STRATEGIC RESEARCH REPORT

1st half-year 2023 (1H2023)

DISTRIBUTED GENERATION

Photovoltaic Solar Energy Market

September 2023

Greener

Highlights of the Report

1. The volume of PV modules demanded by the **Brazilian market in the first half of 2023 remained above 7 GW**, despite a **19% drop** compared to the same period in 2022, arising from solar **PV investments of more than R$ 25 billion** including both distributed generation and large-scale power plants.
2. **Prices for PV systems fell by 17% in the first half of the year,** from January to June 2023. A decrease in the cost of modules, a devaluation of the US$ and high stock levels at wholesalers were factors that contributed to the fall in prices for end users.
3. **Bank financing of PV systems currently supports 48% of completed sales.** The prevailing higher interest rates and banks' increased perception of risk are reflected in a more restricted credit market for PV systems in Brazil.
4. There was an **improvement in the return on investment in PV systems**, resulting in a **15% reduction in the payback period** for residential installations compared to January 2023. The price decrease of PV systems (lower CAPEX) was the main factor behind this variation.

Presentation:

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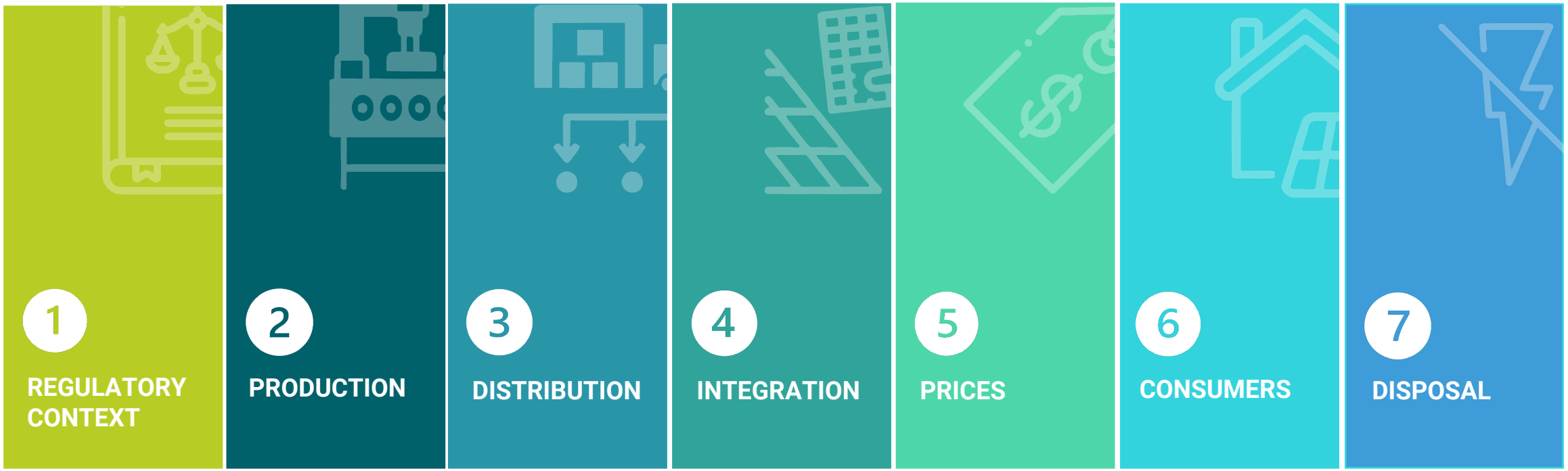
THE REPORT

Topics



01.
REGULATORY CONTEXT

APPLICATION OF THE NEW RULES OF LAW

- After the transition period, **starting in 2029, the new tariff rules will be instituted** according to guidelines that will be previously established by the CNPE and by valuing the costs and benefits of DG in accordance with ANEEL regulations.

2022

07/01/2022
Publication of Law 14.300/2022

6 months (07/07/2022) for CNPE to determine its guidelines*.

2023

07/01/2023
Start of the Transition Rules, valid until 2029/2031

Up to 18 months (07/07/2023) for ANEEL to establish the standard calculation for valuation of costs and benefits*.

2029

The new rules begin to apply to projects that filed a connection **permit request after the 18th month** of publication of the Law.

2031

The new rules begin to apply to consumer units that filed a connection **permit request between the 13th and 18th month** from the publication of the Law.

2045

End of legacy rights and start of application of the new rules for projects that already existed before the publication of the Law and for those that filed before the start of the Transition Rules.

* Up to this moment (September 2023) there has been no further information from the CNPE or ANEEL.

METHODS FOR TRANSITION UNDER LAW 14.300/2022

Method	Description	What happens?
GD I	**Existing connections** or **those requested up until 7 January** 2023 (art. 26 of Law 14.300/2022).	Remain under the **previous rules**, with all energy price components being compensated until 2045 (Legacy Rights).
GD II	**Grid connection requests filed after January 7, 2023 that fall under the following categories:** • Local or remote self-consumption of less than 500 kW; • Shared generation of up to 500 kW (where a single beneficiary does not retain 25% or more of the surplus); • Enterprises with Multiple Consumer Units (EMUCs) (caput of art. 27 of Law 14.300/2022).	A gradual, staggered reduction in the compensation of the TUSD Fio B, starting at 15% in 2023 up to 90% in 2028 or 2030*. After the transition period, the units will be subject to the tariff rules established by ANEEL. *Consumer Units that file their access request between the 13th and 18th month from the publication of the Law will remain under this rule until 2030.
GD III	**Grid connection requests filed after January 7, 2023** that fall under the following categories: • Remote self-consumption above 500 kW; • Shared generation over 500 kW (in which a single owner holds 25% or more of the surplus). (§1 of art. 27 of Law 14.300/2022).	Non-compensation, already starting from 2023 until 2028 or 2030*, of: • 100% TUSD Fio B • +40% TUSD Fio A • +100% TUSD P&D • +100% TE R&D • +100% TUSD TFSEE *Consumer Units that file their access request between the 13th and 18th month from the publication of the Law will remain under this rule until 2030.

DG II – TRANSITION RULE: GRADUAL REDUCTION IN TUSD LINE B EXEMPTION

Consumers who file a request for a connection permit **within 12 months of the publication of the Law and who fall under the compensation categories** are subject to the Transition Rules, whereby:

- The new Availability Cost rule applies;
- The new billing rule for the plant's contracted demand applies, with immediate collection of TUSD G.
- Compensation: **partial and gradually increasing payment of the TUSD Line B price component** over a period of 6 to 8 years (depending on the period in which the request was filed) until, in the final year, 90% of the payment for this component is charged.

Compensation Categories

- Local and remote **self-consumption limited to 500 kW of installed capacity.**
- Shared generation*;
- EMUC;

2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
15%	**30%**	**45%**	**60%**	**75%**	**90%**	90% or to be defined	90% or to be defined	to be defined	to be defined	to be defined	to be defined	to be defined	to be defined	to be defined	to be defined	to be defined	to be defined	to be defined	to be defined	to be defined	to be defined	to be defined

Transition period: gradual increase in the percentage of TUSD Line B energy price component to be paid.

The **compensation rules as of 2029 or 2031** will depend on a study to be carried out by Aneel and will **not necessarily remain at 90% of the Line B charge.**

* Provided that a single owner does not retain 25% or more of the surplus energy.

CHANGES IN LAW 14.300/2022 vs REN 482/2012

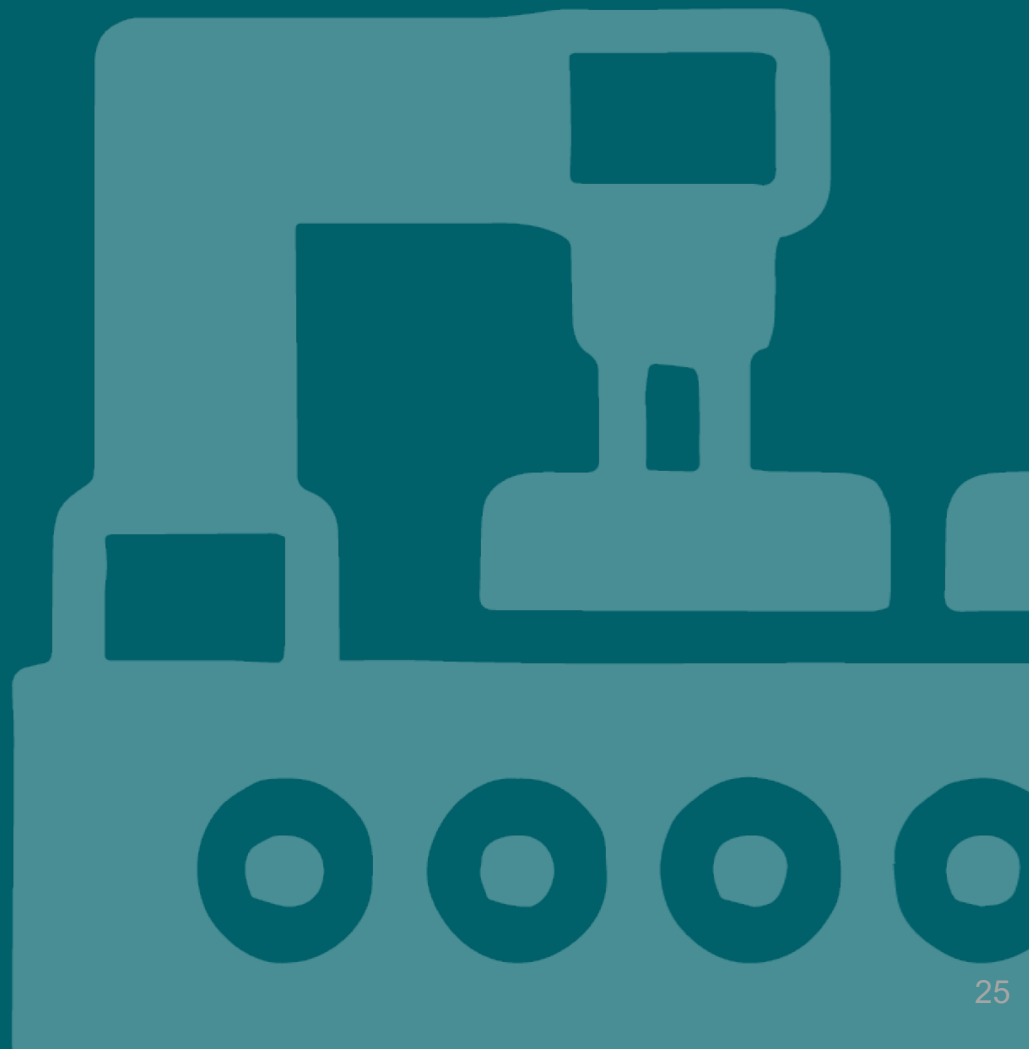
AVAILABILITY COST

- Availability Cost is is a fee that **compensates energy distribution concessionaires for the availability of the electricity network** to low voltage (LV) consumers, according to the type of connection of the UC (single-phase, two-phase or three-phase). Thus, the Cost of Availability is the **amount in local currency equivalent to**:

- If a consumer, for example, has not consumed any energy in a given month, or has consumed energy below the reference value of the Availability Cost, they must pay this minimum amount on their electricity bill.

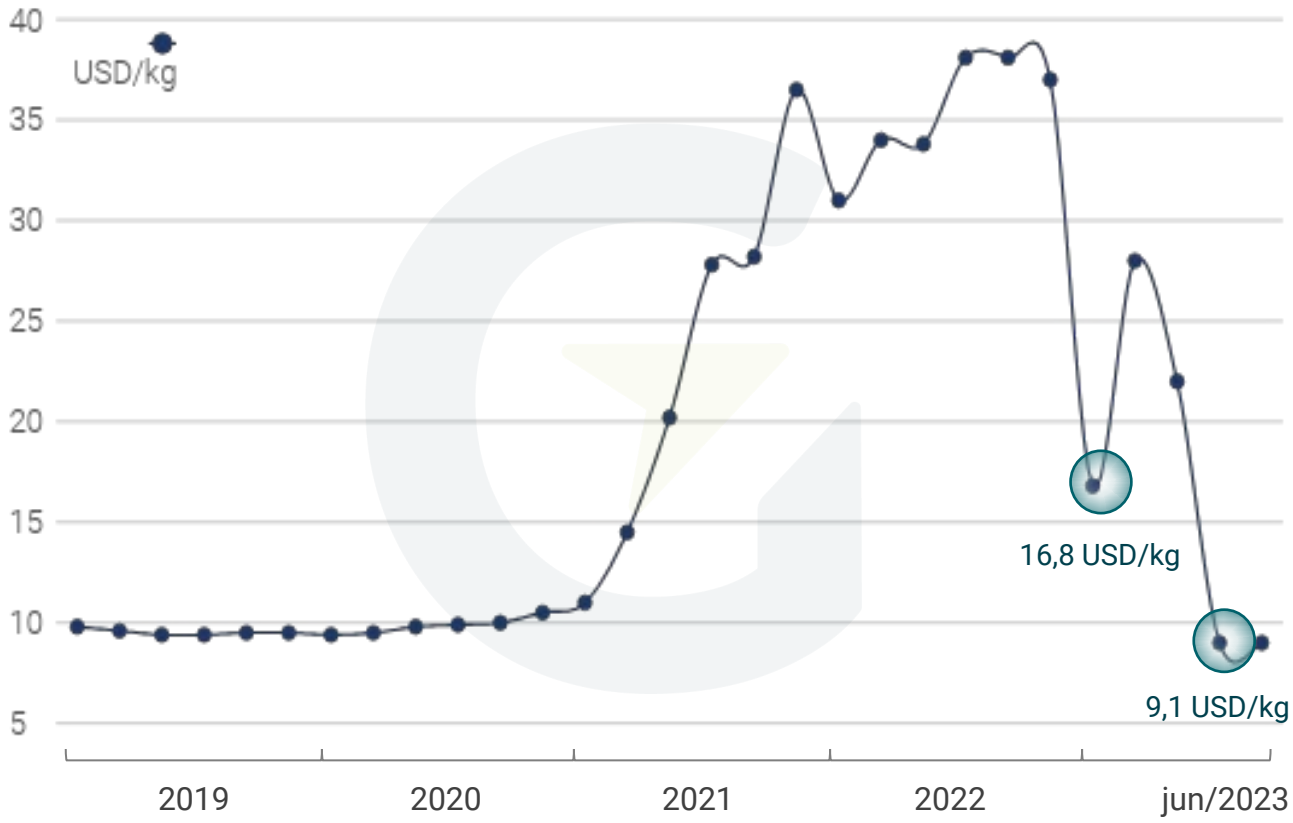
Source: REN 1.000/2021, Art. 291.

02.
MANUFACTURING



PRICE OF RAW MATERIALS

Polysilicon



June/23

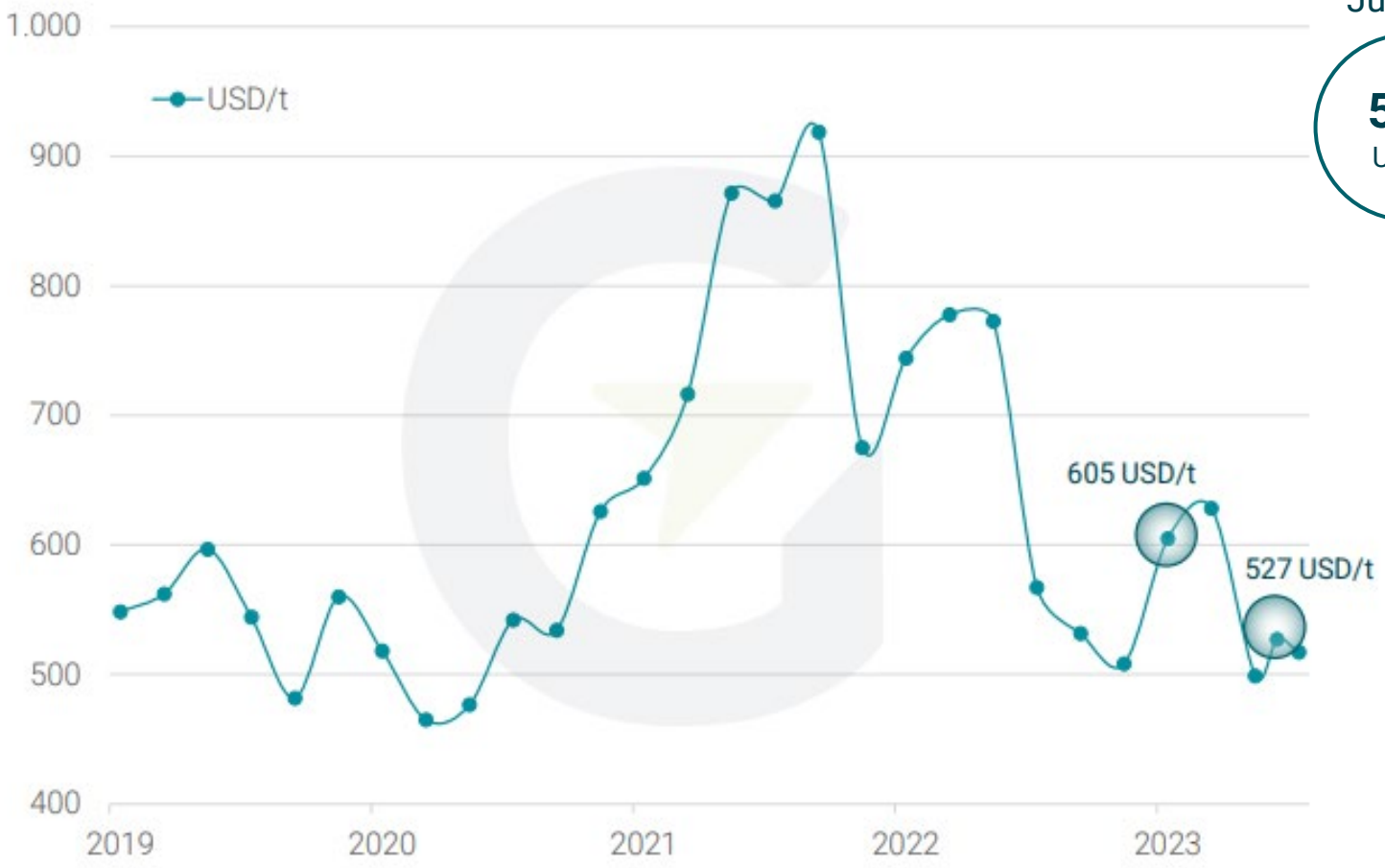
9.1
USD/kg

- The price of polysilicon reached 9.1 USD/kg in June 2023, **down 46% compared to January** of the same year, and showed stability in the following weeks.
- The oversupply of polycrystalline silicon due to the significant **increase in production capacity in China and the consequent rise in stock levels** were factors that contributed to this variation.

