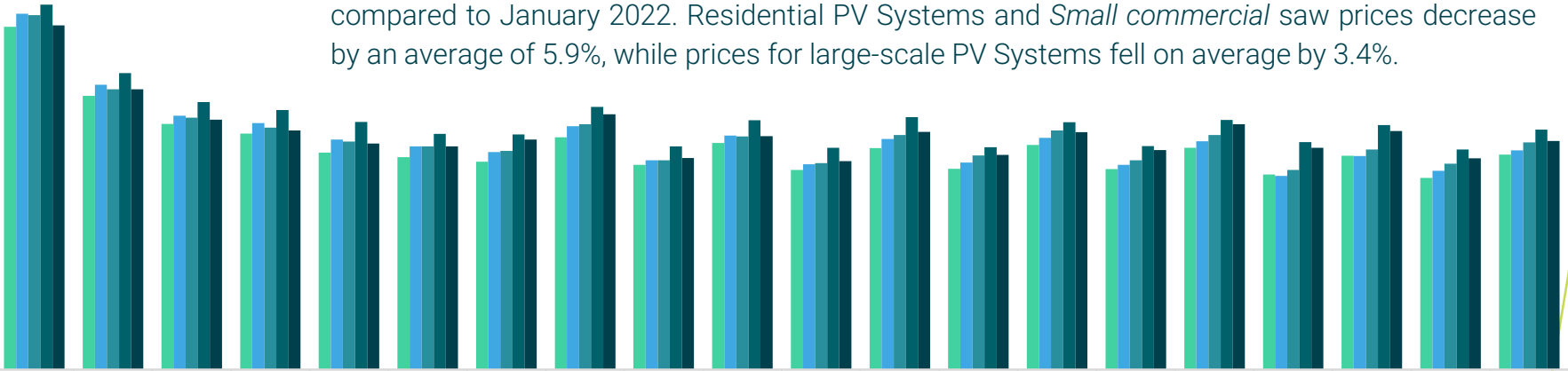
PV System Prices

On average, PV System prices for the end customer showed a **fall of 4.3% in June 2022** compared to January 2022. Residential PV Systems and *Small commercial* saw prices decrease by an average of 5.9%, while prices for large-scale PV Systems fell on average by 3.4%.

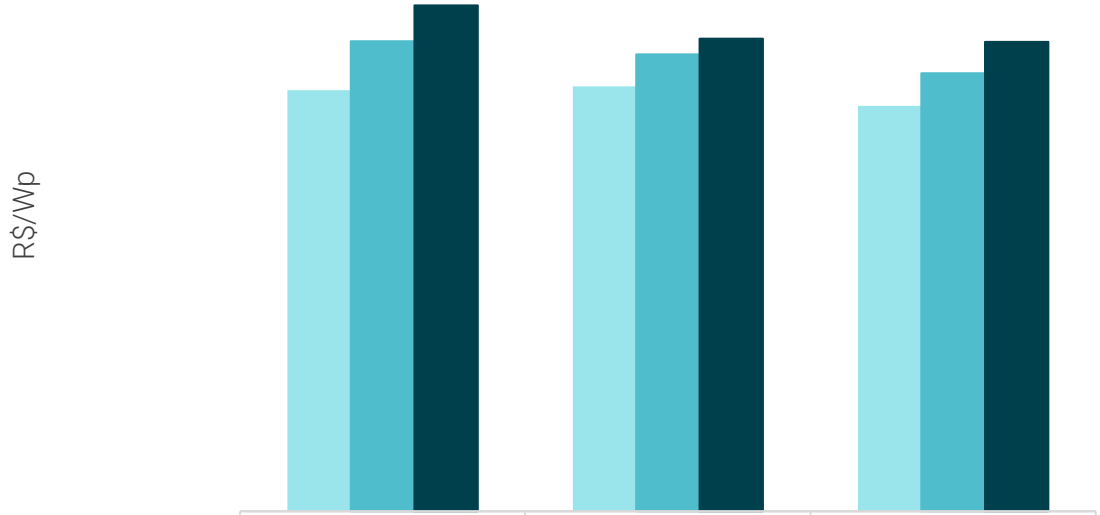


	2kWp	4kWp	8kWp	12kWp	30kWp	50kWp	75kWp	75kWp ground	150kWp	150kWp ground	300kWp	300kWp ground	500kWp	500kWp ground	1MWp	1MWp ground	3MWp	3MWp ground	5MWp	5MWp ground
jun/20	5,97	4,76	4,27	4,11	3,78	3,70	3,62	4,04	3,56	3,94	3,47	3,85	3,50	3,91	3,49	3,86	3,39	3,72	3,34	3,74
jan/21	6,19	4,96	4,42	4,29	4,00	3,88	3,79	4,23	3,64	4,07	3,57	4,02	3,60	4,03	3,56	3,97	3,37	3,72	3,46	3,81
jun/21	6,17	4,88	4,38	4,21	3,97	3,89	3,81	4,27	3,64	4,06	3,59	4,08	3,73	4,16	3,64	4,09	3,47	3,83	3,59	3,95
jan/22	6,35	5,16	4,66	4,52	4,31	4,10	4,09	4,57	3,89	4,34	3,86	4,40	3,87	4,31	3,89	4,35	3,96	4,25	3,83	4,18
jun/22	5,99	4,88	4,35	4,16	3,93	3,88	4,00	4,45	3,69	4,07	3,63	4,14	3,74	4,13	3,82	4,27	3,86	4,15	3,68	3,98
	Residential							Small Commercial							Large Scale					

Source: Greener, 2022. Access here.

PV System Prices

Fixed Structure vs Tracker



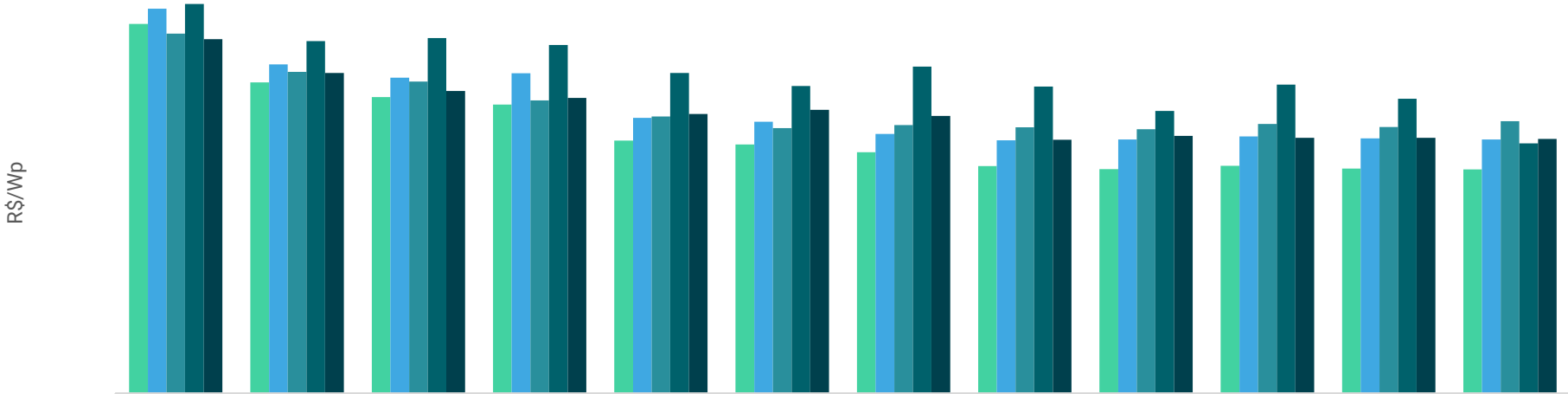
	1 MWp	3 MWp	5 MWp
Roof-Based	R$ 3,82	R$ 3,86	R$ 3,68
Ground-Based Fixed	R$ 4,27	R$ 4,15	R$ 3,98
Ground-Based Tracker	R$ 4,60	R$ 4,29	R$ 4,26

- Overall, the end-consumer price of Ground-based PV Systems with trackers showed an **average markup of 6%** compared to Ground-based installations with fixed structures.
- Ground-based PV plants with fixed structures were **on average 9% more expensive than** PV systems installed on rooftops.

Prices refer to data from Survey carried out in June/22.

Prices of PV Kits

- The prices of PV Kits showed **an average decrease of 12%** in June 2022 compared to the beginning of the year. High levels of inventory throughout the supply chain and a continuous increase in competitiveness among wholesalers were the 2 main contributing factors to the fall in prices.