Source: Bernreuter Research, 2023 (Adapted).

PRICE OF RAW MATERIALS

Steel



June/23

527 USD/t

- The **price of steel fell by 12% compared to January 2023, reaching 527 USD/t in June** 2023. The decrease in consumption in China due to the slowdown in the economy has contributed to the devaluation of the material.
- The price of steel has an impact on the cost of manufacturing mounting structures, especially for ground-mounted PV plants.

Source: Trading Economics, 2023 (Adapted).

*Data collected up to end of June 2023

PRICE OF RAW MATERIALS

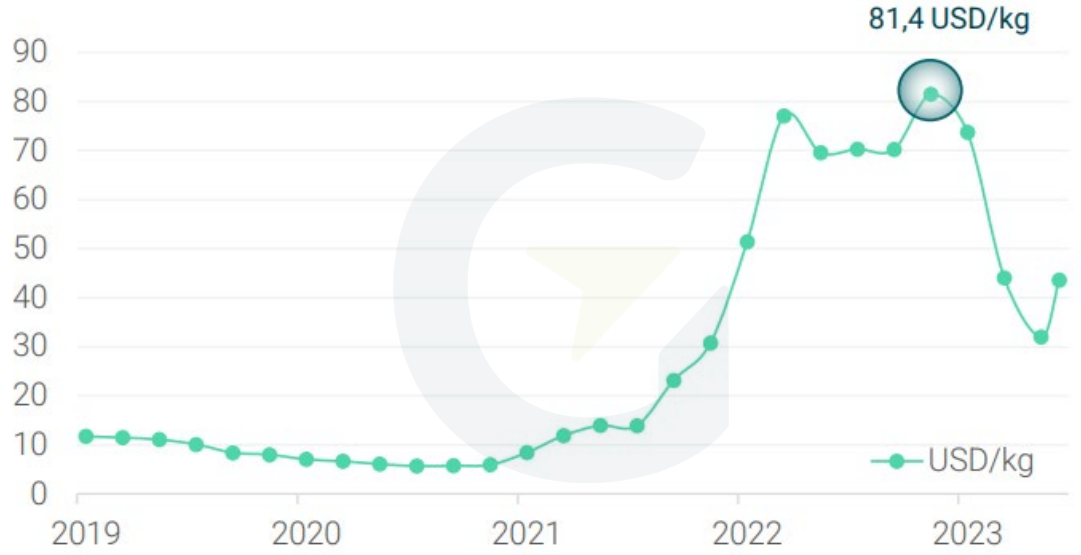
Copper and Lithium

- **A 16% increase in the price of copper in June 2023 compared to January** of the same year. The change in the price of copper can have an impact on the production costs of conductive and electronic components, thus influencing the costs of PV systems.

- **A 41% drop in the price of lithium in June compared to January** 2023. The price of lithium is directly related to production and demand for **lithium-ion batteries**.

Copper

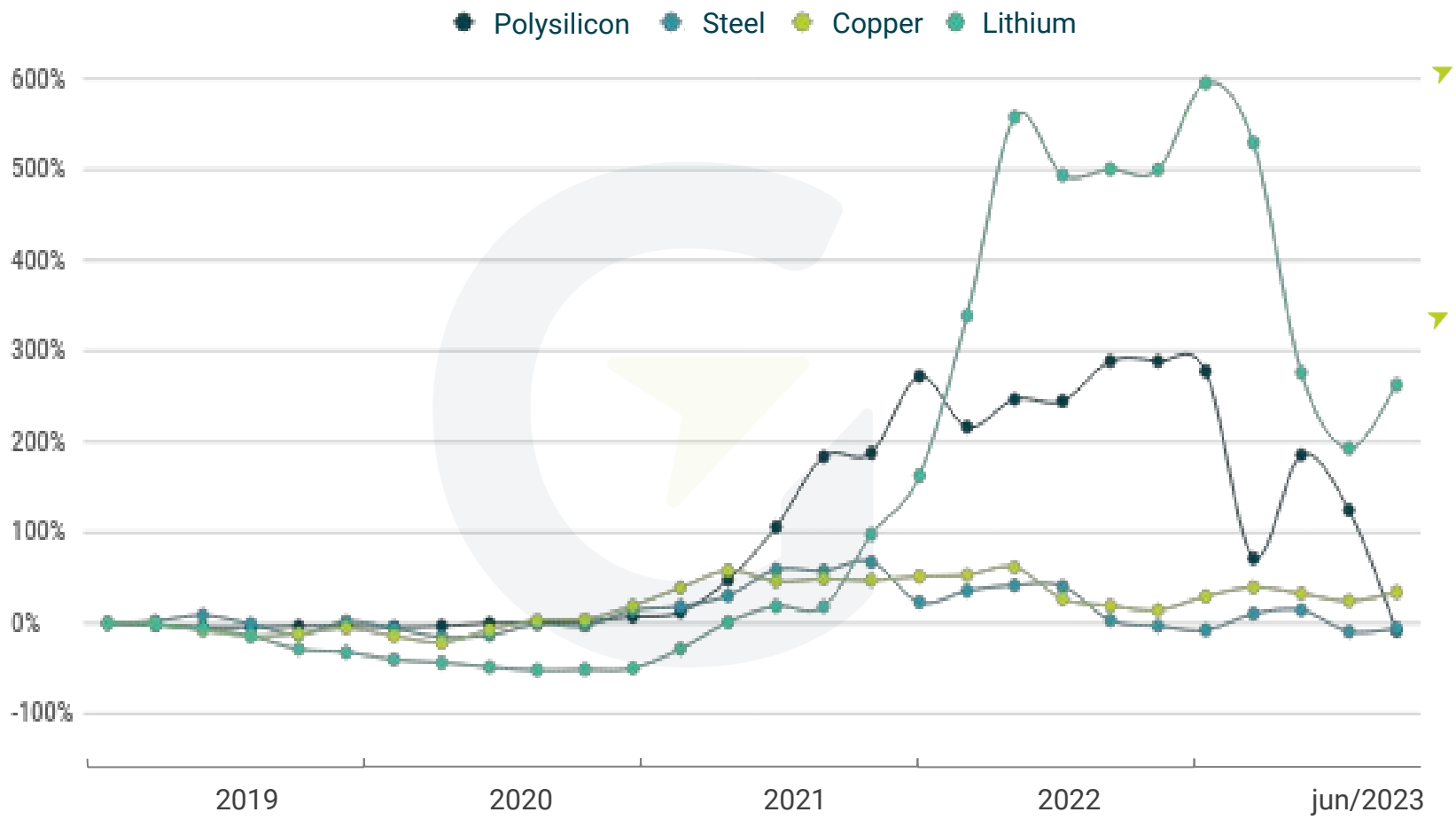
Lithium



Source: Trading Economics, 2023 (Adapted).

VARIATION IN RAW MATERIAL PRICES

Using a US$ Base



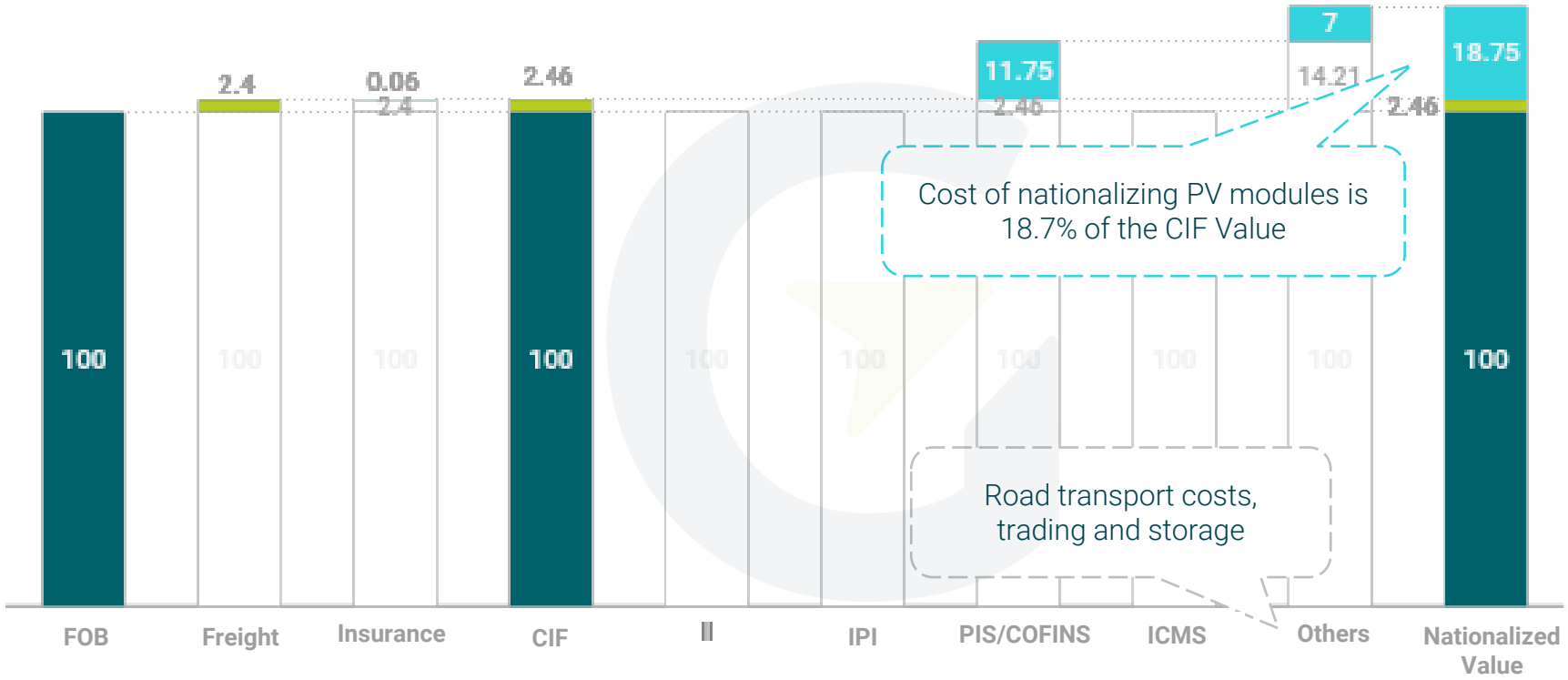
- The graph shows the **variation in the price of each input** over the same period of time.
- From 2019 to June 2023, **Lithium and Polysilicon showed the greatest variations**, increasing by more than 600% and 300% respectively.

Source: Trading Economics, 2023 (Adapted); Bernreuter Research, 2023 (Adapted); Greener, 2023.

PV MODULES

Import and nationalization costs at Brazilian ports

- **Nationalization costs have remained stable** since January 2023, **representing 18.75% of the CIF price** in June 2023 compared to 20.85% in January of the same year.



Rates	2.4%	0.06 %	2.46 %	0%	0%	11.75%	0%	7%	**21.21%**

Changes to the criteria and revocations of the Ex-Tariff treatment may alter the rate of Import Tax (II).

Source: Greener, 2023.

03.
DISTRIBUTION

THE SURVEY

Introduction

- From July 1, 2023 to August 8, 2023, Greener carried out its market research by **interviewing 24 photovoltaic equipment distributors** (kits*) responsible for approximately **52% of the volume sold in 1H2023** through the distribution market.
- Of the 24 distributors, **80% also took part in the 2022 survey**. Greener therefore provides some specific analyses between 2022 and 2023, in order to indicate the dynamism of the market for this group as well.

Start of commercial activities of surveyed companies:

2018 Or before	2019	2020	2021**
54%	21%	4%	21%

* PV Kit consists of: PV Modules + Inverter + Mounting System + Cabling System + Protection System

** There were no companies responding to the survey which started up in 2022 and 2023.

DISTRIBUTORS IN NUMBERS

1st Half of 2023

R$ 4.8 bi

Total revenue* of the distributors interviewed, where **those with 5 years or more of operation accounted for 70%** of this amount.

3.04 GWp

Total volume invoiced by the distributors interviewed, representing **more than 101,800 kits sold.**

2,325

Total number of employees dedicated to the solar market, **with 46% of companies having up to 50 employees and 25% between 101 and 200.**

21,294

Total number of active integrators,** representing 12% of the total number of integrators registered with the surveyed companies.
(does not represent the total number of integrators in the market due to double counting)

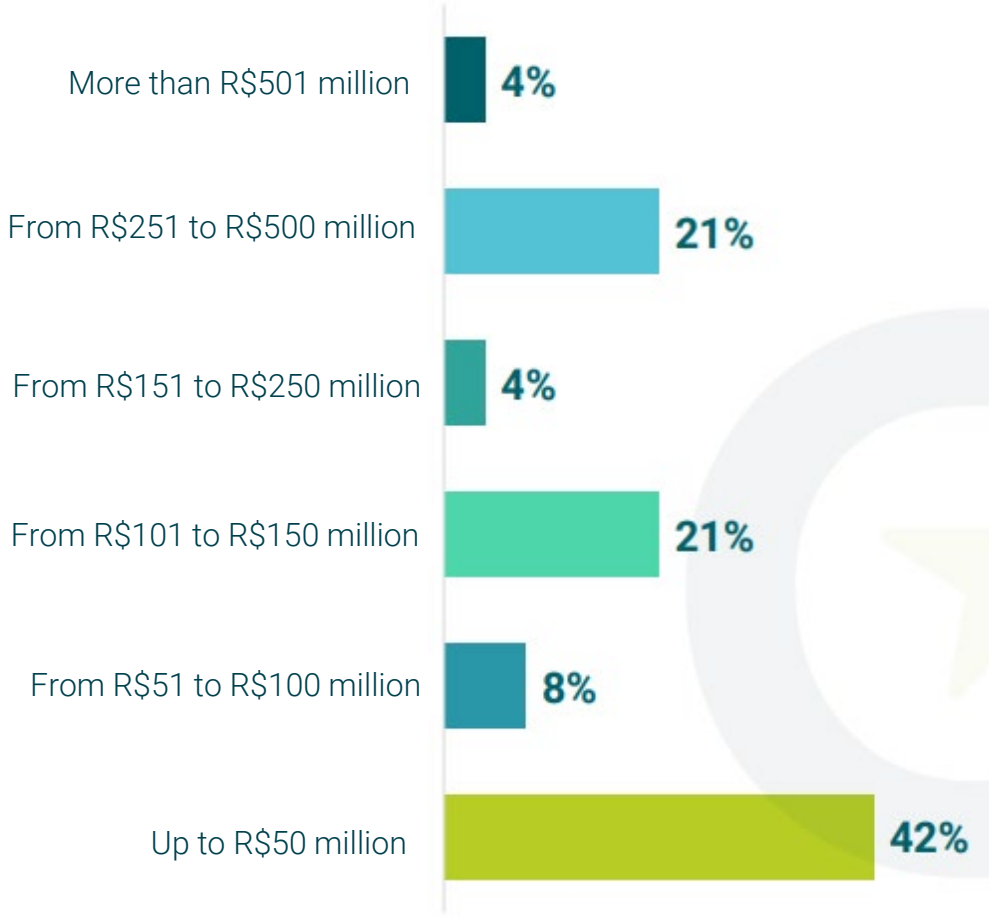
10 working days

Average time required for the delivery of PV kits, based on the responses of 25% of the distributors interviewed.

**Total turnover, including any commissions to the integrator.*
***Integrators who made at least one purchase in 2023.*

SALES REVENUE (R$) FROM PV KITS

% of surveyed distributors of PV equipment



- Although the majority of distributors had **revenues of up to R$50 million (42%)**, this represented only **5% of the total turnover** of R$4.8 billion.
- As for the relationship between turnover and the number of employees, **companies with between 100 and 200 employees accounted for 61%** of total turnover.

COMPANIES WITH RECURRING RESPONSES IN 2022 E 2023:

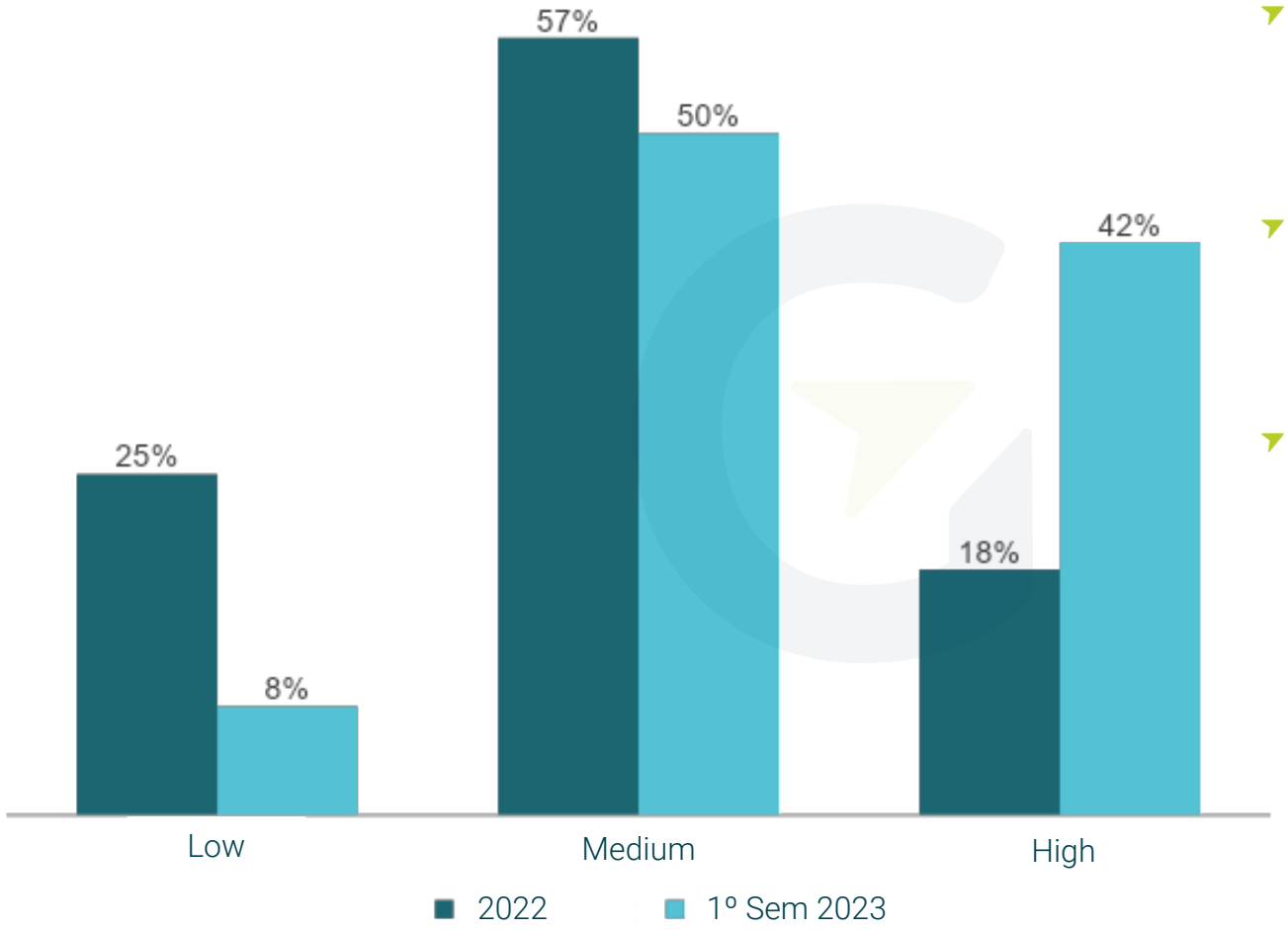
Average drop of **30% in distributors' monthly turnover** when comparing 2023 to 2022*. If we only take into account the **distributors that had a reduction in turnover, the average is -42%**. A point to bear in mind is that this is billing and not sales, i.e. part of what was billed in the first quarter of 2023 refers to sales at the end of 2022.

***Important**: to calculate the monthly average for each year, the year 2022 was considered proportionally (data referring to the last survey carried out). However, for 2023, only the 1st semester was considered, thus not incorporating the effect of the seasonality of sales in the 2nd semester.*

Source: Greener, 2023.

IMPORTS VS SALES

Stock Levels

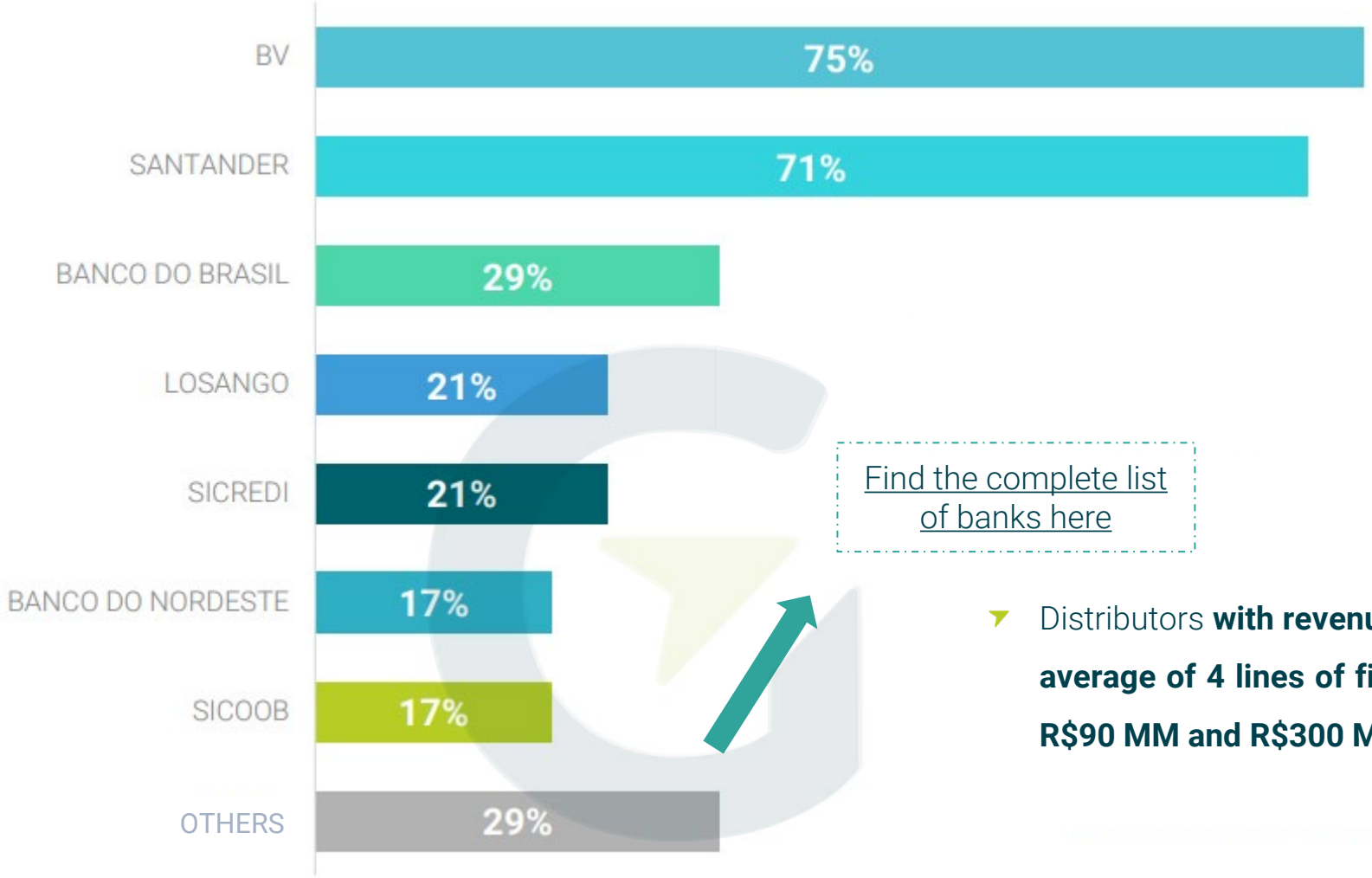


- Compared to 2022, there was a **24 percentage point increase in companies reporting high stock** levels.
- **22 of the 24 distributors** who took part in the survey reported **medium or high stock levels**.
- According to the data collected in the survey, **low stock levels belong only to smaller distributors** with turnover of up to R$50 million. However, 40% of distributors of similar size cited medium stock levels.

Source: Greener, 2023.

SOLAR FINANCING

Financing Institutions mentioned by surveyed Distributors



Find the complete list of banks here

Note: These figures relate to the fragmentation of financing agents and not to market share. *They represent the percentage of companies that have had at least one loan from a given bank. The same company may have concluded different sales with different banks/financing lines.*

- Distributors **with revenues of more than R$300 million cited an average of 4 lines of financing**. Those with **revenues between R$90 MM and R$300 MM usually have 6 lines** of financing.

Source: Greener, 2023.

AFTER-SALES SERVICES

Support Processes for existing customers

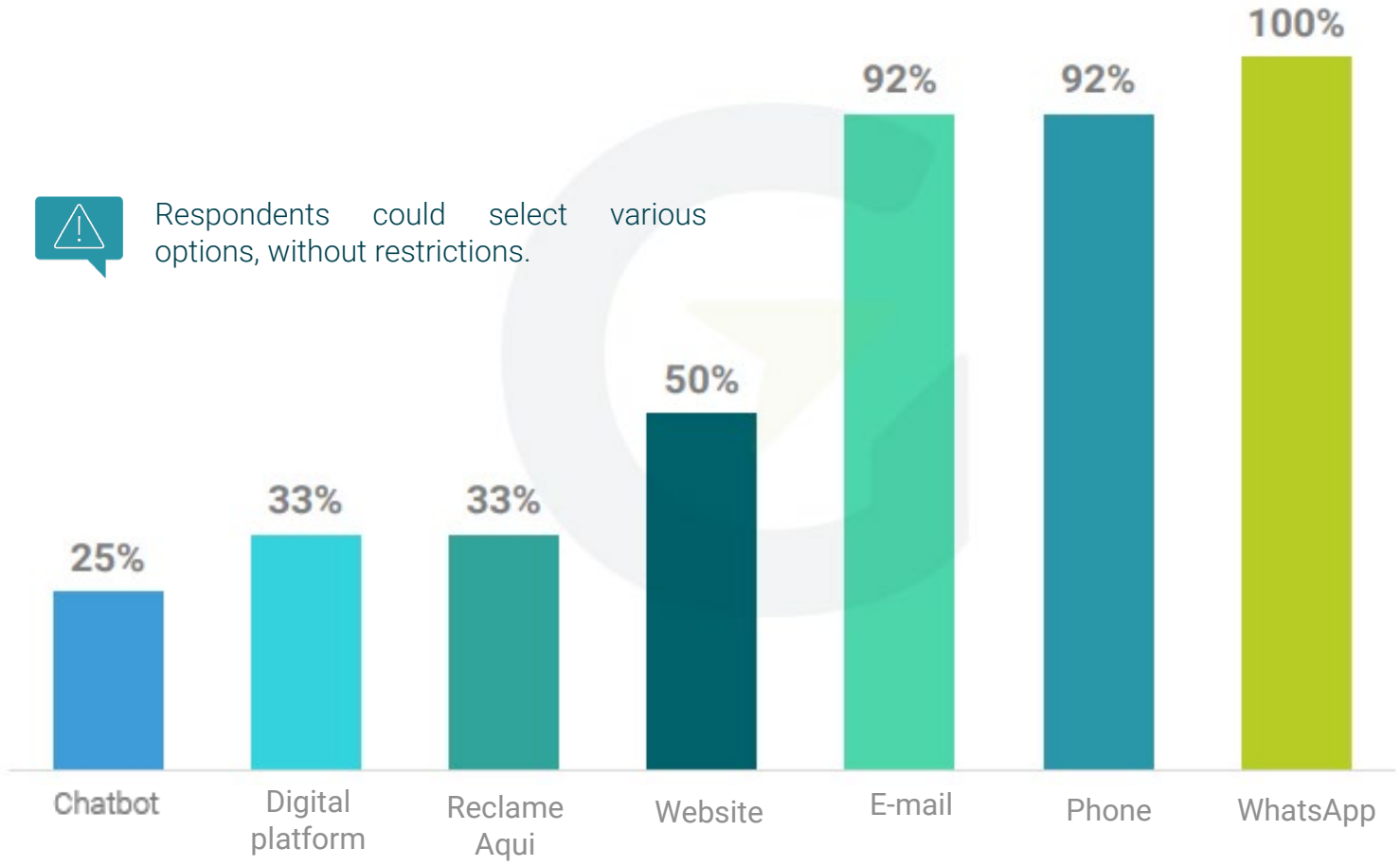
Respondents could select various options, without restrictions.

- The **warranty** service is provided by **almost all of the respondents.**
- **Satisfaction surveys** are still not provided by **half of the distributors**.
- **38% of the distributors replied that they have all of the mentioned after-sales channels,** i.e. Technical Assistance, Returns, Warranty and Customer Satisfaction Surveys.

Source: Greener, 2023.

AFTER-SALES SERVICES

Support Channels for existing customers



Respondents could select various options, without restrictions.

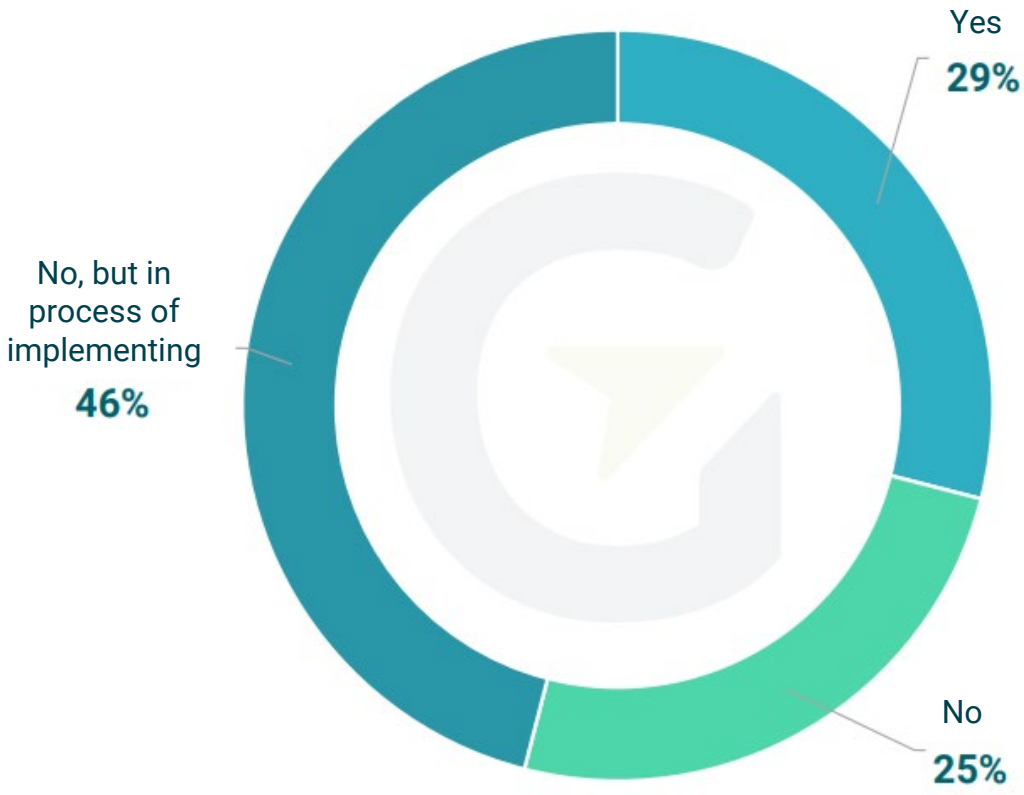
- **WhatsApp, telephone and email** are the channels most used in after-sales processes.
- **Chatbot and Website were the channels that most increased their relevance** in the market compared to the first half of 2022, being used simultaneously by 16% of distributors.
- **Only 13% of the surveyed distributors have all the feedback channels** mapped in this study.

Source: Greener, 2023.

"Reclame Aqui" is a Website that allows users to register complaints about products and services from companies.

AFTER-SALES SERVICES

Area for customers to evaluate their purchase

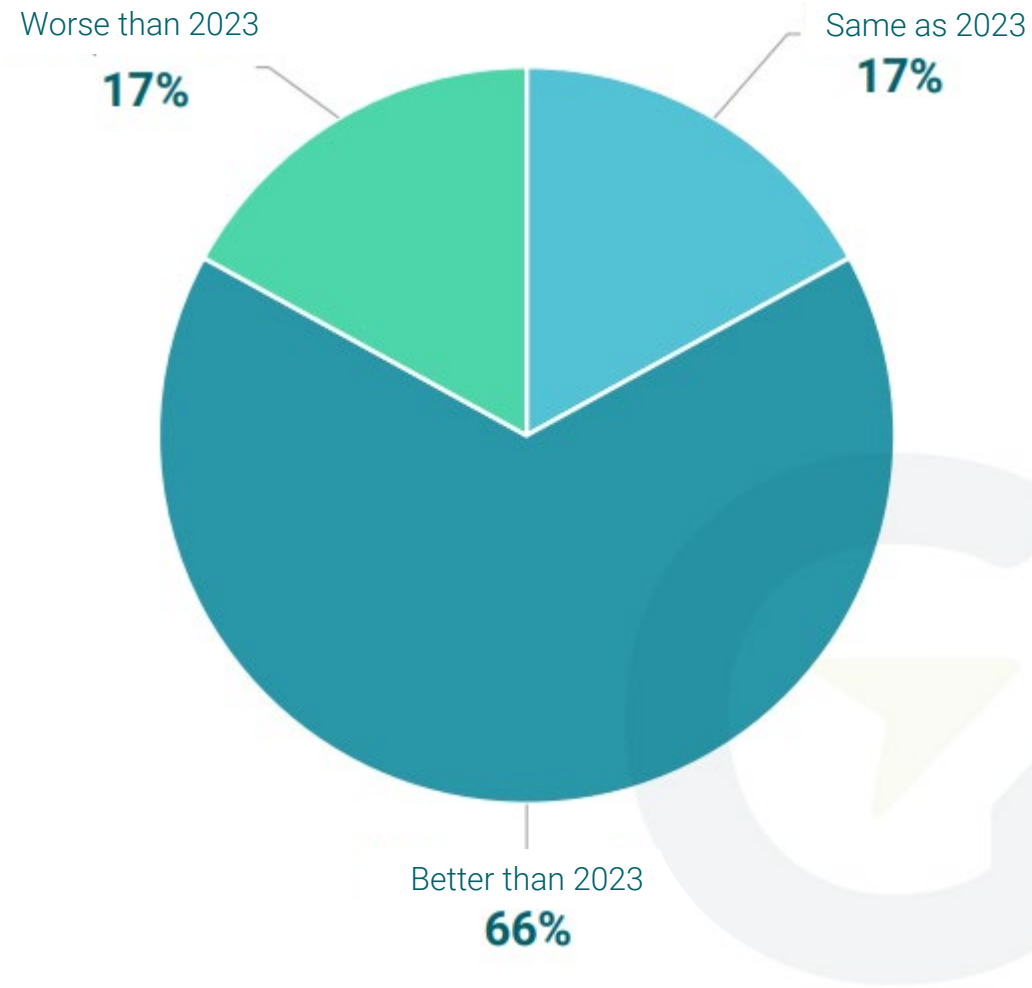


- **71% of the distributors** taking part in the survey still **don't have any space for the customer to evaluate the product/service** after purchase.
- However, **46% of the companies**, despite not having a space at the moment, **are in the process of implementing** a solution of this kind.
- **Of those that do have such services, 71%** have been operating in the photovoltaic **market for at least 4 years**, reflecting an improvement in customer experience processes.