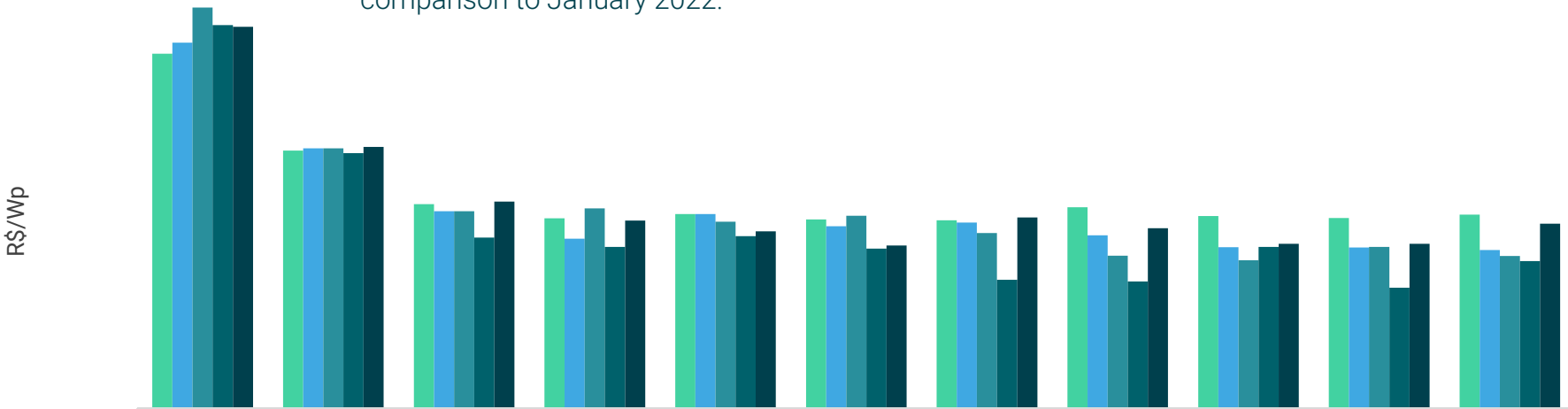


	2kWp	4kWp	8kWp	12kWp	30kWp	50kWp	75kWp	150kWp	300kWp	500kWp	1MWp	5MWp
jun/20	R$3,70	R$3,12	R$2,97	R$2,89	R$2,53	R$2,49	R$2,42	R$2,28	R$2,25	R$2,28	R$2,25	R$2,24
jan/21	R$3,85	R$3,30	R$3,16	R$3,21	R$2,76	R$2,72	R$2,60	R$2,54	R$2,54	R$2,57	R$2,55	R$2,54
jun/21	R$3,60	R$3,22	R$3,12	R$2,94	R$2,77	R$2,66	R$2,69	R$2,67	R$2,65	R$2,70	R$2,67	R$2,73
jan/22	R$3,90	R$3,53	R$3,56	R$3,49	R$3,21	R$3,08	R$3,27	R$3,07	R$2,83	R$3,09	R$2,95	R$2,50
jun/22	R$3,55	R$3,21	R$3,03	R$2,96	R$2,80	R$2,84	R$2,78	R$2,54	R$2,58	R$2,56	R$2,56	R$2,55

Source: Greener, 2022. Access here.

Prices of PV Integration Services

- The prices for PV Integration Services for residential systems **increased by an average 7%** in comparison to January 2022.



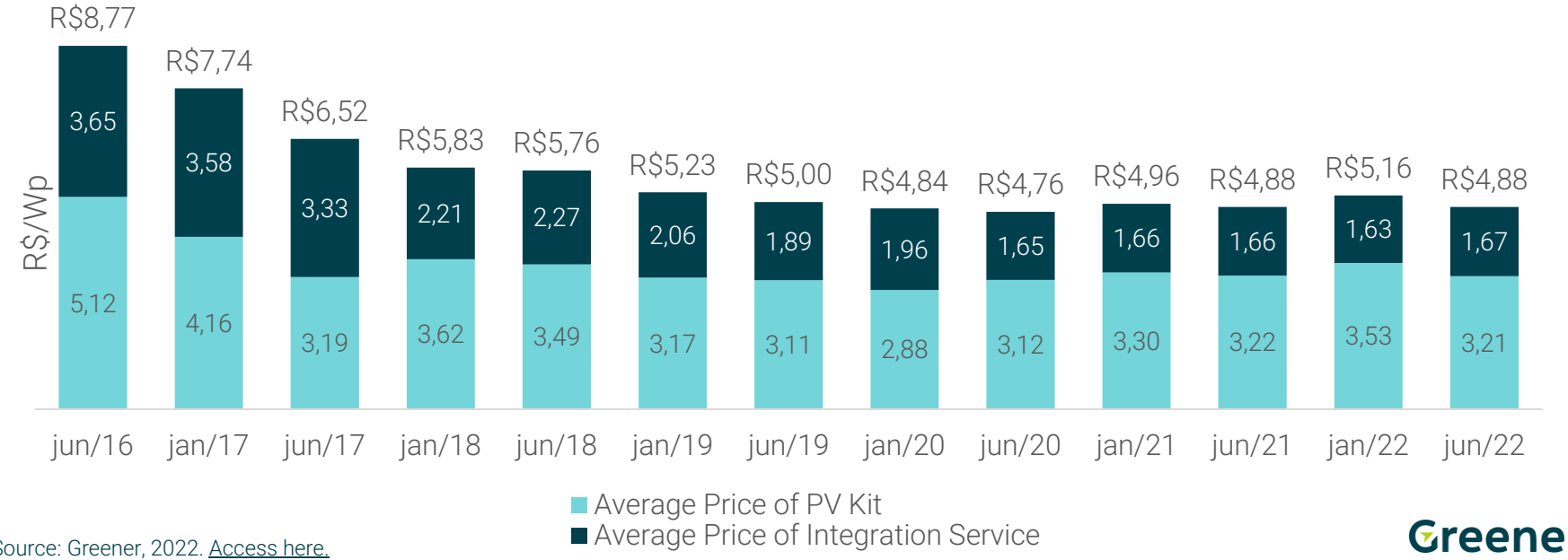
	2kWp	4kWp	8kWp	12kWp	30kWp	50kWp	75kWp	150kWp	300kWp	500kWp	1MWp
jun/20	R$2,27	R$1,65	R$1,30	R$1,21	R$1,24	R$1,21	R$1,20	R$1,28	R$1,23	R$1,22	R$1,24
jan/21	R$2,34	R$1,66	R$1,26	R$1,08	R$1,24	R$1,16	R$1,19	R$1,11	R$1,03	R$1,03	R$1,01
jun/21	R$2,56	R$1,66	R$1,26	R$1,28	R$1,19	R$1,23	R$1,12	R$0,98	R$0,95	R$1,03	R$0,97
jan/22	R$2,45	R$1,63	R$1,09	R$1,03	R$1,10	R$1,02	R$0,82	R$0,81	R$1,03	R$0,77	R$0,94
jun/22	R$2,44	R$1,67	R$1,32	R$1,20	R$1,13	R$1,04	R$1,22	R$1,15	R$1,05	R$1,05	R$1,18

Source: Greener, 2022. Access here.

Evolution of PV System Prices

Residential System (4 kWp) in Reais

- Residential PV systems have undergone a cumulative average price **reduction of 44% in the last 6 years**.



Source: Greener, 2022. Access here.

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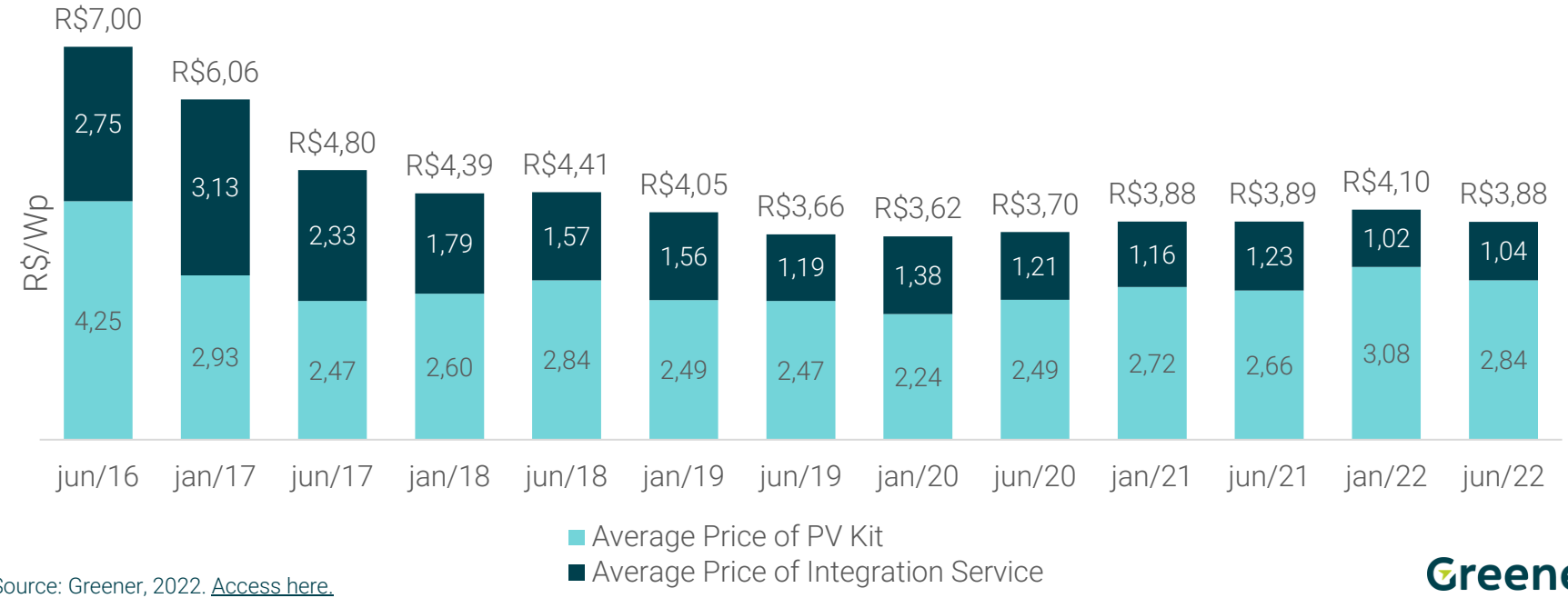
Evolution of PV System Prices

Commercial System (50 kWp)

- Commercial PV Systems have shown an average **price decrease of 44% for end consumers in the last 6 years**.