Source: Greener, 2023.

EXPECTATIONS FOR 2024

% share of surveyed equipment distributors



- **The distributors who consider a more optimistic scenario for 2024 (66%),** have an average expectation of an **increase in sales of 83%** for the 2nd half of 2023.
- Among the **distributors that sold more than 200 MWp of kits** in the 1st half of 2023, **40% expect a more pessimistic scenario** for next year.
- 17% of the distributors who believe that the scenario will be the same in 2024 expect their combined sales to increase by 515 MWp.

Source: Greener, 2023.

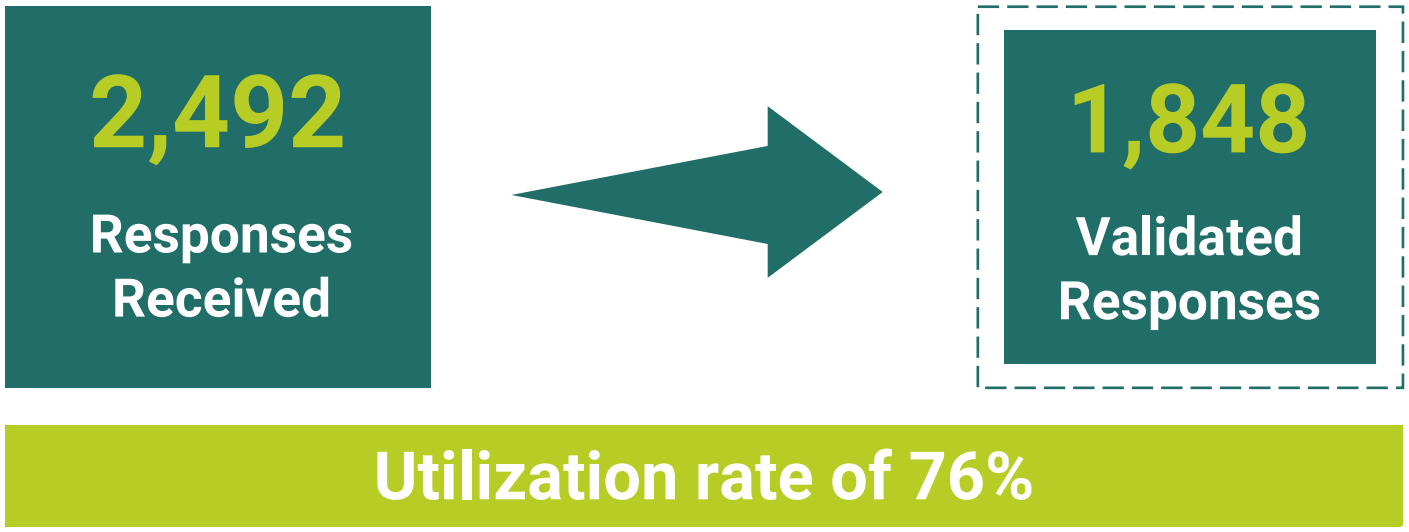
04.
INTEGRATION

THE SURVEY (INTEGRATORS)

Introduction

- Greener conducted a **new market survey** with integrator companies from **July 1 to July 31, 2023**, obtaining a total of 2,492 responses from integrators in all regions of the country. These companies vary in size and in time in operation, thus providing an overview of the broad diversity of the photovoltaic integration market.

Data Validation



Source: Greener, 2023.

THE SURVEY

Introduction

Start of Business Operations of Responding PV Integrators:

2018 or before	2019	2020	2021	2022	2023
24%	16%	16%	19%	19%	6%

- The percentage figures represent the **distribution of the start of commercial activities** of the integrating companies that took part in the survey in July 2023.
- For example, the 6% referring to **2023** reflects the number of integrating companies that started their activities in the solar sector **in the first half of this year**.
- Of the integrating companies that responded to the survey, **56% have been operating in the PV market for more than three years**, with experience both before and after the implementation of Law No. 14.300/2022.

Source: Greener, 2023.

THE SURVEY

Estimated Number of Active PV Integrator Companies

- **The total population of PV Integrator Companies** is estimated based on cross-referencing data from Greener's survey with information provided by organizations and companies in the sector.

26,640

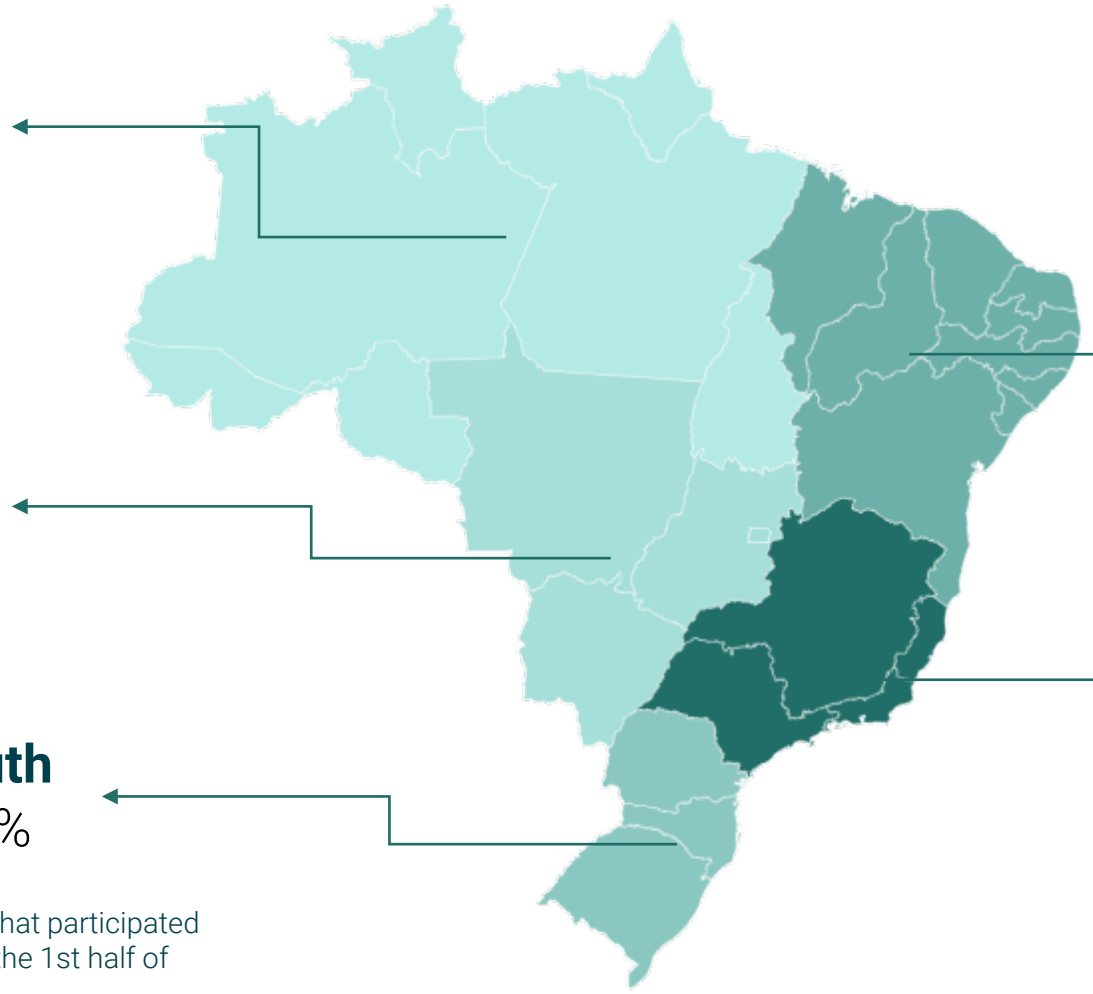
Actively trading PV Integrators *

* Companies actually doing business in 2023. This is a conservative estimate by Greener, so the actual number in the market may be higher

Source: Greener, 2023.

THE INTEGRATORS

Percentage of PV Integrators * per Region

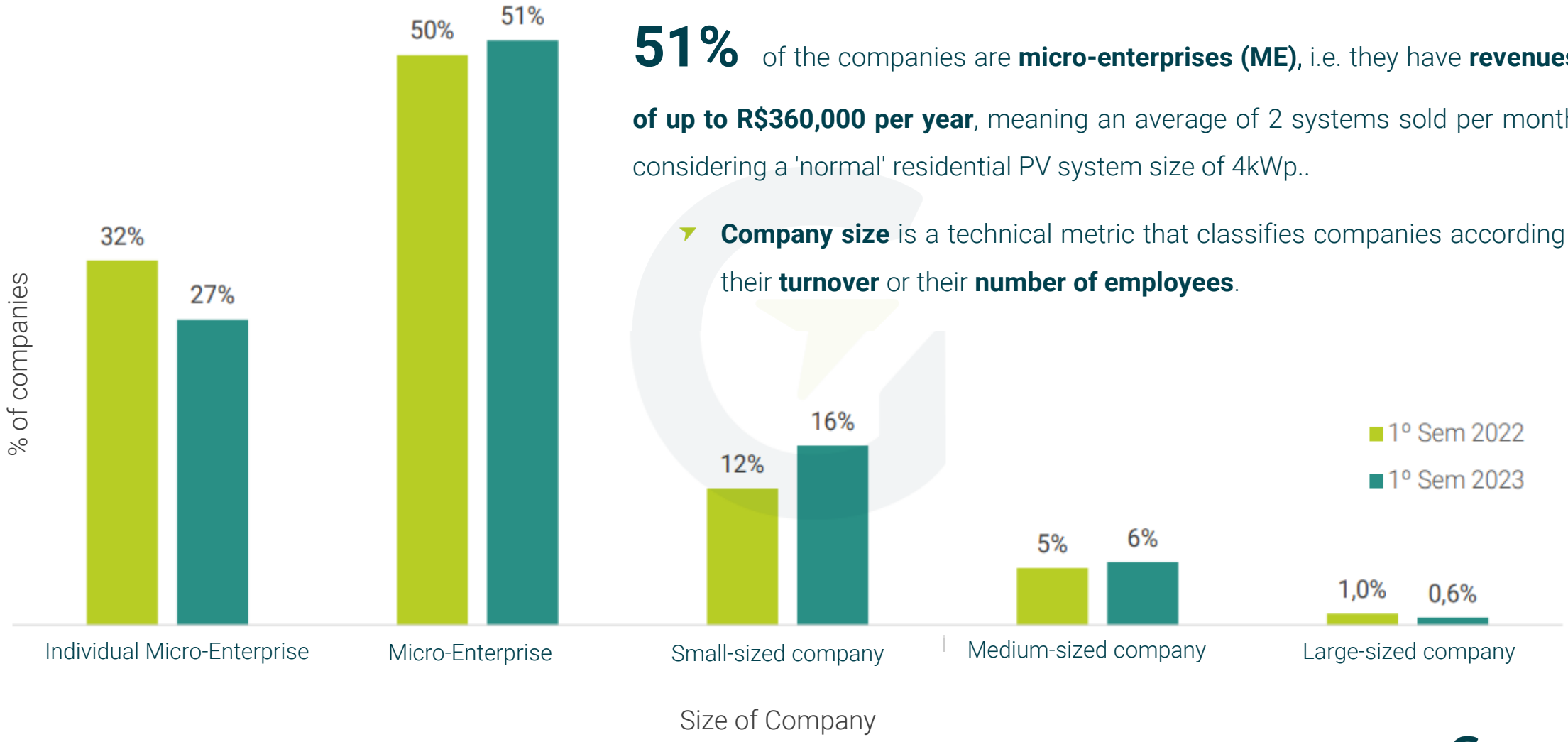


*PV Integrator Companies that participated in the DG Market Survey in the 1st half of 2023.

Source: Greener, 2023.

PROFILE OF THE INTEGRATOR COMPANIES

Size of Companies



51% of the companies are **micro-enterprises (ME)**, i.e. they have **revenues of up to R$360,000 per year**, meaning an average of 2 systems sold per month considering a 'normal' residential PV system size of 4kWp..

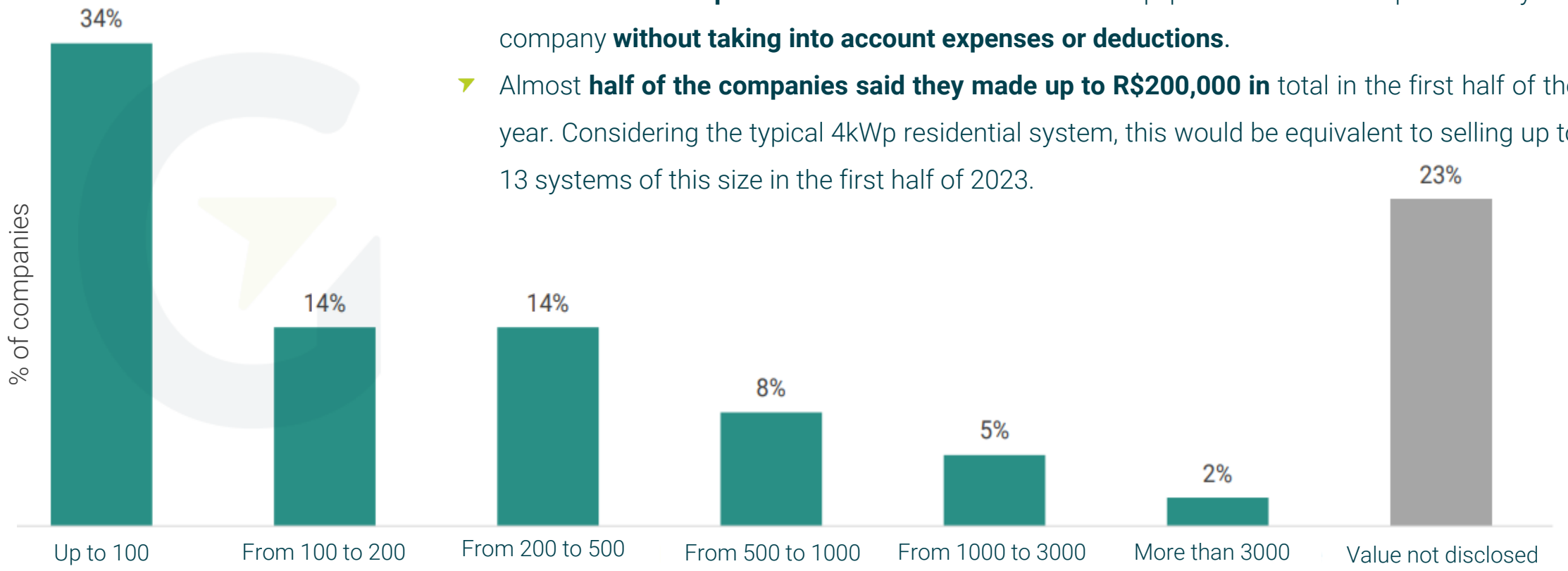
- **Company size** is a technical metric that classifies companies according to their **turnover** or their **number of employees**.

Source: Greener, 2023.

GROSS TURNOVER

Turnover of Integrators during 1H2023 [in thousands of R$]

- **Gross turnover represents the total sales** value of equipment or services provided by the company **without taking into account expenses or deductions**.
- Almost **half of the companies said they made up to R$200,000 in** total in the first half of the year. Considering the typical 4kWp residential system, this would be equivalent to selling up to 13 systems of this size in the first half of 2023.



Gross Turnover 1H2023

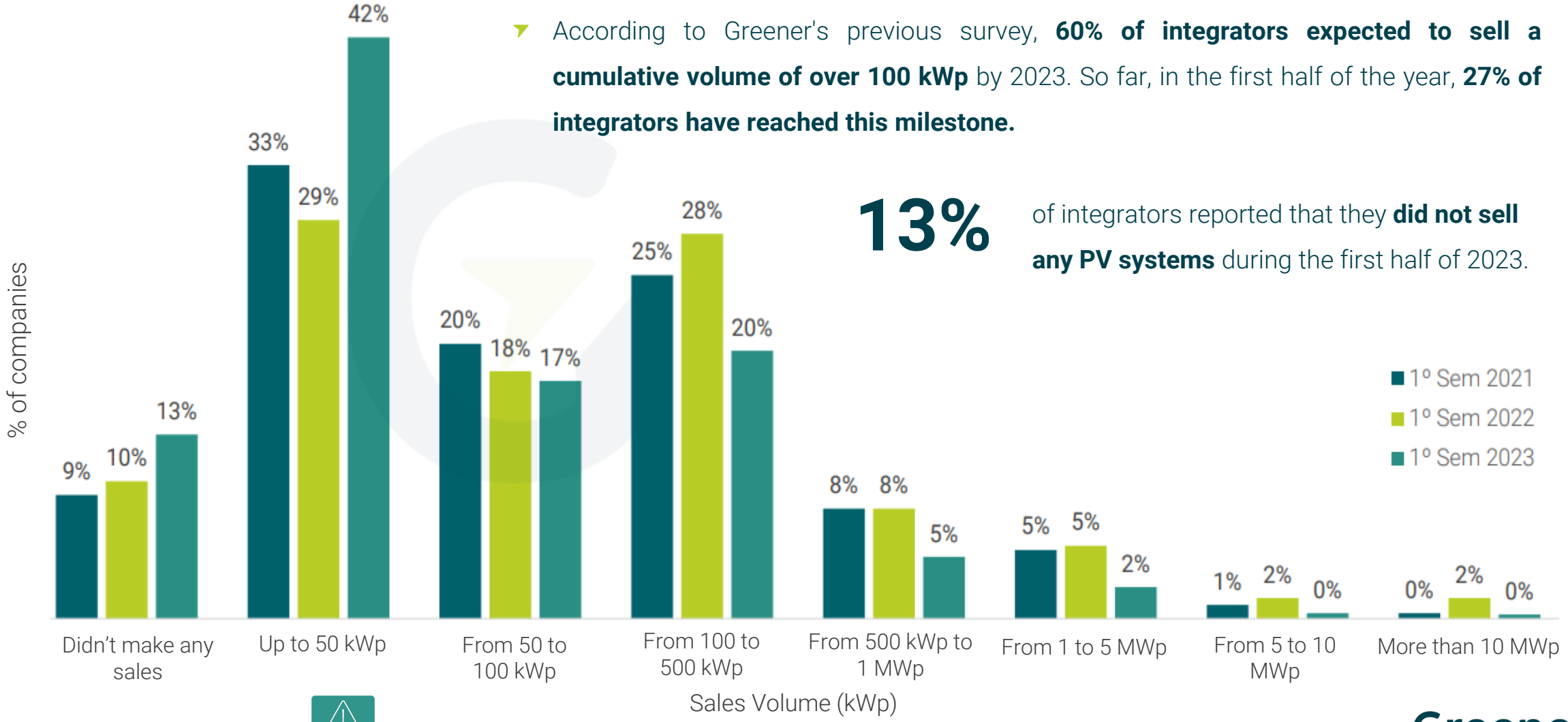
Source: Greener, 2023.

SALES VOLUME (kWp)

Comparison in terms of generating capacity

- According to Greener's previous survey, **60% of integrators expected to sell a cumulative volume of over 100 kWp** by 2023. So far, in the first half of the year, **27% of integrators have reached this milestone.**

13% of integrators reported that they **did not sell any PV systems** during the first half of 2023.



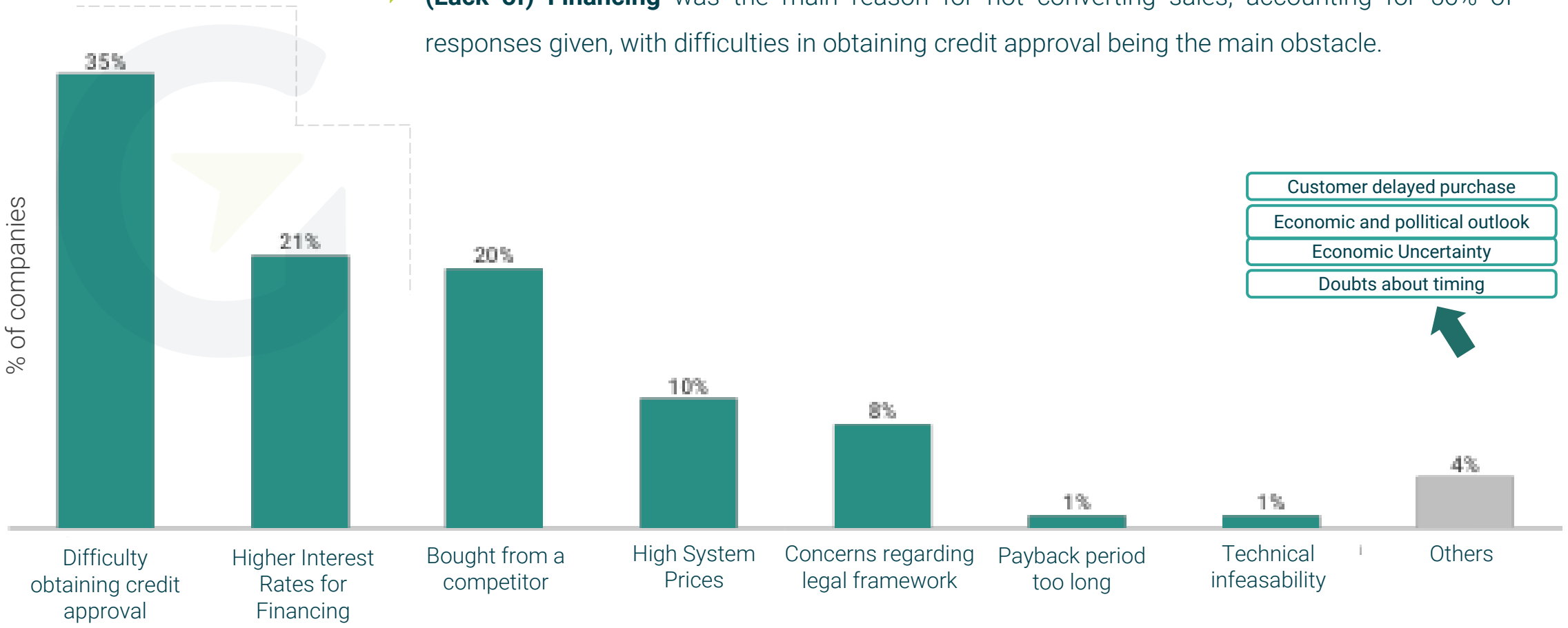
Source: Greener, 2023.

Note: Percentages may not add up to exactly 100% due to rounding of decimal places.

UNCONVERTED SALES

Principal reasons for lost sales

- **(Lack of) Financing** was the main reason for not converting sales, accounting for 56% of responses given, with difficulties in obtaining credit approval being the main obstacle.



Principal reasons for unconverted sales pitches

Source: Greener, 2023.

SOLAR FINANCING

Sales Volume with Financing

48% was the **percentage of sales that were financed** (through bank loans) in the first half of 2023.

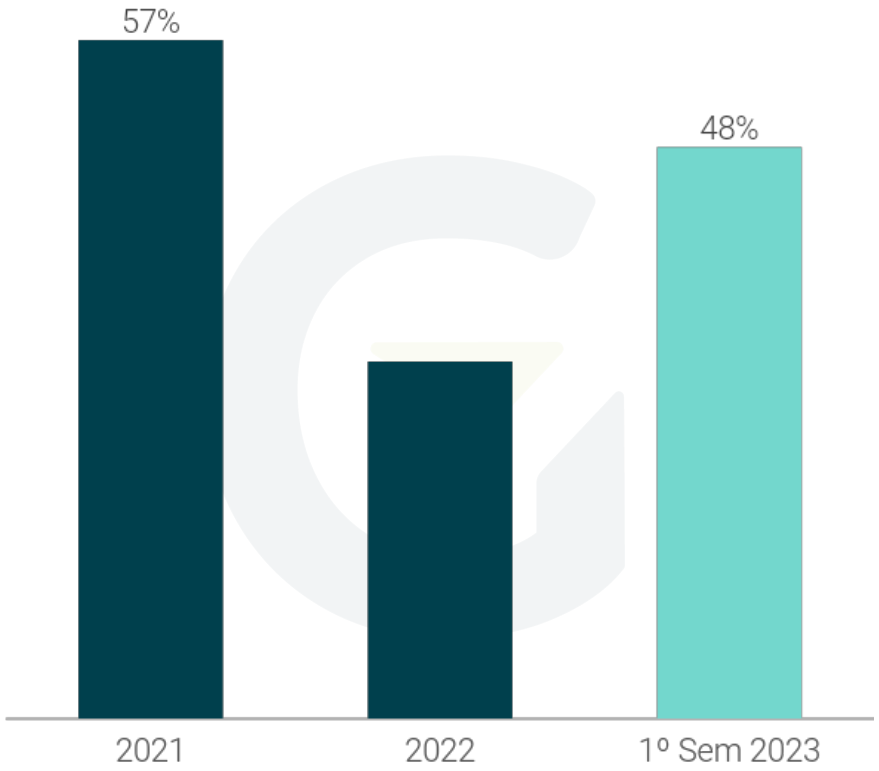
- Although the volume of financed sales reached **48%, an apparent increase in the number** of loans compared to 30% in the previous year, attention should be paid to the **60% drop in total sales, which distorts the figures somewhat.**

- Since this indicator is based solely on completed sales, with a significant reduction in total sales, loan-financed sales have a higher share because **those who managed to get credit approval had a greater incentive to do business**, risking less investment of their own capital.

ERRATA: there was a correction for the percentage previously quoted for 2022.

Source: Greener, 2023.

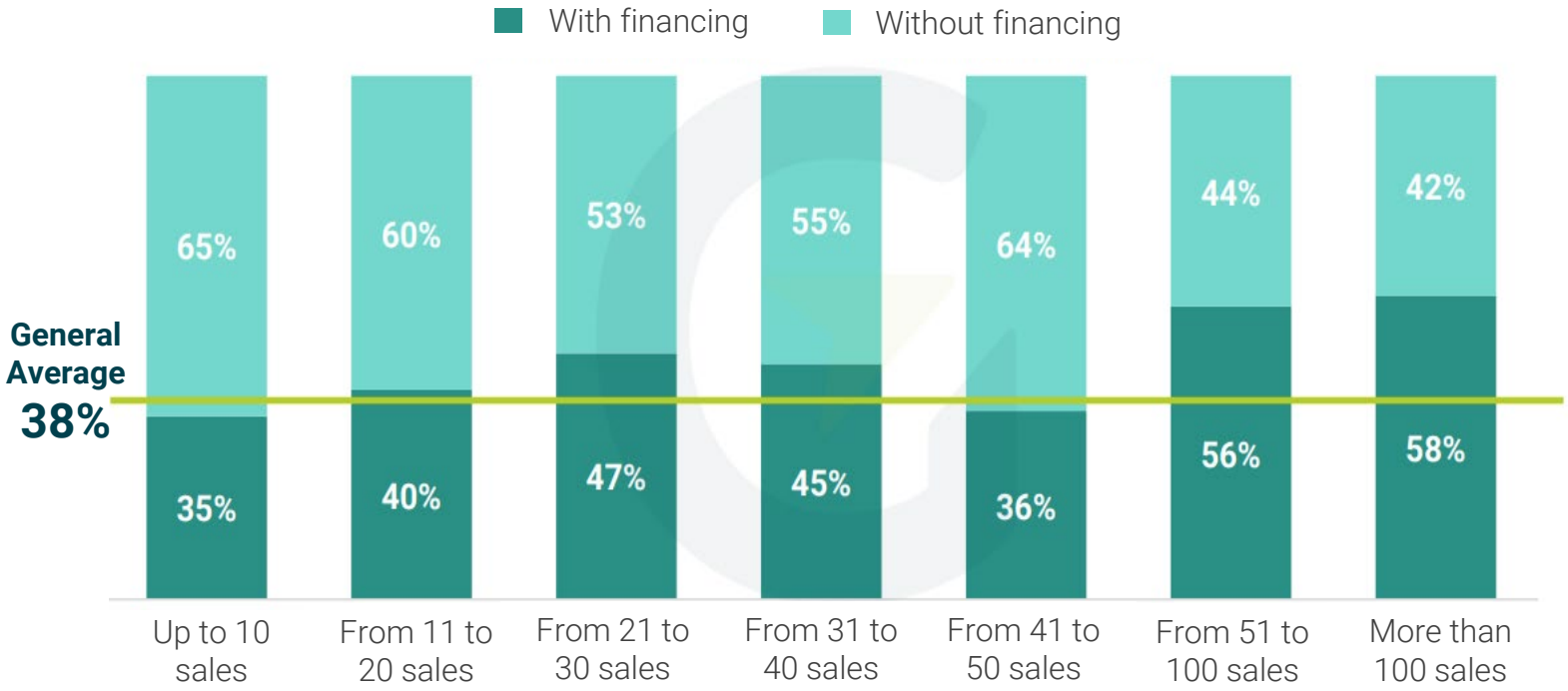
Percentage of total with (bank) financing



SOLAR FINANCING

Average number of bank-financed PV system sales

- In this report, we have introduced a **new indicator regarding financing** that directly affects the integrator's day-to-day operations. **The average number of financed sales** serves as a **gauge of the maturity of the operation**, as we can see in the graph that there is a tendency for the percentage of financed sales to increase with the increase in the number of total sales.



How to interpret this table

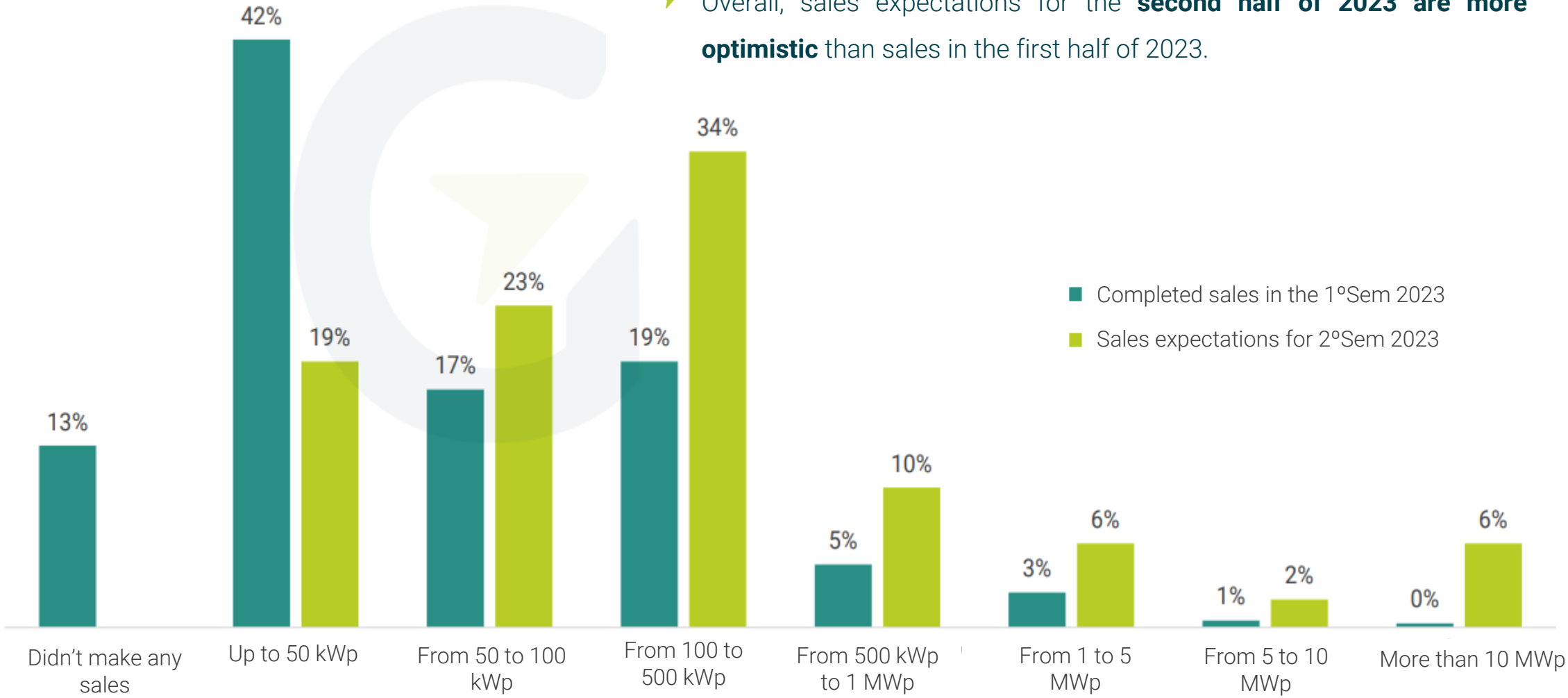
Integrators who sold up to 10 systems during the first half of the year reported that 35% of sales were bank financed, while integrators who sold more than 100 systems reported that 58% were bank financed.

Source: Greener, 2023.

SALES EXPECTATIONS

Completed sales and sales expectations

- Overall, sales expectations for the **second half of 2023 are more optimistic** than sales in the first half of 2023.