Source: Greener, 2022. Access here.

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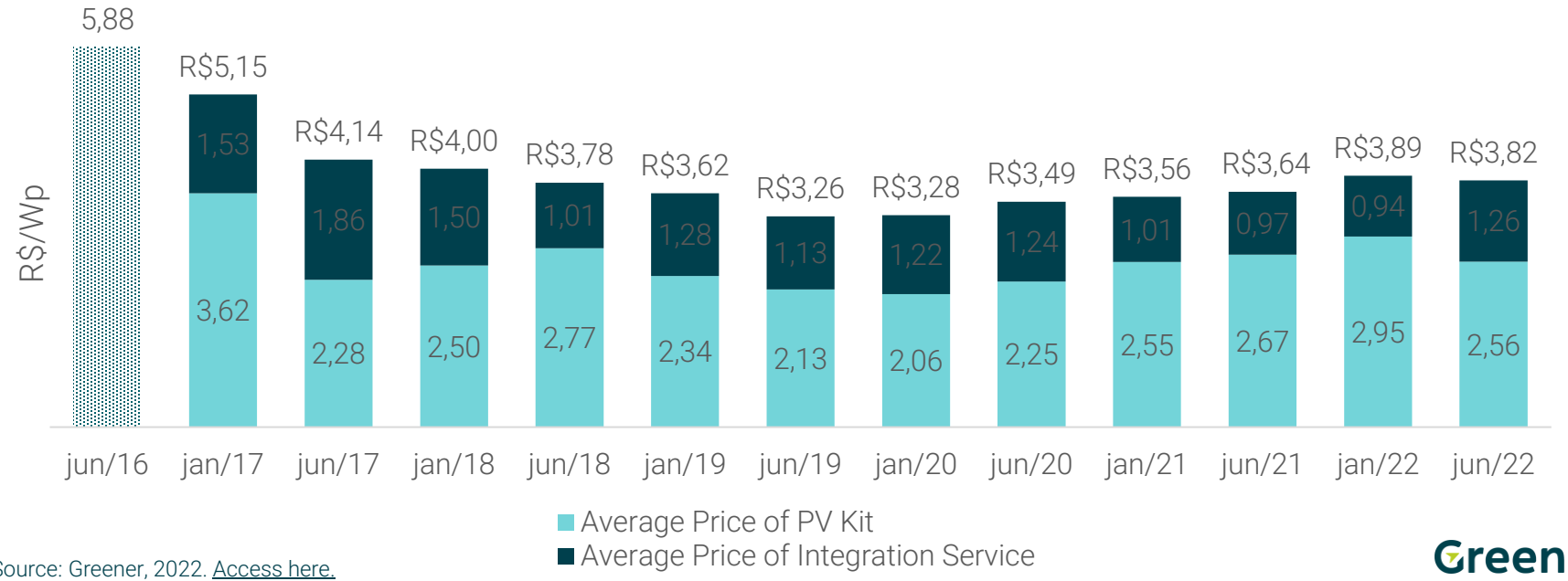
Evolution of PV System Prices

Industrial/Large-Scale Systems (1 MWp)

- Industrial PV Systems have on average become **35% cheaper in the last 6 years**.



Source: Greener, 2022. Access here.

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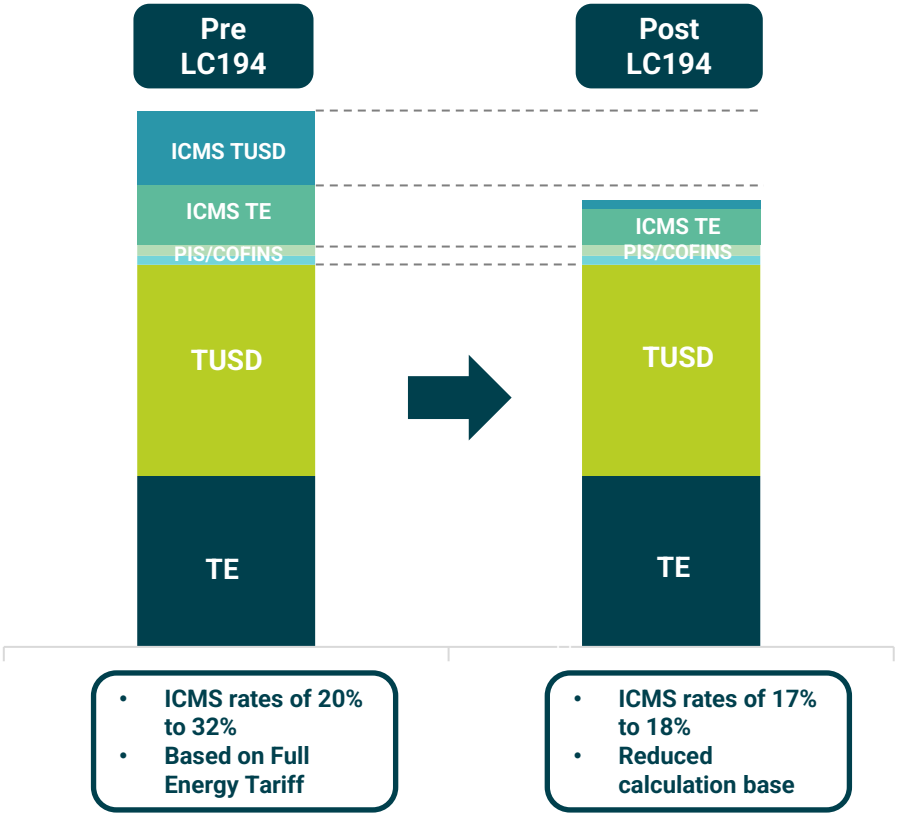
Energy Tariffs

Impacts from law LC nº 194 (ICMS / VAT)

- Complementary Law (LC) 194 approved in 2022 stipulated the **application of minimum ICMS/VAT rates (17% / 18%)** to fuels, electrical energy, communications, and mass transportation.

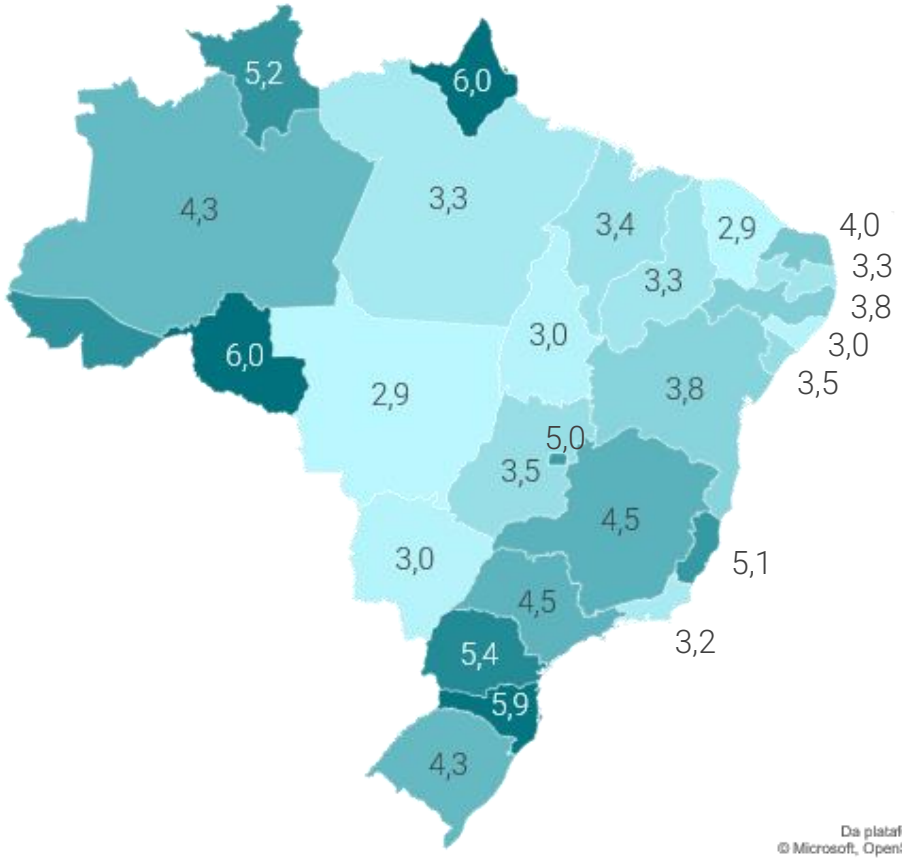
- Among the **35 main energy distributors** across Brazil that were analyzed, the law caused an **average decrease of 19.1% in the residential energy tariff** (B1).