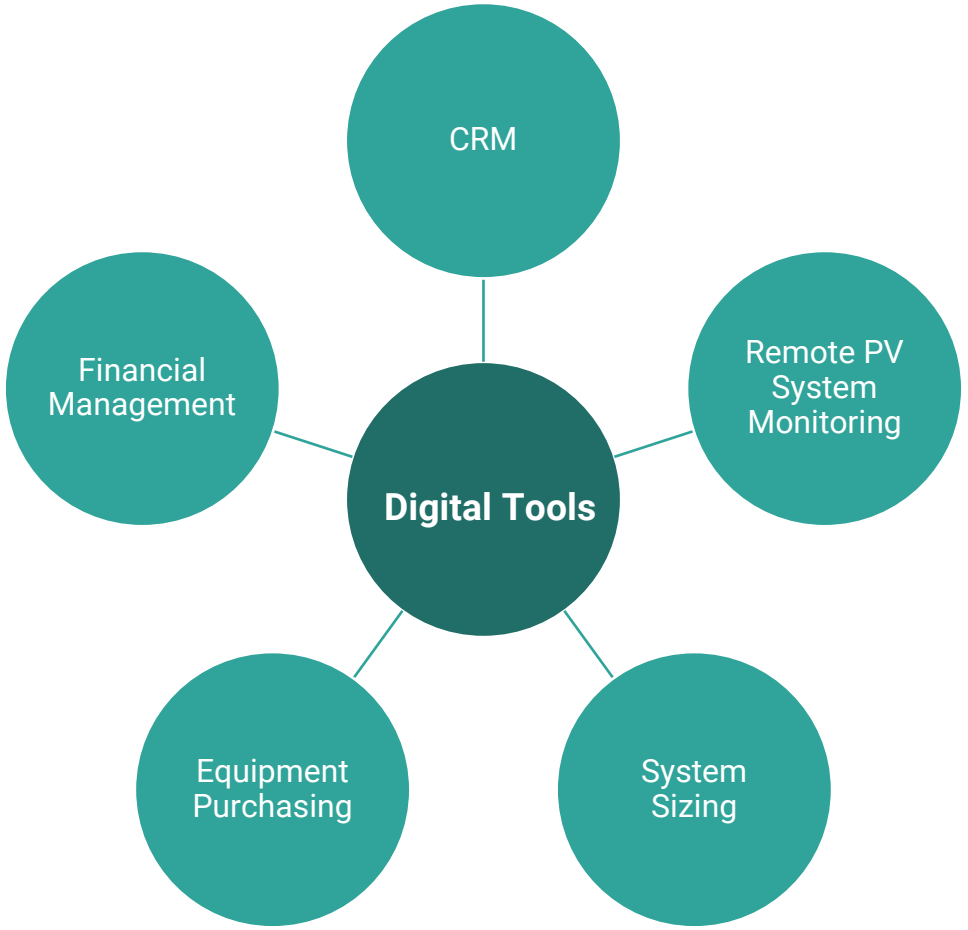
Source: Greener, 2023.

DIGITAL TOOLS

Introduction

- **Automation tools**, such as platforms, programs and software, are used to optimize the entire operational flow of the company, and make **all stages from customer acquisition to the sale and monitoring of PV systems more efficient**.

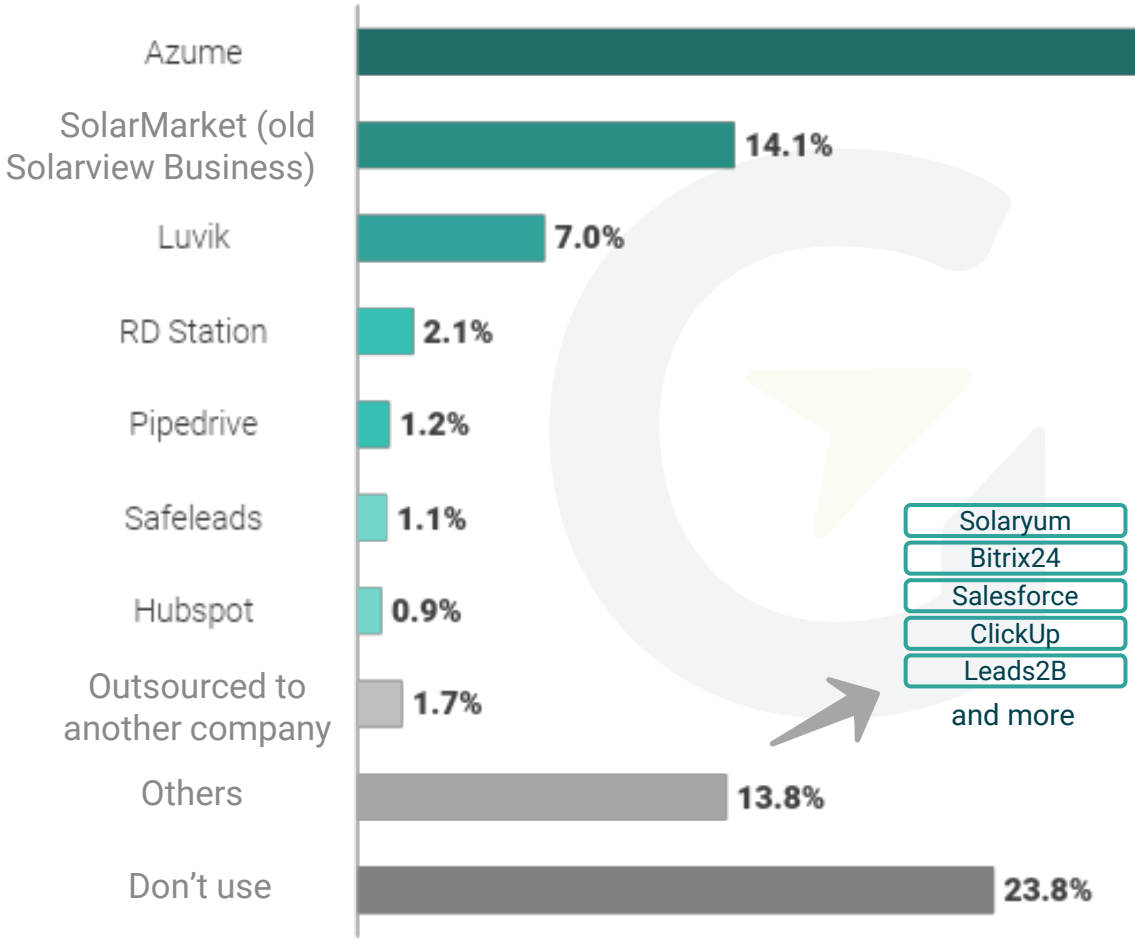
- Through the DG Integrator Survey, Greener sought to understand the behavior of the integration market in the face of **accelerating digitalization and automation**.



Source: Greener, 2023.

DIGITAL TOOLS

Tools for *sales automation (CRM)** that integrators use



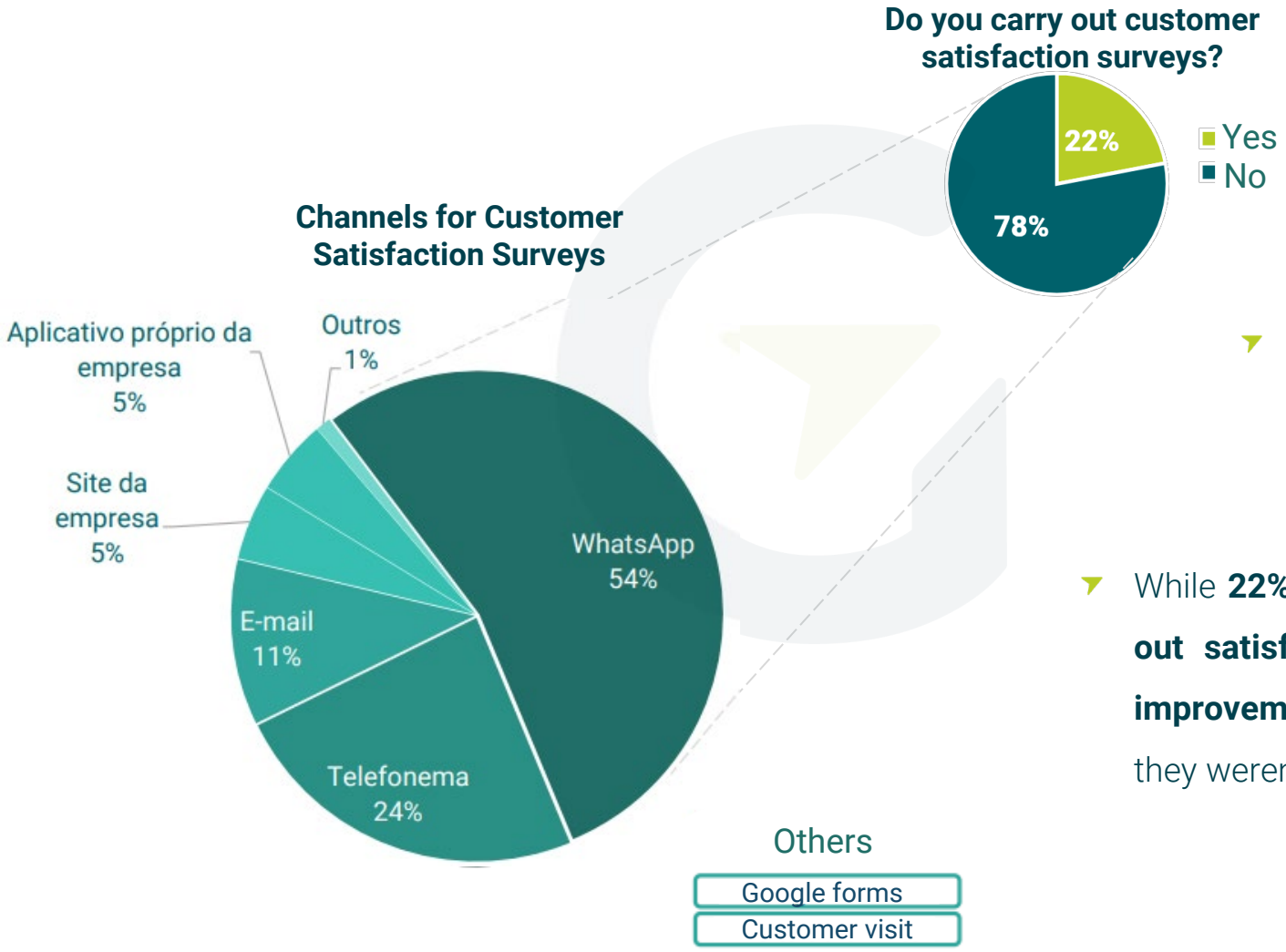
- **Although 23.8% of companies are not using CRM, this figure has decreased** compared to the first half of 2022, when the proportion of companies not using such a system was 42%.

*CRM – Customer Relationship Management. In Portuguese, "Gestão de Relacionamento com o Cliente"

Source: Greener, 2023.

DIGITAL TOOLS

Methods through which integrators carry out after-sales client satisfaction surveys



- The main evaluation tool continues to be **WhatsApp**, accounting for **more than half of the responses.**

- While **22% of companies reported that they still don't carry out satisfaction surveys**, this figure shows a **significant improvement** on the same period **last year**, when **47%** said they weren't conducting surveys of this type.

Source: Greener, 2023.

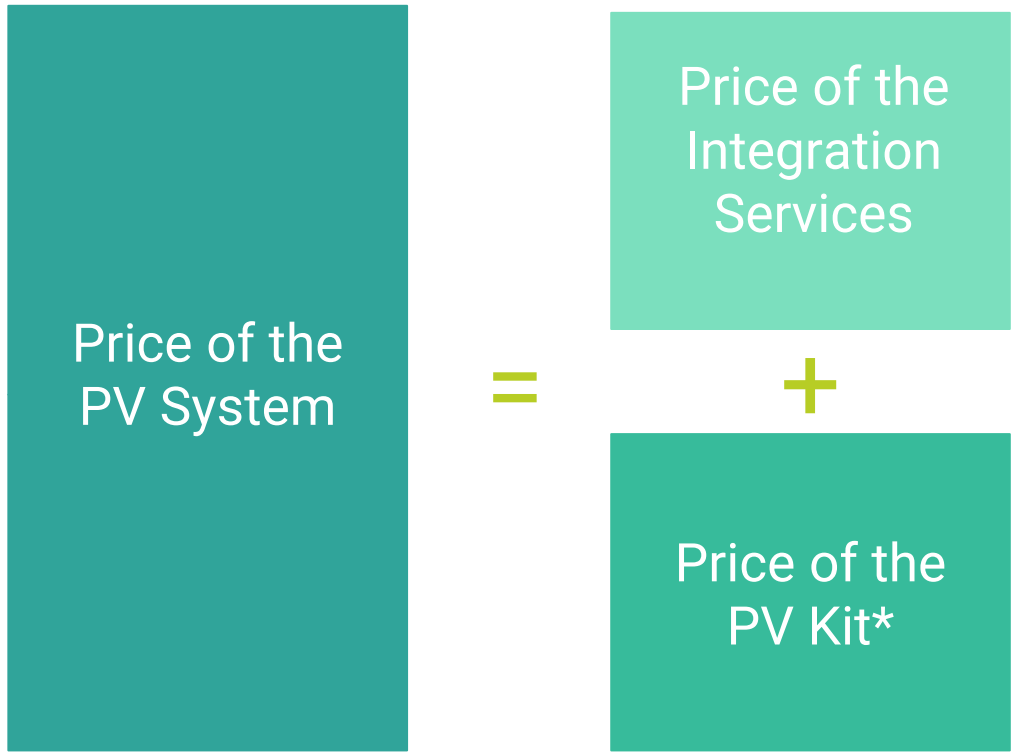
05.
PRICES

RATIO OF PRICES

Price of the PV Kits + Price of Services = Price of PV System

- The **average price** of a PV system categorized by size is obtained by **analyzing the prices provided by thousands of integrators** who respond to the DG Surveys carried out every six months by Greener.
- The **average price of the kits** is obtained through **price mapping and research** among the distributors.
- The average price of the integration service is the difference **between the price of the PV system and the price of the kit,** and represents the service provided by the integrator.

** PV Kit is composed of PV Modules + Inverter + Mounting System + Cabling System + Protection System*

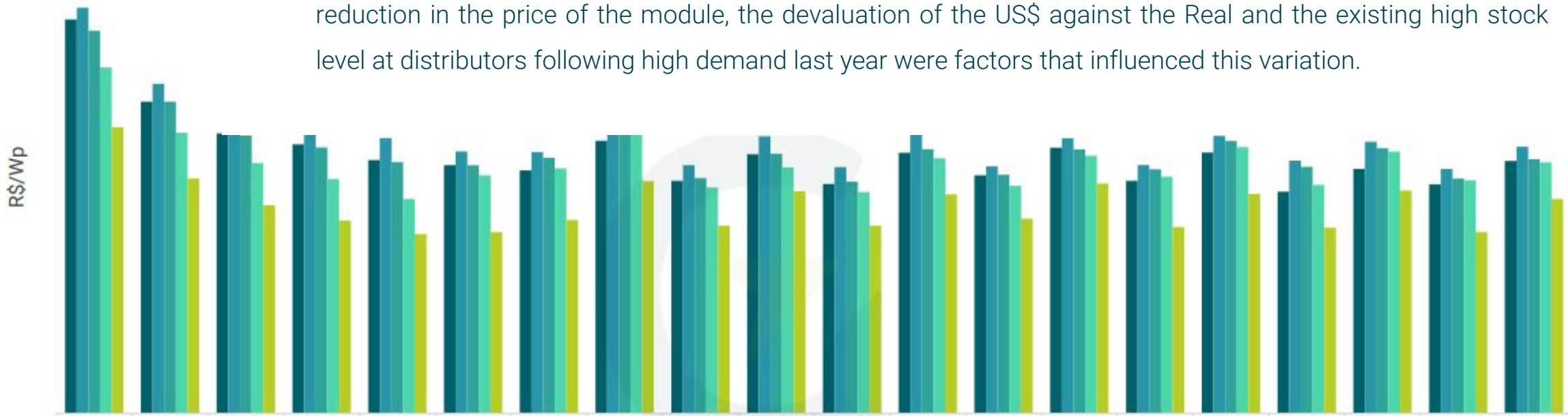


The ratio in the figure is purely illustrative and is not proportional.

Source: Greener, 2023.

PRICES OF PV SYSTEMS

- On average, **PV system prices for end customers fell by 17%** in June 2023 compared to January 2023. The reduction in the price of the module, the devaluation of the US$ against the Real and the existing high stock level at distributors following high demand last year were factors that influenced this variation.



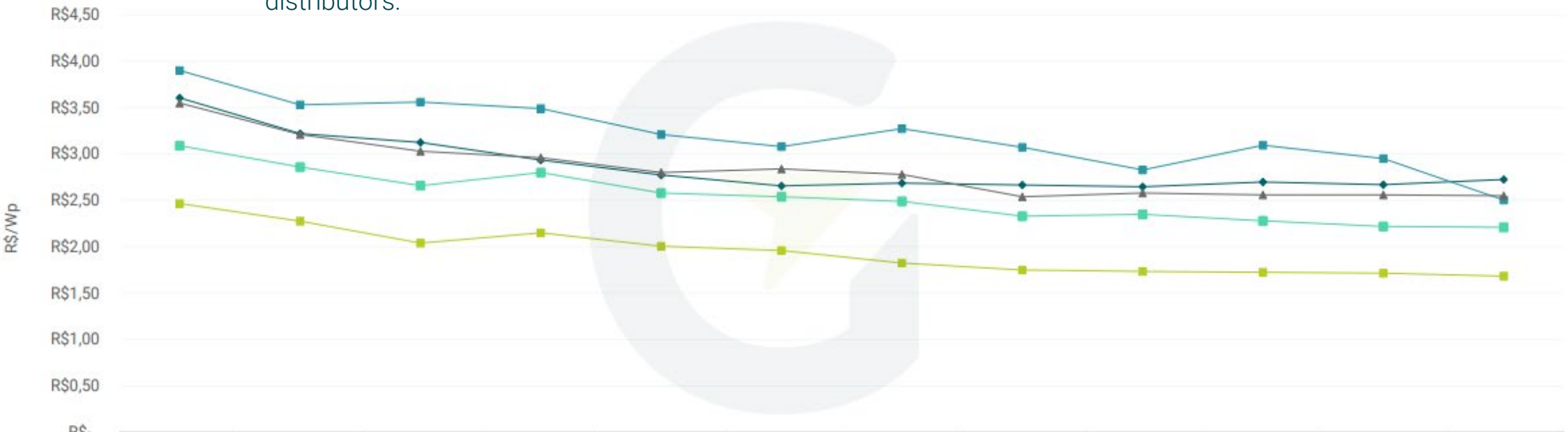
	2kWp	4kWp	8kWp	12kWp	30kWp	50kWp	75kWp	75kWp Solo	150kWp	150kWp Solo	300kWp	300kWp Solo	500kWp	500kWp Solo	1MWp	1MWp solo	3MWp	3MWp solo	5MWp	5MWp solo
jun/21	6,17	4,88	4,38	4,21	3,97	3,89	3,81	4,27	3,64	4,06	3,59	4,08	3,73	4,16	3,64	4,09	3,47	3,83	3,59	3,95
jan/22	6,35	5,16	4,66	4,52	4,31	4,10	4,09	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
jan/23	5,42	4,39	3,92	3,67	3,36	3,73	3,84	4,38	3,54	3,85	3,47	4,00	3,56	4,04	3,71	4,17	3,58	4,10	3,65	3,93
jun/23	4,48	3,68	3,26	3,02	2,81	2,84	3,03	3,64	2,94	3,48	2,94	3,43	3,05	3,60	2,92	3,44	2,91	3,49	2,84	3,36

Residential | Small-Scale Commercial | Large-Scale

Source: Greener, 2023.

PRICES OF PV KITS

- **Average PV kit prices in June 2023 fell by 23% compared to January** 2023. In addition to the reduction in kit costs, the fall in retail prices was enhanced by low market demand and the high volume of stock held by distributors.



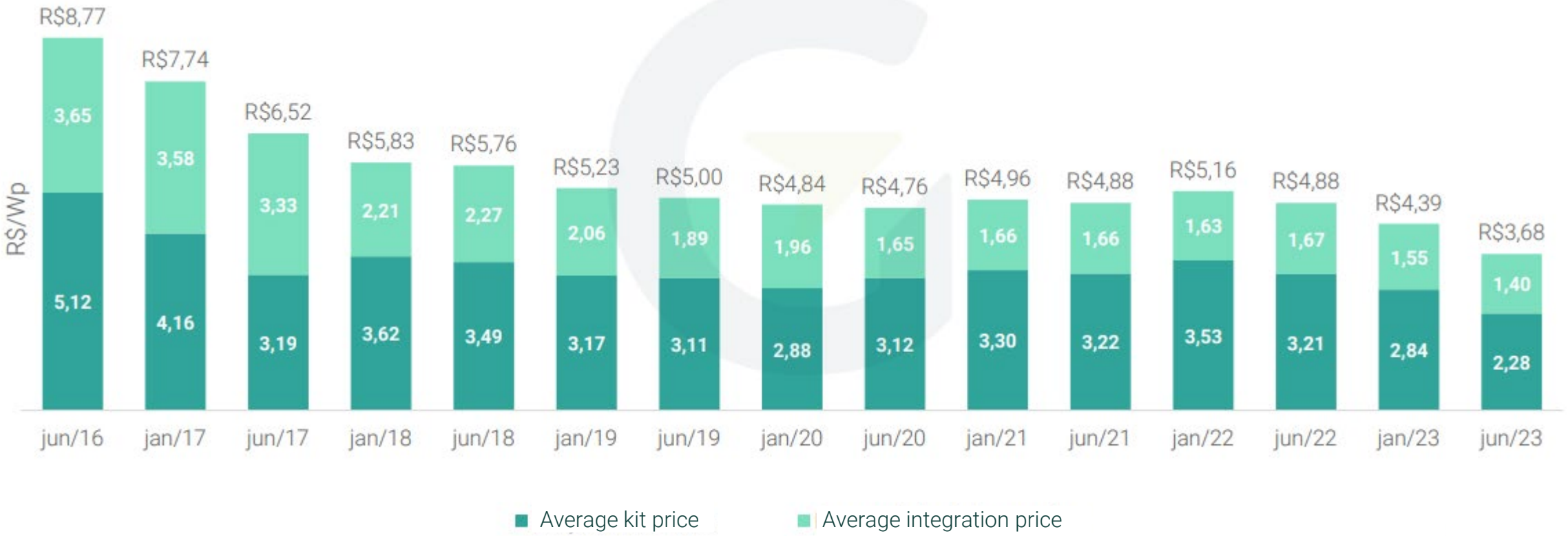
	2kWp	4kWp	8kWp	12kWp	30kWp	50kWp	75kWp	150kWp	300kWp	500kWp	1MWp	5MWp
jun/21	R$3,60	R$3,22	R$3,12	R$2,94	R$2,77	R$2,66	R$2,69	R$2,67	R$2,65	R$2,70	R$2,67	R$2,73
jan/22	R$3,90	R$3,53	R$3,56	R$3,49	R$3,21	R$3,08	R$3,27	R$3,07	R$2,83	R$3,09	R$2,95	R$2,50
jun/22	R$3,55	R$3,21	R$3,03	R$2,96	R$2,80	R$2,84	R$2,78	R$2,54	R$2,58	R$2,56	R$2,56	R$2,55
jan/23	R$3,09	R$2,86	R$2,66	R$2,80	R$2,58	R$2,54	R$2,49	R$2,33	R$2,35	R$2,28	R$2,22	R$2,21
jun/23	R$2,47	R$2,28	R$2,04	R$2,15	R$2,01	R$1,96	R$1,82	R$1,75	R$1,74	R$1,73	R$1,72	R$1,68

Source: Greener, 2023.

PRICE EVOLUTION OF PV SYSTEMS

Residential PV system (4 kWp) in Reais

- The **average price of a typical residential PV system** in June 2023 **fell by 16% compared to January** of the same year **and by 25% compared to June 2022**.



Source: Greener, 2023.

AVERAGE PAYBACK PERIOD PER STATE

General Assumptions

- Two perspectives were analyzed: **Scenario 1 showing the difference in payback times between DG I and DG II in January** 2023, showing the impact of only the regulatory change after January 7, 2023 and; **Scenario 2**, providing a comparative analysis between the **payback times of DG II in January and June 2023**, also taking into account the change over time in the energy price and equipment price variables.
- The payback period is calculated for typical 4 kWp, 50 kWp and 300 kWp sizes, which are representative for each category of system sizes, with **the following assumptions**:

4 kWp (Low Voltage)

PV system prices in Jan/2023 of R$4.39/Wp and **in Jun/2023 of R$3.68/Wp.** The calculation takes into account the local solar productivity, the local distributor's energy price (including Availability Cost*), a **PR of 75% and simultaneity factor of 30%**.

*Triple Phase Consumer Unit

50 kWp (Low Voltage)

PV system prices in Jan/2023 of R$3.73/Wp and **in Jun/2023 of R$2.84/Wp.** The calculation takes into account the local solar productivity, the local distributor's energy price (including Availability Cost*), a **PR of 75% and simultaneity factor of 70%**.

*Triple Phase Consumer Unit

300 kWp* (Medium Voltage)

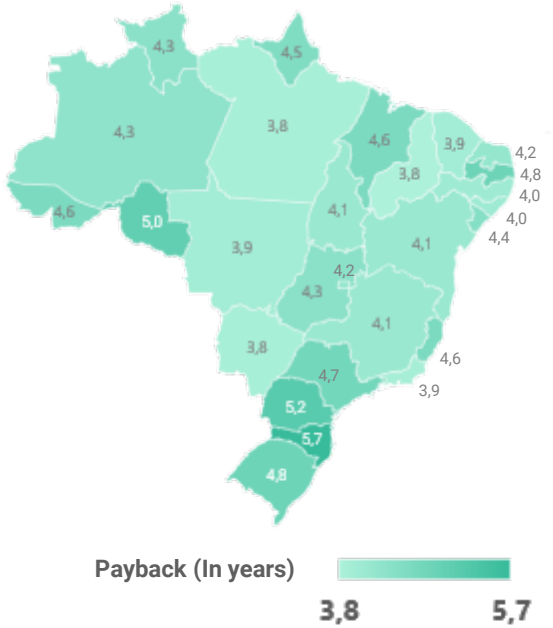
PV system prices in Jan/2023 of R$3.47/Wp and **in Jun/2023 of R$2.94/Wp** The calculation takes into account the local solar productivity, the local distributor's energy price , a **PR of 75% and a simultaneity factor of 50%**.

*Solar Capacity lower than the contracted demand. No TUSDg charges.

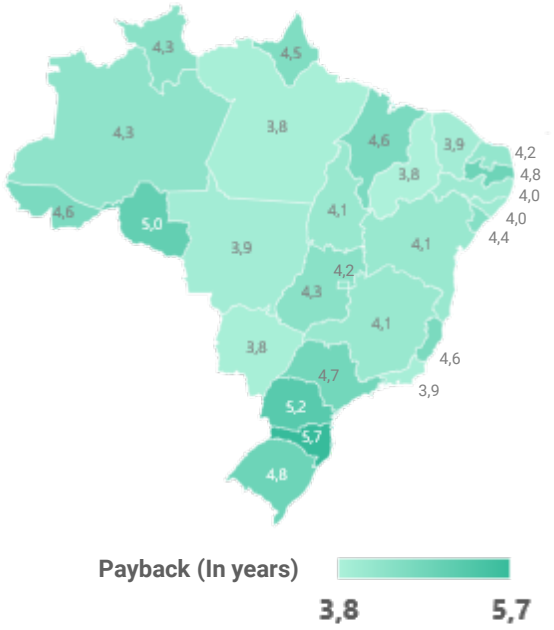
AVERAGE PAYBACK PERIOD PER STATE

Residential (4 kWp) – Low Voltage

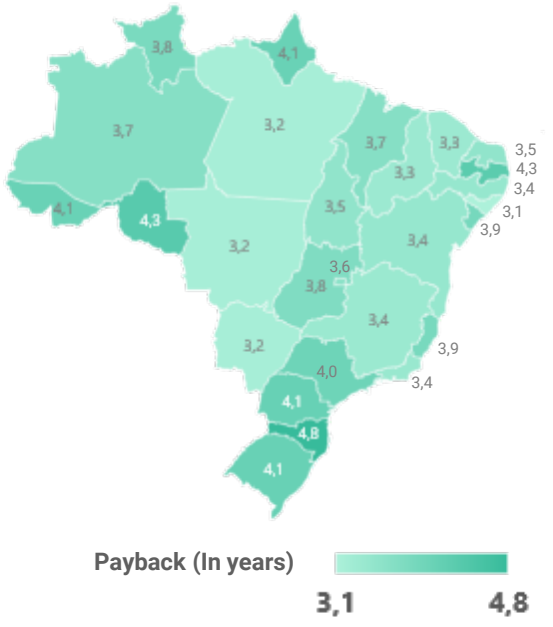
DG I in January 2023*



DG II in January 2023



DG II in June 2023



- The **payback period remained stable** under the assumptions of **Scenario 1.** On the other hand, for the conditions of **Scenario 2 there was an improvement** in the return on investment, **with a 15% reduction in payback time**, with **the fall in CAPEX** being the main factor behind this improvement, comparing June (DG II) and January 2023 (DG I).

**Different values from the DG Report published in February 2023 due to the clarification of the Availability Cost in REN 1059/2023 published in the same period, which was not taken into account in the previous version..*

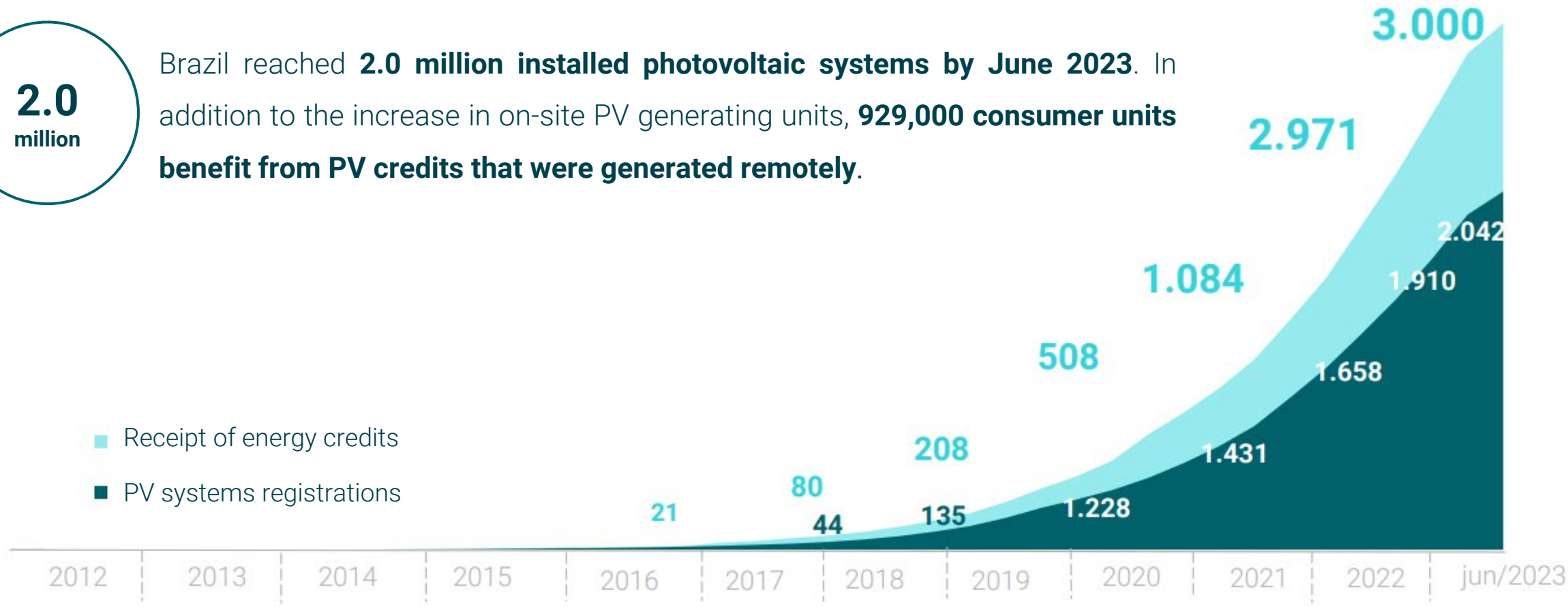
06.
CONSUMERS

EVOLUTION OF DISTRIBUTED GENERATION

Consumer PV system registrations and receipt of energy credits (in thousands)

2.0
million

Brazil reached **2.0 million installed photovoltaic systems by June 2023**. In addition to the increase in on-site PV generating units, **929,000 consumer units benefit from PV credits that were generated remotely**.



*UCs: conumer units

Source: ANEEL, 2023; Greener, 2023.

EVOLUTION OF DISTRIBUTED GENERATION

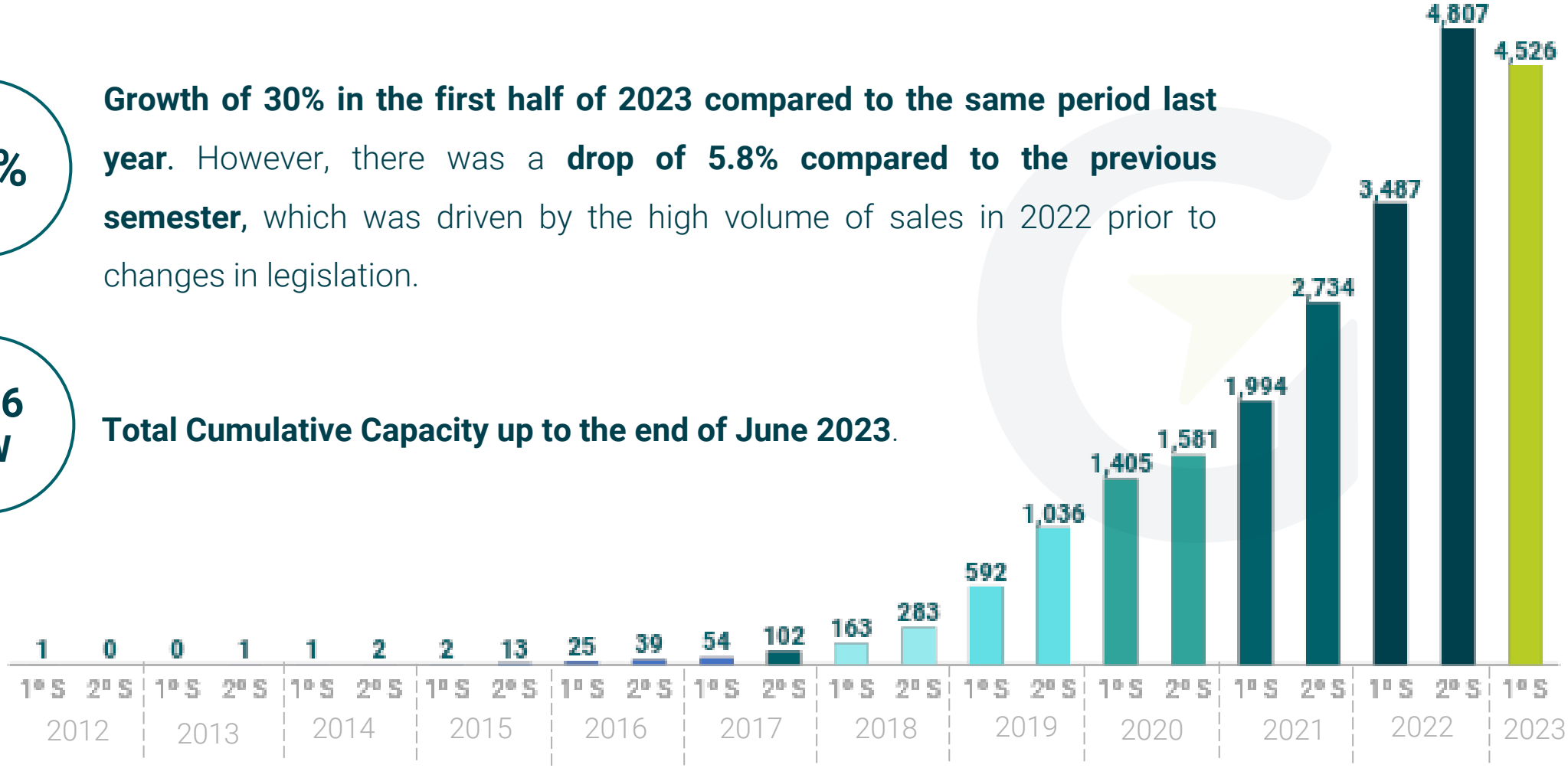
Additional Capacity [MW] installed at customers per semester

30%

Growth of 30% in the first half of 2023 compared to the same period last year. However, there was a **drop of 5.8% compared to the previous semester,** which was driven by the high volume of sales in 2022 prior to changes in legislation.