Average Payback Period per State

Residential system (in years)

- The average cost for residential systems was **R$ 4.88/Wp** for **4 kWp systems** (average values according to the 1H/2022 DG survey). The calculation takes into account the local solar insolation / productivity, the average cost of the PV system, the energy price charged by providers (post CL 194), a PR* of **75%,** and a simultaneity index of **30%.**

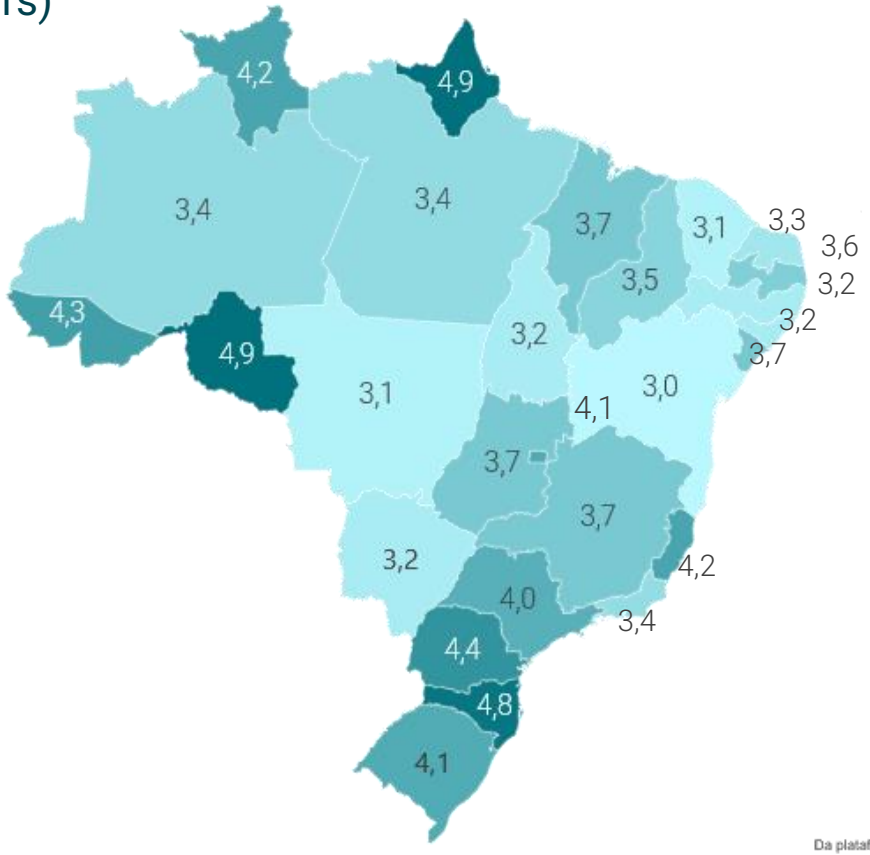


PR = Performance Ratio

Average Payback Period per State

Commercial System – Low Voltage (in years)

- The average production cost for low-voltage commercial PV systems was **R$ 3.88/Wp for 50 kWp systems** (average values according to the 1H/2022 DG survey). The calculation takes into account the local solar insolation / productivity, the average cost of the PV system, the energy price charged by providers (post CL 194), a PR* of **75%** and a simultaneity index of **70%.**

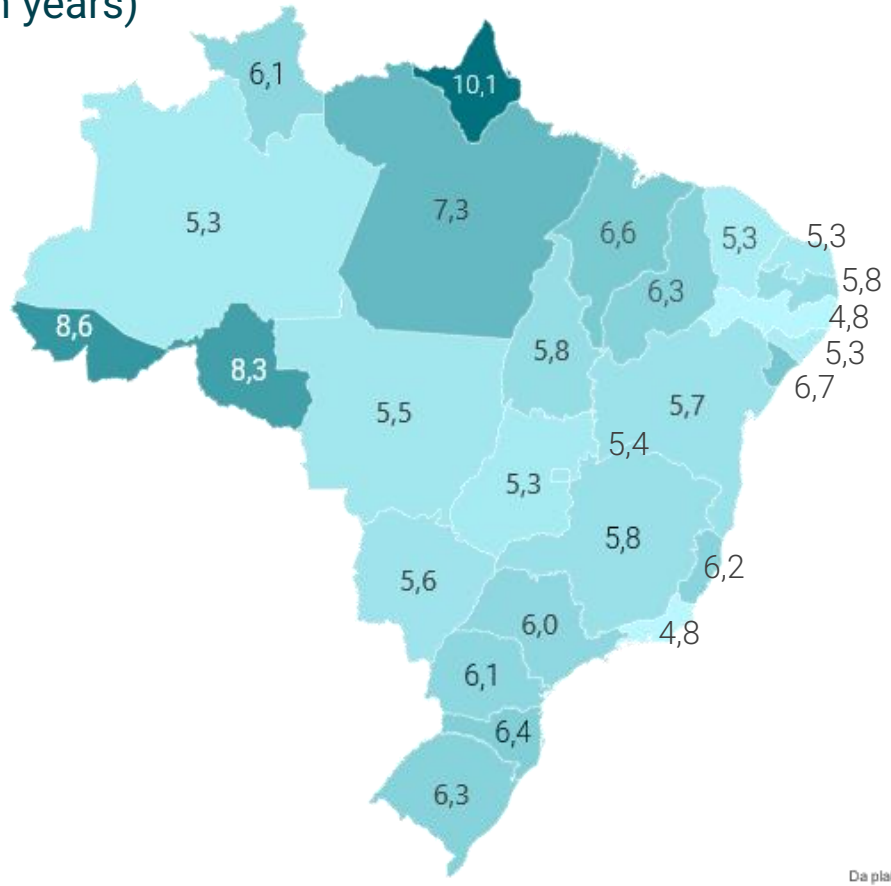


*PR = Performance Ratio

Average Payback Period per State

Commercial System– Medium Voltage (in years)

- The average production cost for medium-voltage commercial PV systems was **R$ 3.63/Wp for 300 kWp systems** (average values according to the 1H/2022 DG survey). The calculation takes into account the local solar insolation / productivity, the average cost of the PV system, the energy price charged by providers (post CL 194), a PR* of **75%** and a simultaneity index of **50%.**

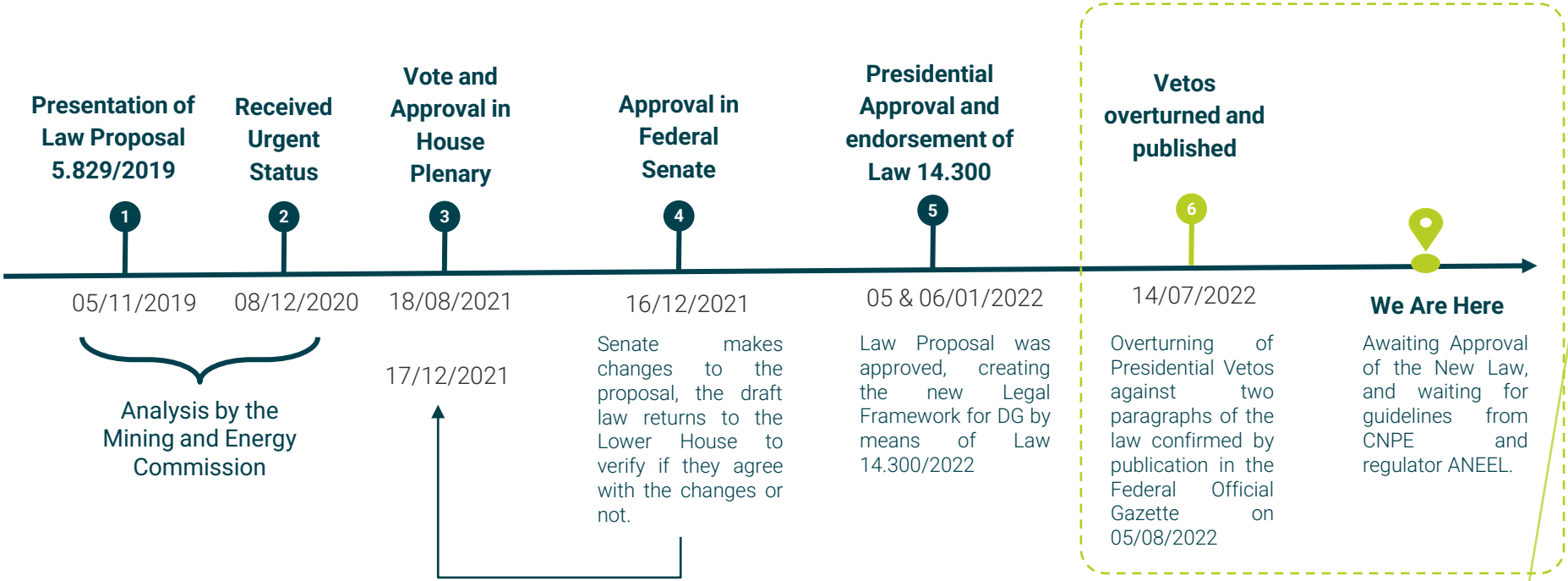


*PR = Performance Ratio

CHAPTER 6

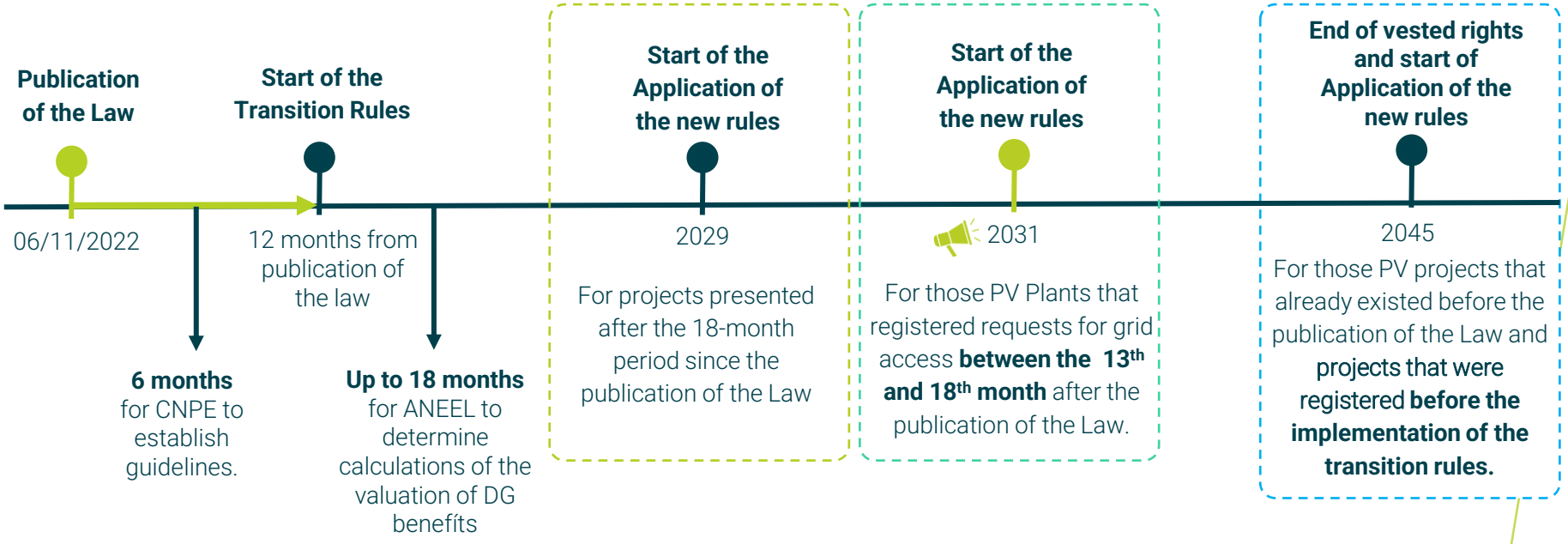
Regulatory Context

Approval of the new MMDG Legal Framework



Transition / Application of the new Law

- After the transition period, **from 2029 onwards**, the **new energy tariff rules** will be defined according to a directive from CNPE (National Council for Energy Policy) and a valuation of the benefits of DG in accordance with the ANEEL regulations.



Transition Rules for new Legal Framework

- The rules for transition to the new regulation will depend on **two principal factors**:

Date of Grid Access Request

Whoever registers grid access requests **BEFORE** the start date → Stays under the current rules **until 2045 (vested rights)**

Whoever registers grid access requests **AFTER** the start date → Will fall under the **transition rules**

When does the new law enter into effect?

Date of publication of new legislation + 12 months → **Date of start of new regulation**

Business Model Category

- Micro DG
- Mini DG
- Shared Generation
- Energy Use in Multiple Consumption Units (EMUC)
- Remote autoconsumption **limited to** 500 kW of installed capacity

→ **Transition rules that will be applied:** Gradual increase of TUSD Line B payment up to 100%

- Shared Generation*
- Remote autoconsumption **over** 500 kW of installed capacity

→ **Transition rules that will be applied:** Payment of 100% TUSD Line B; 40% of TUSD Line A; 100% TFSEE and R&D.

*Shared Generation in which one single owner/beneficiary possesses more than a 25% participation in the surplus production of electricity.

Greener Insights – Analysis of Case Studies

- Greener created four case studies analyzing the differences in economic viability of each proposed project, with the intention of clarifying some of the potential impacts of the new Legal Framework for MMGD.

1. Micro DG Local PV - Residential
2. Micro DG Local PV - Commercial

Simple Payback

3. Mini DG Remote PV - Shared Generation
4. Mini DG Remote PV - Self-consumption

Internal Rate of Return of the Project *

* Emphasizing again that this is based on the Project IRR. The investor's IRR could, subsequently, be leveraged by changing the capital structure used for financing it.

- The 4 case studies were analyzed within the context of the 51 principal energy distribution concessionaries that operate throughout Brazil. The analysis was carried out using the average solar productivity of the operating area of each distributor.
- Energy price surcharges based on (hydrological) stress on the generating system were not taken into account in the analysis.
- The base case for analysis of the projects in Remote Mini DG category were simulated purely from the viewpoint of REN 482, or in other words, without the possible benefits of the 12 month window after approval of the new Law 14.300.

CHAPTER 7

LARGE-SCALE DG

Introduction

- Greener interviewed the main companies involved in the development, structuring, operation and management of large-scale DG PV plants in Brazil. Among the companies interviewed were a number of **developers, asset owners, and client managers.**

- The **objective of this report is to provide strategic insights into the market** and the status of an important part of large-scale distributed generation projects in Brazil.

- The information presented here takes into account companies that work with **remote generation** plants that are being developed to operate under a **leasing business model**, either through remote self-consumption or shared generation.

- Greener would like to thank **the 35 companies that participated** in the questionnaire for the preparation of this report between February and July 2022.

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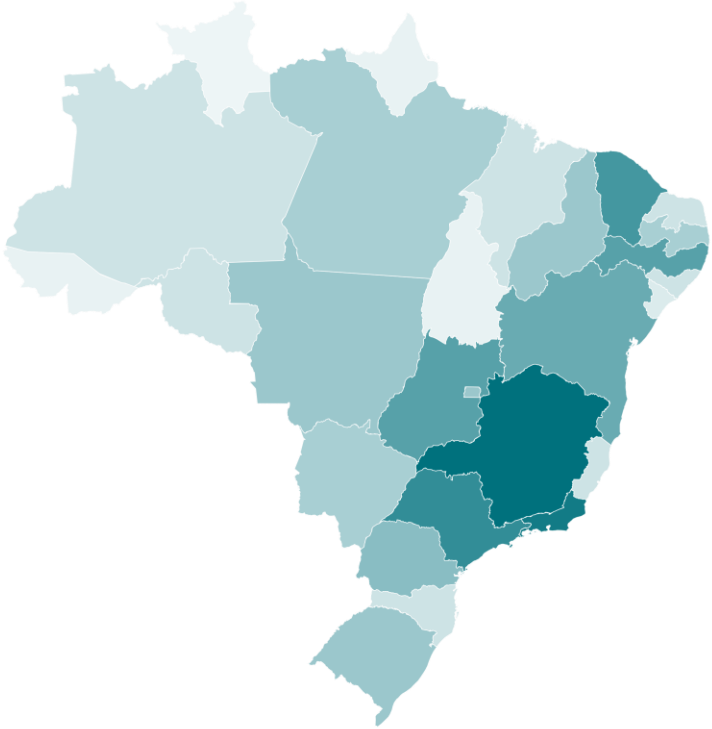
Location of Operations

% of companies interviewed that are active in a specific region



- Top 10 States that attract **the most DG remote consumption investment:**

TOP 10 States	
1st	Minas Gerais
2nd	Rio de Janeiro
3rd	São Paulo
4th	Ceará
5th	Goiás
6th	Pernambuco
7th	Bahia
8th	Paraná
9th	Rio Grande do Sul
10th	Mato Grosso

Data obtained between February and July of 2022.

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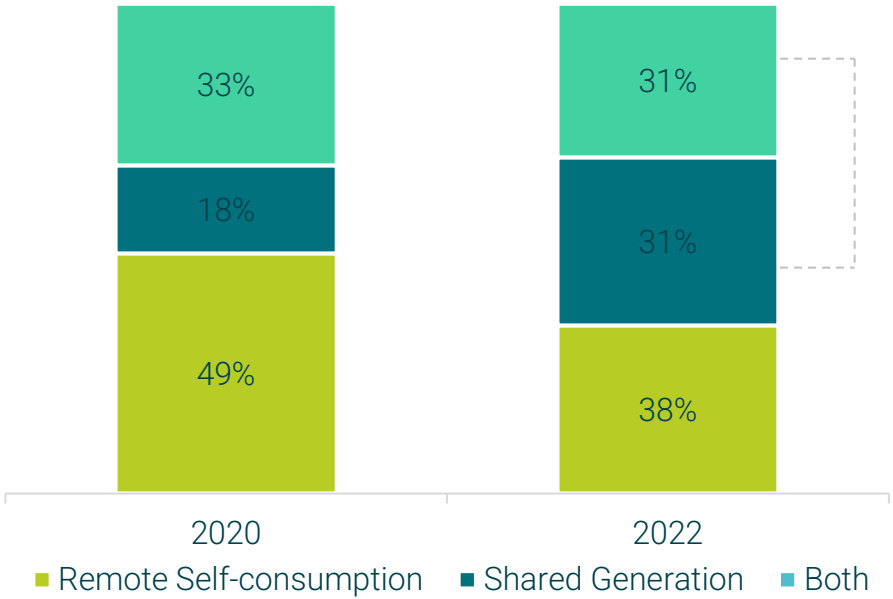
Shared Generation vs Remote Self-consumption

Which compensation model is used?

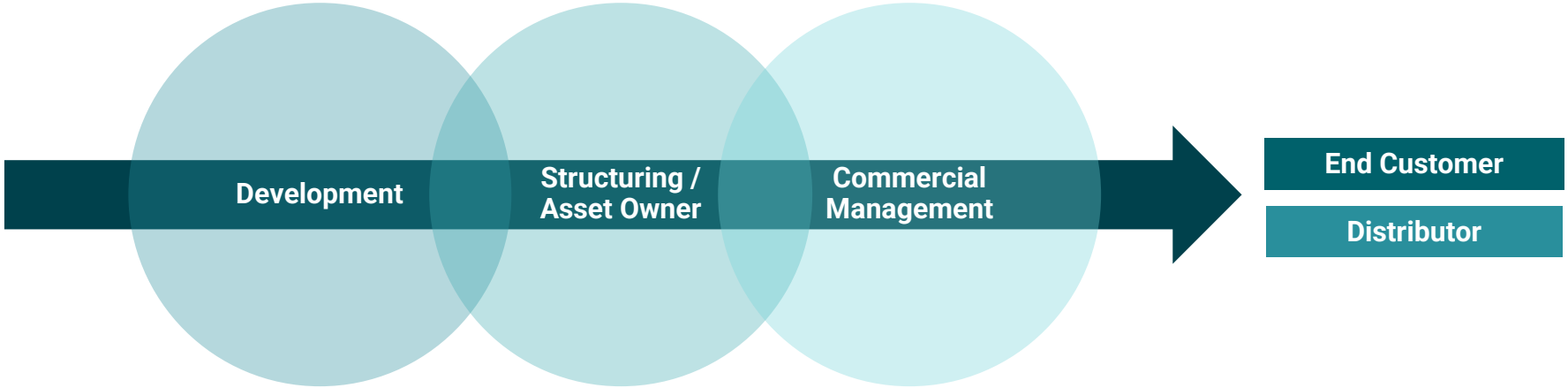


- **Shared generation** has gained in popularity in the last 2 years: **62% of the interviewed companies** operate projects using this business model, compared with 51% in 2020.

Data obtained between February and July of 2022.

Value Chain of DG Remote Generation

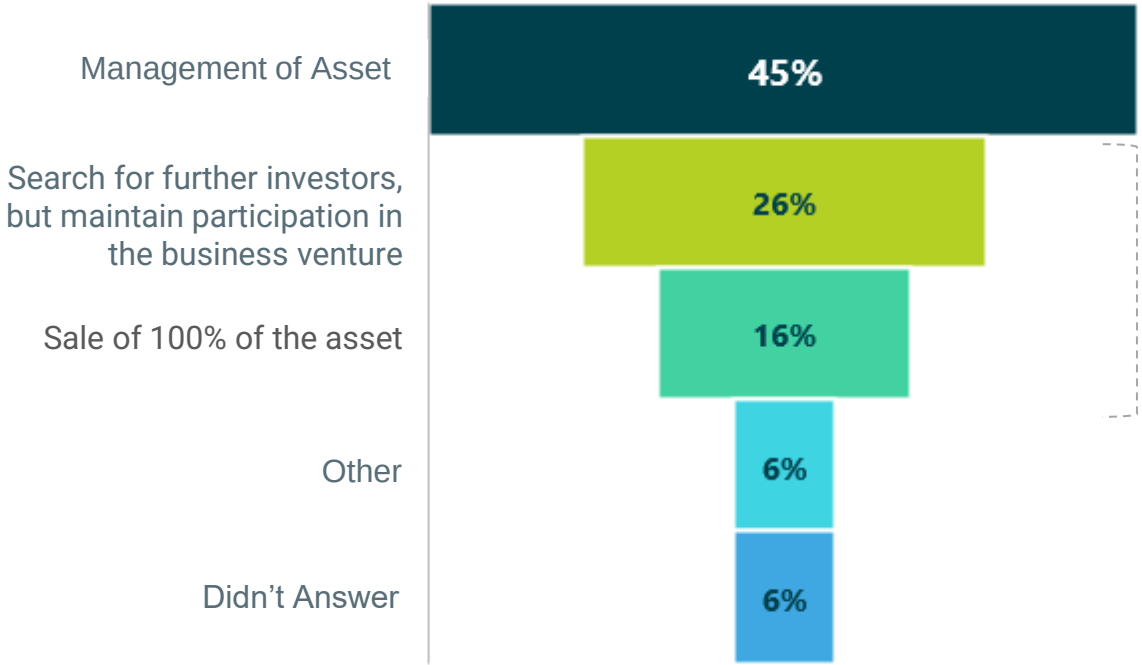
Development, structuring, operation and management of large-scale DG solar plants



Role in Value Chain	Focus	What are their tasks?
1) Developer	Development before construction	Purchases the terrain and enables the licences for grid connection
2) Asset Owner	Facilitate the construction and operation of the PV plant	Finds greenfield projects, obtains funding; builds and operates the PV plant. Completes all the steps between generation and consumers;
3) Commercial Manager	Recruit customers, manage contracts and energy credits	Manages the customers and their credits with energy distributors.

Principal Objectives with Solar Assets

Qual objetivo principal da empresa com os ativos em desenvolvimento ou obras?



- **42% of companies** are open to investments that lead to partial or complete sale of the PV assets.
- **45%** are focused on the structuring and management of their own portfolios.

Data obtained between February and July of 2022.

Status of Principal PV Projects

What is the current status of large-scale DG Solar Plants?

Complete Report Available Soon

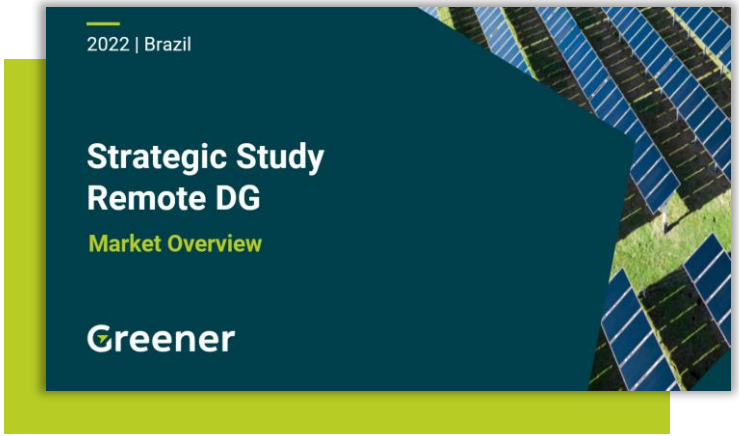
Strategic Report on Large-scale DG solar Power Plants

Pre-Registration for Receiving the Report

Greener

PRE-REGISTRATION NEW REPORT ON **LARGE –SCALE DG PV PLANTS**

Click on the button to receive information about the launch of this new Strategic Report



Click here to start your Pre-Registration

Also Find Out About:

- Volume of projects already in operation, under construction, and in the development phase;
- Profile of consumers ;
- Different business models, such as energy by subscription;
- Reflections on Complementary Law 194 (impacts on ICMS/VAT) and case study.

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CHAPTER 8

Storage

THE ROLE OF STORAGE IN THE TRANSFORMATION OF THE ENERGY SECTOR

Generation

Energy Storage Systems:

- Facilitate the dispatch of energy from large renewable energy plants (solar, wind).
- Together with solar PV plants can substitute diesel generators in off-grid energy systems.

Transmission + Distribution

In transmission lines and distribution they can offer:

- Improved grid efficiency; instead of building new transmission lines or substations to meet temporary peaks in demand or supply,
- Higher quality / more reliable supply of electricity.

Consumption

For the individual consumer:

- Manage consumption and contracted demand;
- Serve as energy backup;
- Enhance the advantages of distrbuted generation;
- Provide ancillary services (remunerated) to the energy grid;

Storage Systems **'in front of the meter'**

Systems **'behind the meter'**

Source: https://www.greener.com.br/estudo/estudo-estrategico-do-mercado-de-armazenamento-de-energia-no-brasil-2021/

MAIN APPLICATIONS IN THE BRAZILIAN ENERGY SECTOR

Off-Grid	• Batteries have been used in smaller off-grid systems for many years. Using Lead-acid batteries, this is the oldest application of energy storage in Brazil. Programs for universalization of access to electrical energy, such as “Mais Luz” in the Amazon region, will continue to drive this market. • Hybrid Applications – Solar + Diesel + Batteries – have gained in competitiveness, reducing costs and CO2 emissions. Isolated communities and rural energy consumers already use these solutions, for example in irrigation pivots. • In the context of ANEEL’s call for strategic R&D (nr 21/2016) a micro-grid project with battery storage was created on the island of Fernando de Noronha, which could serve as a reference for other off-grid systems in the north of the country.
Behind the Meter	• ‘On-grid’ energy storage projects behind the meter are a recent phenomenon in Brazil. Despite this, we have already seen important cases of commercial projects being realized since 2020.
In Front of the Meter	• Storage projects in front of the meter, capable of providing services to the grid, represent the final frontier in the development of the energy storage sector in Brazil. At this moment there are a number of R&D projects that emanated from ANEELS’s strategic research request 21/2016. Commercial projects in front of the meter will require an adjustment to the regulatory framework.

Source: https://www.greener.com.br/estudo/estudo-estrategico-do-mercado-de-armazenamento-de-energia-no-brasil-2021/

STORAGE BEHIND THE METER

Possible Applications in Brazil

Application	Medium and High Voltage (Group A)	Low Voltage (Group B)		
		Conventional Tariff	White Tariff	Binomial Tariff
Backup	●	●	●	●
Reduction of Peak Demand	●	✕	✕	●
Management of Consumption Hours	●	✕	●	●
DG without Grid Injection	●	●	●	●

● Only if the volumetric component is measured per time slot

- Not all types of storage applications can be used by all types of energy consumer. It should be emphasized, however, that a system can provide more than one service at the same time, thus amplifying its financial return. The Table on the left shows some of the storage applications that could be used to the benefit of customers, grouped by customer type / energy tariff structure.

Source : https://www.greener.com.br/estudo/estudo-estrategico-do-mercado-de-armazenamento-de-energia-no-brasil-2021/

STRATEGIC RESEARCH REPORT ON STORAGE

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CHAPTER 9

Conclusions

Insights & Conclusions

1. **The prices of solar PV Systems decreased by an average of 4.3% in 1H / 2022.** International logistics costs, an elevated amount of equipment inventory, and the high level of competitiveness among wholesalers were all contributing factors to the reduction in equipment costs and were largely passed on to end consumers.

2. **The residential customer group** once again led the way in the growth of DG solar, representing 56% of the total capacity added in 1H 2022, while commercial customers were responsible for 27% of that growth.

3. **The sharp acceleration in import volumes of PV equipment**, especially in 1Q/22 (growth of 128%), reflects the high expectations for 2022 throughout the solar PV supply chain. **On the other hand**, the significant increase in interest rates combined with continuing high Capex requirements is a challenge, contributing to a **more moderate rise** in demand for PV systems in the first half of the year.

4. Despite higher interest rates, there was an **important increase in the number of financial agents providing solar PV Financing**. A total of 52 institutions were mentioned in the survey, compared to 40 in the prior edition. While the economic scenario is difficult, the financial sector should continue to be an important lever for the growth of DG in Brazil.

Insights & Conclusions

5. **In general, the attractiveness of investments in DG solar was maintained.** While the cost of grid energy was reduced as a result of changes in ICMS (LC 194) some other factors contributed positively towards solar PV's profitability: (i) Reduction in CAPEX compared to the amounts budgeted at the beginning of the year; (ii) Increases in energy prices charges by distributors due to annual readjustments in the first half of the year.

6. The regulatory changes enacted through the new Law 14.300/22, which above all change the compensation criteria for energy injected into the grid, should be an **important driver for further investments**, especially for **Remote Generation DG projects,** accelerating demand for projects to be completed in 2H/2022 and 2023.

7. **The digitalization of the solar sector is continuing apace.** Companies intensified their use of digital tools with the intent of automating and optimizing their processes. Nonetheless, it is noteworthy that the adoption of these widely available resources is still limited in a large part of the sector, and that the large majority of companies still use non-specialized software and tools to support various critical business processes.

CHAPTER 10

Glossary

Glossary: Distributed Generation

- **DG** – Distributed Generation
- **CG** – Centralized Generation
- **MMDG** – Micro and Mini Distributed Generation
- **Distributed Microgeneration** – (PV) systems less than or equal to 75 kW
- **Distributed Minigeneration**– (PV) systems larger than 75 kW and less than or equal to 5 MW
- **PV** – Photovoltaic
- **Additional Capacity** – the generating capacity that was added in a particular period
- **Cumulative Capacity** – the cumulative generating capacity active at a time, total of all previous periods
- **MW** – Megawatt
- **kW** – kilowatt
- **CU** – Consumer Unit

Concerning **Consumer Units**, it is important to distinguish between:

- **Consumer Units** – are the actual number of PV installations, in other words, any Consumer Units with a solar photovoltaic system that is generating energy. The credits generated at this Unit can be consumed at this same location or at other Units that can receive the credits.

- **Consumer Units receiving credits** – are all Consumer Units that receive some benefit from the credits that are generated, regardless of whether the PV system is installed locally/on-site or remotely.

Glossary: Types of Consumers and Methods of Consumption

Types of Consumers

There are 5 **Types of Energy Consumers,** with additional subcategories. These types depend on the **kind of business/consumer that is being supplied**, and were created by the National Electrical Energy Agency (ANEEL).

The defined consumer types are the following:

- **Residential**
- **Commercial**
- **Industrial**
- **Rurals**
- **Public** (Public/Street Lighting, Government, Public Services)

Methods of Consumption

There are 4 defined **Methods of Consumption** (or DG business models). The choice of method depends on which format most closely matches the desired consumption profile of each project/business.

As such, the defined methods are as follows:

- **On-site Generation** (at the Consumer Unit, or alongside the load)
- **Remote Self-consumption**
- **Shared Generation**
- **Businesses with multiple consumption units /locations (EMUC)**

Find out more about the variety of DG Business Models. *Access the Research Here.*

Find Out More through our Strategic Research

Or access at greener.com.br/estudos

Strategic Report Utility Scale PV Market Brazil 2022

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Greener Strategic Report: DG Market Brazil | 2nd Half of 2021

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The A.Dias Air Condirioning Group embodies 52 years of tradition and is one of the leaders in its market segment. Now, through its sister company A.Dias Solar, it is also a distributor of PV equipment. For the best customer experience the company has created a specialized sales and customer service team, and offers fully support to PV Integrators, including an exclusive online platform and training throughout Brazil, among other special advantages.

contato@adiassolar.com.br

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Amara NZero's mission is to facilitate the energy transition and provide electrification, de-carbonization and energy efficiency. More than 60 years of experience in the distribution of materials, related services, and logistics. Active in Brazil for 23 years, the company has distribution centers in the NorthEast and SouthEast regions, and a technical support team with more than 10 years of solar PV experience.

sac@amaranzero.com

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Distributors

BelEnergy is one of the largest importers in the Brazilian PV market and is engaged in the distribution of some of the best brands in the sector, with a possibility of providing personalized configurations in order to always meet the specific needs of our customers. With a solid history and growth trend in the market, BelEnergy offers its clients innovation, speed, security and cost savings.

belenergy@belenus.com.br

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Connectoway is a company with more than 22 years of experience in the telecoms market, with solutions for companies and the public sector, and has now expanded its portfolio into a new business segment. In the renewable energy sector, Connectoway Solar is the newest distributor of PV equipment in Brazil. Supplying the leading brands available in the market, such as Huawei, Longi, Trina and Kehua, we provide integrators with the highest quality equipment and also guarantees in inverters, panels and metallic structures for constructing PV plants of any size.

vendas.solar@connectoway.com.br

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energia.solar@elgin.com.br

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FOTUS
distribuidora solar

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nexen

Nexen is a fast-growing distributor of PV equipment which works with a humanized and personalized customer service, differentiated forms of payment, fast logistics and free shipping, thus gaining more and more business partners.

With our complete focus on solar integrators, we ain to always present new products and solutions, which contribute positively to the day-to-day of our customers, contributing to better profitability of their projects, and more sustainability for the world.

contato@nexen.com.br

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phb Solar

PHB Solar is a 100% Brazilian company, has shown leadership and technical competence in the solar energy sector, and is developing solutions for all types of Distributed Generation projects.

contato@phb.com.br

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SERRANA SOLAR

Serrana Energia has been active in the solar market for 15 years and is certified ISO9001:2015. It supplies complete PV solutions, as well as a variety of PV Kits for On-Grid and Off-Grid Installations & Solar Pumps. All are distributed with free overland shipping country-wide, Liberty insurance for installation/assembly and an exclusive Cashback program.

serrana@serranaenergia.com.br

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sou energy

Sou Energy is one of the 6 largest PV equipment distributors in Brazil and the biggest in the North/Northeast regions, with over 6500 resellers active across all of Brazil.

sol@souenergy.com.br.

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Distributors

WDC Networks has become one of the tech market leaders, creating a web of sales channels that cover all of Brazil. With more than 19 years of experience, WDC has now brought its expertise to the solar PV market, quickly becoming one of the largest and most reliable distributors in the sector.

solar@wdcnet.com.br

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Founded in 1961, WEG is a global electric and electronic equipment company, in particular active in the capital goods sector, with innovative solutions for various markets. With a presence in more than 135 countries, WEG distinguishes itself through the constant development of innovative solutions to meet the evolving global needs related to energy efficiency, renewable energies and electrical mobility.

automacao@weg.net

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PV MODULES

Solar PV Modules

Intelbras (INTB3) has been present throughout Brazil for 46 years with certified and high-quality products. Its product portfolio contains complete and innovative solutions in the security, communications and energy sectors. Intelbras Solar offers On Grid and Off Grid PV solutions for the most diverse applications, from residences to small and large businesses – and always with the well-known Intelbras quality guarantee.

atendimento.revendasolar@intelbras.com.br

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JA Solar is listed among the 4 largest global producers of PV Modules in Bloomberg's ranking, with a 14% global market share, more than 100 GW shipped capacity. Also a technology leader with > 850 approved patents in the sector, and extra differential being the in-house production of wafers and cells, meaning a consistent high quality in modules, and efficiency recognized through various prizes such as PVEL, RETC among others, and production capacity of 50 GW/year.

brazil@jasolar.com

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Solar PV Modules

SUNOVA SOLAR
Leading one-Stop PV Supplier

Sunova Solar was founded in 2016 and is a multinational company that supplies integrated system solutions with a focus on R&D, manufacturing solar energy products that are distributed globally, and development of PV power plants. Currently Sunova Solar operates three factories in China and Vietnam, with integrated capacity for 3GW of solar modules per year. At the same time, Sunova has established fully-owned branches and offices in Germany, Brazil, Poland, the Netherlands, Ukraine, Mexico, Vietnam and other countries. Furthermore it has created more than 100 partnerships with industry leaders in more than 20 countries and regions. In June 2021, Sunova Solar passed the landmark of 2GW of PV capacity installed around the world.

info@sunova-solar.com

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Trinasolar

Pioneers in the manufacturing of solar PV modules, with more than 25 years of experience and more than 77 GW of installed capacity around the world, we also possess 888 active product patents, and offer top of the line solutions for all market segments.

joao.ferrer@trinasolar.com

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INVERTERS

PV Inverters

CHINT POWER

Chint Power is a Chinese manufacturer of PV inverters owned by the CHINT group, a global leader in intelligent energy solutions since its creation in 1984. Currently has more than 20GW of inverters installed in projects around the world, including many in extreme conditions/climates.

contato.br@chint.com

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Deye 德業®

Created in 1990, Ningbo Deye is one of the 3 biggest companies in the world that produces PV Inverters for solar energy, Globally recognized as a leader in the production and sale of residential Hybrid Inverters, the company is fully dedicated to the development of high quality Hybrid, String and Micro Inverters.

comercial@deyeinversores.com.br

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PV Inverters

FoxESS has taken up a global leadership position in the development of PV inverters and solutions for energy storage. Designed by some of the top global specialists in batteries and inverters, our products are highly innovative, offering our customers the most advanced equipment currently available in the market, as well as unparalleled performance and reliability.

henry@fox-ess.com

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Founded in 2010, Growatt is a global leader in intelligent energy solutions, being the nr. 1 manufacturer in the world for residential solar inverters, according to IHS Markit. The company is also in the global top 5 for three-phase string inverters for commercial and industrial PV projects. As of the end of 2020, Growatt had exported 2.6 million inverters to more than 100 countries.

info@ginverter.com

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PV Inverters

HUAWEI

Zero Carbon is a shared mission around the world. Huawei Digital Power was created to develop the digital energy business and accelerate its growth. Its mission is to integrate digital technologies and power electronics, developing clean energy and energy digitization to drive the energy revolution in search of a better and greener future. Huawei has already helped customers generate 482.9 billion kWh of green energy, save 14.2 billion kWh of electricity and reduce CO2 emissions by 230 million tons.

huawei.solarbrasil@huawei.com

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HYPONTECH
ENERGIZING FUTURE

HYPONTECH is taking the world a step forward with a portfolio of efficient string inverters, storage inverters and intelligent solutions for energy storage. Our products are delivered all over the world, contributing to a better environment in more than 50 countries on 6 continents.

info@hypontech.com

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PV Inverters

KSTAR

Founded in 1993, Shenzhen KSTAR Science & Technology Co., Ltd. has created a leading brand in high-output electronics and innovative products in the energy sector, including PV Inverters, designs for PV systems and Energy Storage systems.

ted@kstar.com

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SAJ

SAJ is a global leader in the manufacturing of PV Inverters. We offer the best cost-benefit ratio for on-grid and hybrid inverters for the Distributed Generation market, as well as Lithium batteries for energy storage solutions. We can count on an excellent sales team and a technical support and repairs center in Brazil, always aiming to provide efficient and high-quality service to our local partners.

brasil@saj-electric.com

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PV Inverters

SOFARSOLAR is a global leader in solar PV inverter and energy storage solutions, dedicated to being the leader in digital energy solutions with an extensive portfolio of PV inverters ranging from 1kW to up to 255 kW, hybrid inverters ranging from 3kW to up to 20kW , energy storage systems and strategic energy solutions for homes, businesses and industries, as well as CG applications. SOFARSOLAR has always insisted on independent innovation, establishing a global R&D network with three R&D centers and around 30% of its R&D task force located there. SOFARSOLAR has an annual growth rate of around 86%, and its annual production capacity reaches 10GW for PV and storage inverters, as well as 1GWh for batteries.

info@sofarsolar.com

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Created in 2010, SolaX Power today produces some of the world's most efficient solar inverters, allowing its customers to harness even more of the clean and free energy provided by the sun, and guarantees that its products will continue to be the leading solutions available in the market.

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PV Inverters

solis

Ginlong Solis is the oldest, most experienced and most international manufacturer of string investers and delivers significant ROI to its business partners.

sales@ginlong.com

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CLAMPER is a 100% Brazilian company, created in 1991, and offers solutions to protect electrical and electronic equipment against damage caused by lightning and electrical surges. A pioneer in the segment, the company started its trajectory developing projects for 100% customized Surge Protection Devices (SPD) for large energy, telecommunication, railway, mining and oil and gas exploration companies. It was only a matter of time before the know-how that protects the assets of industrial giants reached the shelves of the largest electrical material stores in our country. As the DPS brand most used and recommended by specialists in the electrical sector, today it is also one of the most requested by technology aficionados, accumulating awards related to the product quality and credibility of supply.

fotovoltaico@clamper.com.br

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SUNWODA ENERGY

As a subsidiary of the Sunwoda Group, founded in 1997 and named one of the Top 10 Battery Manufacturers in the World in 2002, Sunwoda Energy focuses on lithium batteries and energy storage systems. We develop long-life, high-security and thermally stable energy storage systems. We also have a smart demonstration factory which is well known in China, as well as an R&D team of over 200 people, focusing on Utility, C&I, BTS Backup Power, Date Center, Residential and Smart energy.

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inter solar connecting solar business | SOUTH AMERICA

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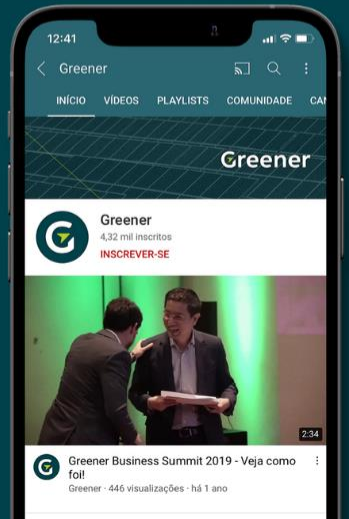

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