22.6 GW

Total Cumulative Capacity up to the end of June 2023.

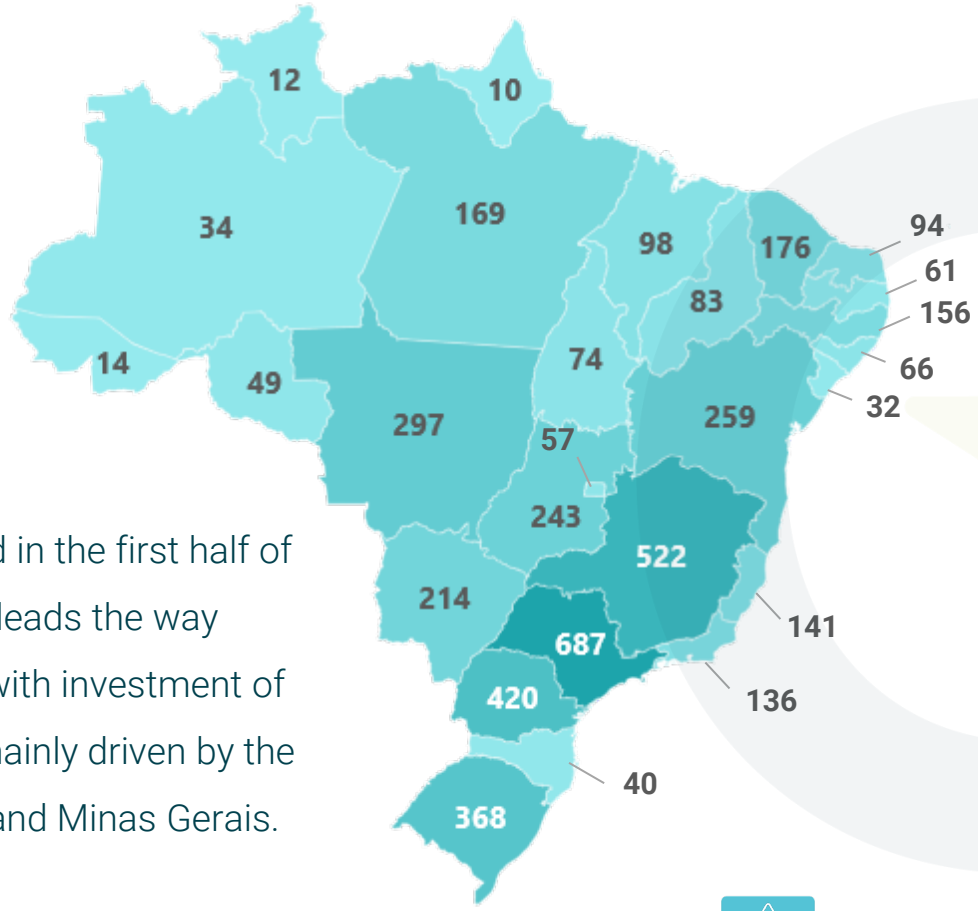


Source: ANEEL, 2023; Greener, 2023.

DG PER STATE IN 2023

Additional Capacity (MW) and estimated investment per State

Additional capacity in 2023 (MW)



- With 1.5 GW installed in the first half of 2023, the Southeast leads the way among the regions, with investment of around R$5 billion, mainly driven by the states of São Paulo and Minas Gerais.

TOP 10 States in 2023

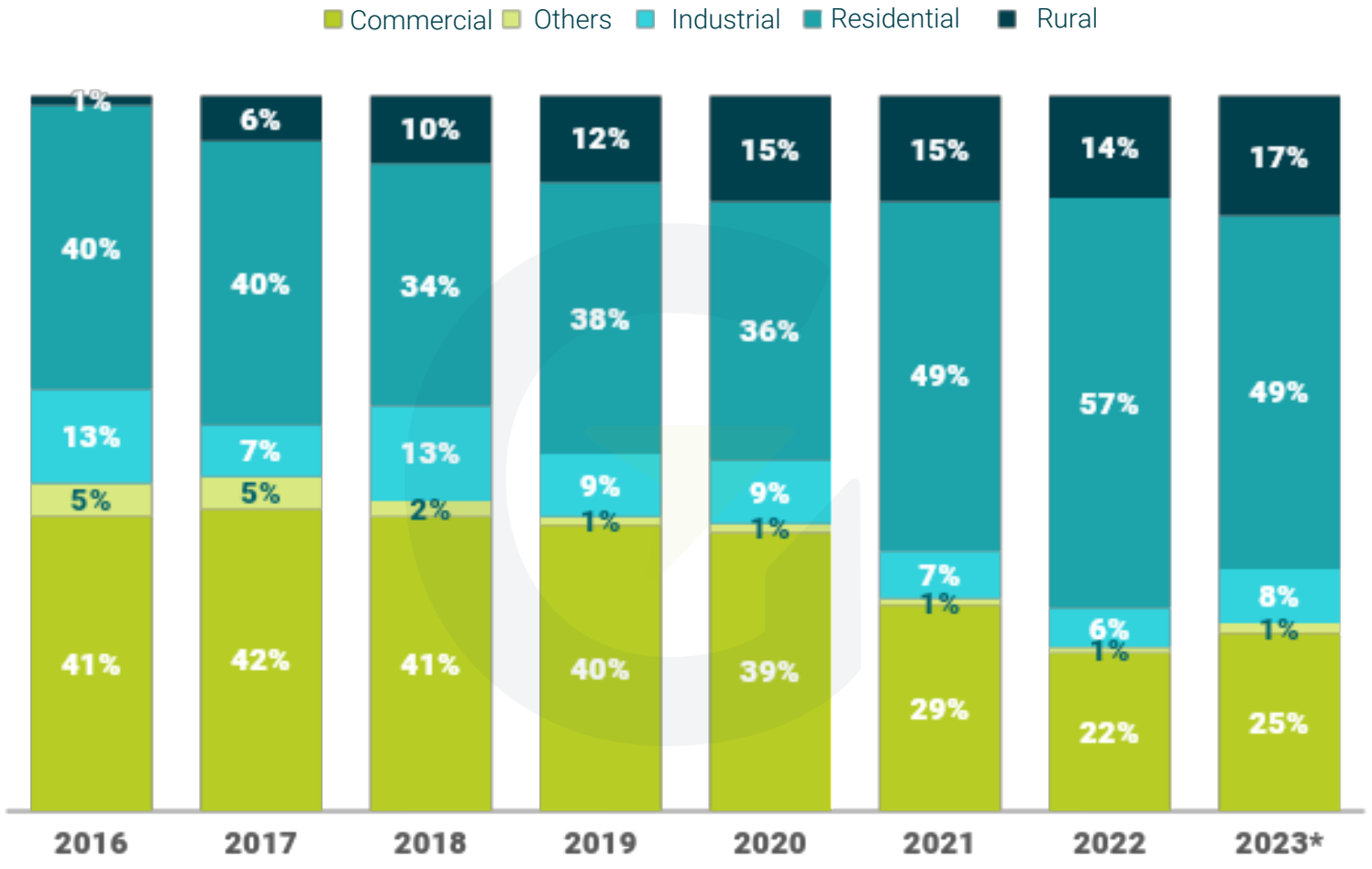
State	Additional Capacity (MW)	Estimated Investment (R$ Billions)
SP	687	2.3
MG	522	1.7
PR	420	1.4
RS	368	1.2
MT	297	0.9
BA	259	0.9
GO	243	0.8
MS	214	0.7
CE	176	0.6
PA	169	0.6

Source: EPE, 2023 (Adapted); ANEEL, 2023 (Adapted); Greener, 2023.

*Data collected up to end of June 2023

CONSUMER PROFILE UNDER DG

Share (%) of additional capacity per consumer type



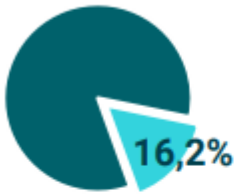
- **The Residential customer type saw an 8% decrease in its share of installed PV capacity,** while Rural and Commercial customers saw a share increase of 3% each in the first half of 2023 compared to 2022.
- The resumption of economic activity and the return to face-to-face work following the Covid pandemic contributed to this scenario.

Source: ANEEL, 2023; Greener, 2023.

*Data collected up to end of June 2023

EVOLUTION OF MINI DG

Evolution of installed capacity (MW) of mini DG solar plants (> 75 kW)



Minigeneration represented 16.2% of added PV capacity in 2023 and **contributed 578 MW in new generating capacity** to the grid.

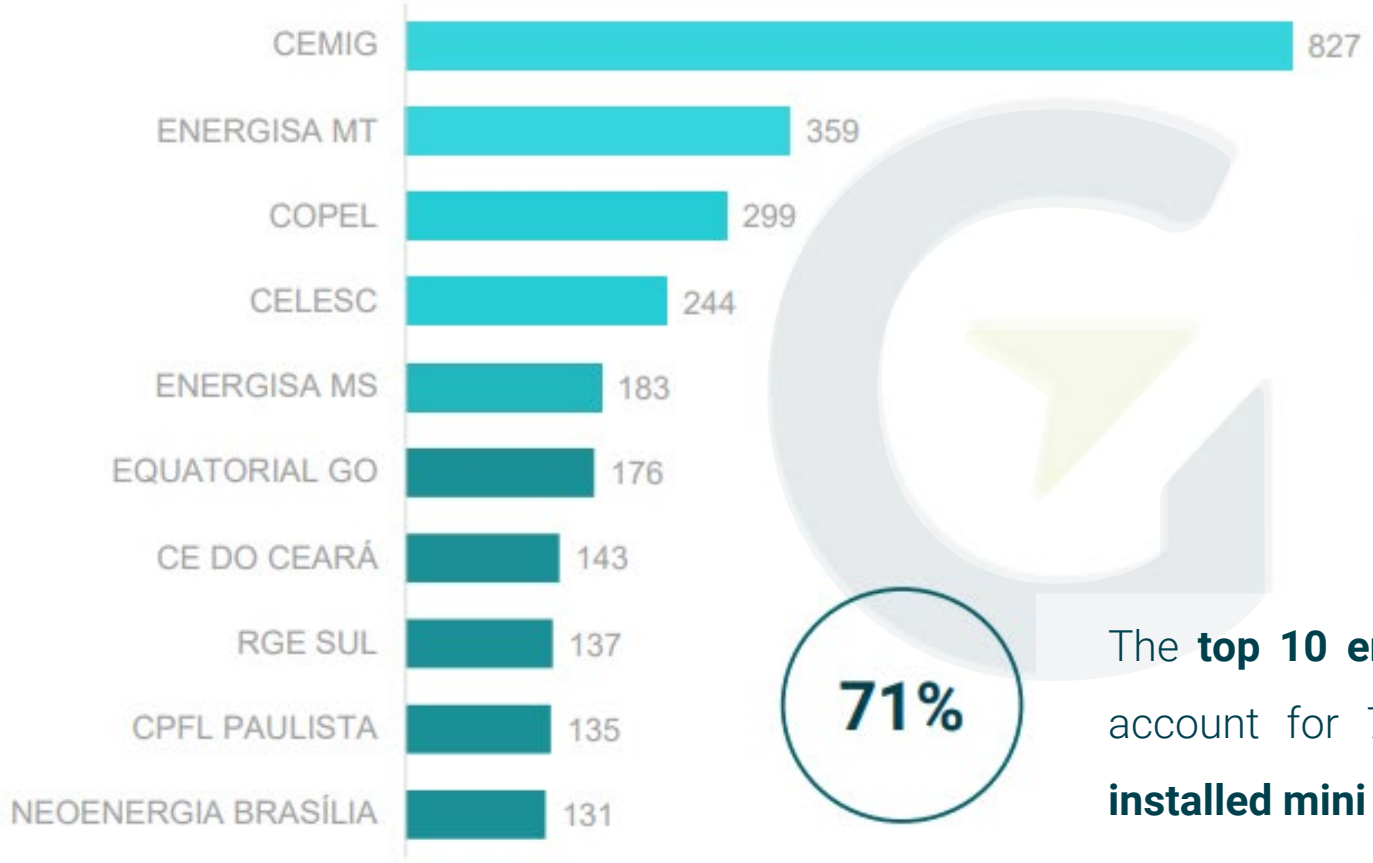
Source: ANEEL, 2023; Greener, 2023.

*Data collected up to end of June 2023

MINI DG PER STATE IN 2023

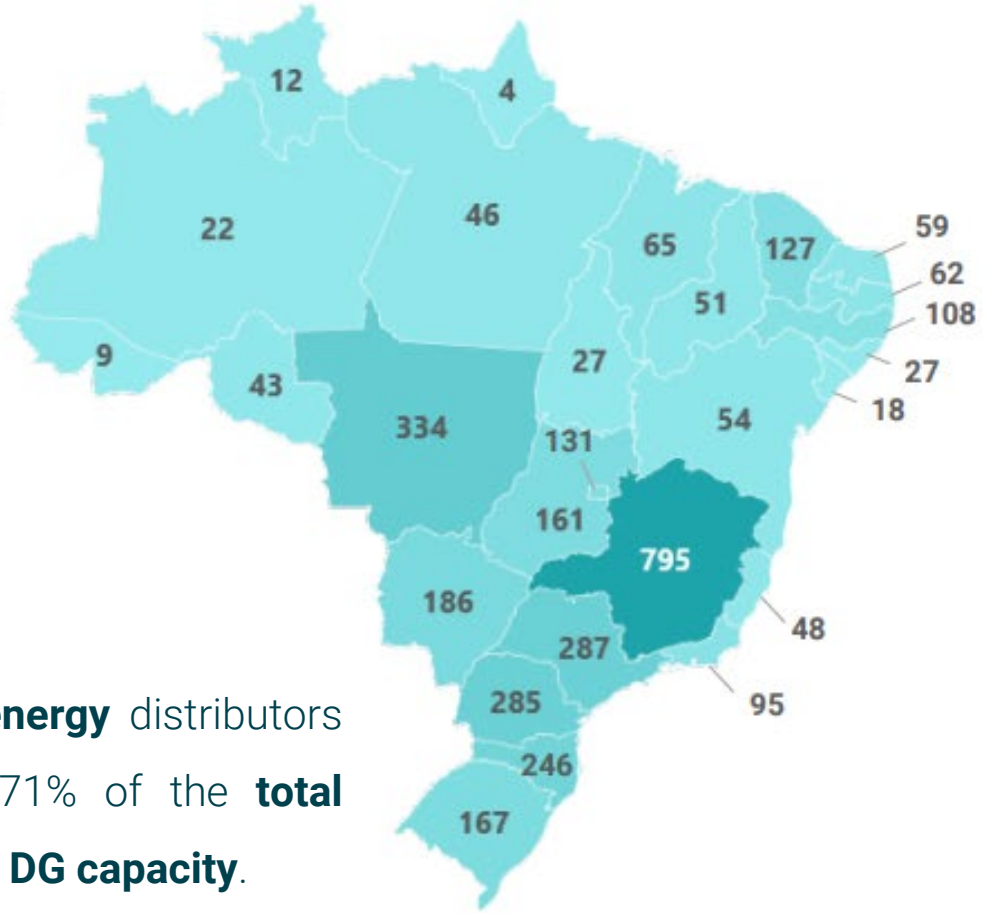
Cumulative Capacity (kW)

10 Most Accessed Distributors (kW)



71%

Cumulative Mini DG Capacity per State (in kW)



The **top 10 energy** distributors account for 71% of the **total installed mini DG capacity**.

Source: EPE, 2023 (Adapted); ANEEL, 2023 (Adapted); Greener, 2023.

*Data collected up to end of June 2023

07.
DISPOSAL

PROCESSES FOR DEACTIVATION AND DISPOSAL

General Context

DISPOSAL

- **The process of disposing of one or more materials / pieces of equipment from a solar photovoltaic plant**, which can be directed to a variety of destinations, from landfill disposal, to **appropriate disassembly/disposal by specialized companies**, or even conscious sustainable disposal through recycling companies. In some cases, the latter allows for the retrofitting of the inputs that make up the modules, for example;

- It **doesn't only happen after a plant has been shut down**. Equipment can be **damaged** and become unsuitable for use during the **natural flow of the value chain,** be it during transportation, assembly or maintenance of the plant.

DEACTIVATION

- **Deactivation usually takes place after the end of the useful life of a solar photovoltaic plant.** It basically consists of the **process of removing a photovoltaic system and its entire structure,** as well as remediating the land with the possible stabilization and replanting of the site. This procedure includes the **disposal of materials on a large scale;**

- Because the plants have recently started operating, IRENA (International Renewable Energy Agency) estimates that **over the next three decades, around 550,000 tons of modules will be discarded in Brazil.**

OVERVIEW – WORLDWIDE AND IN BRAZIL

WORLD

- **Only the European Union has a regulation in this regard,** called the **"Waste Electrical and Electronic Equipment (WEEE) Regulations";**
- **European countries also have their individual waste regulations,** such as Germany's Electrical and Electronic Equipment Act (ElectroG), which requires the collection and recycling of electrical and electronic equipment;
- **The photovoltaic industry has created the PV CYCLE initiative,** a voluntary program to recycle photovoltaic modules and other types of electrical and electronic waste.

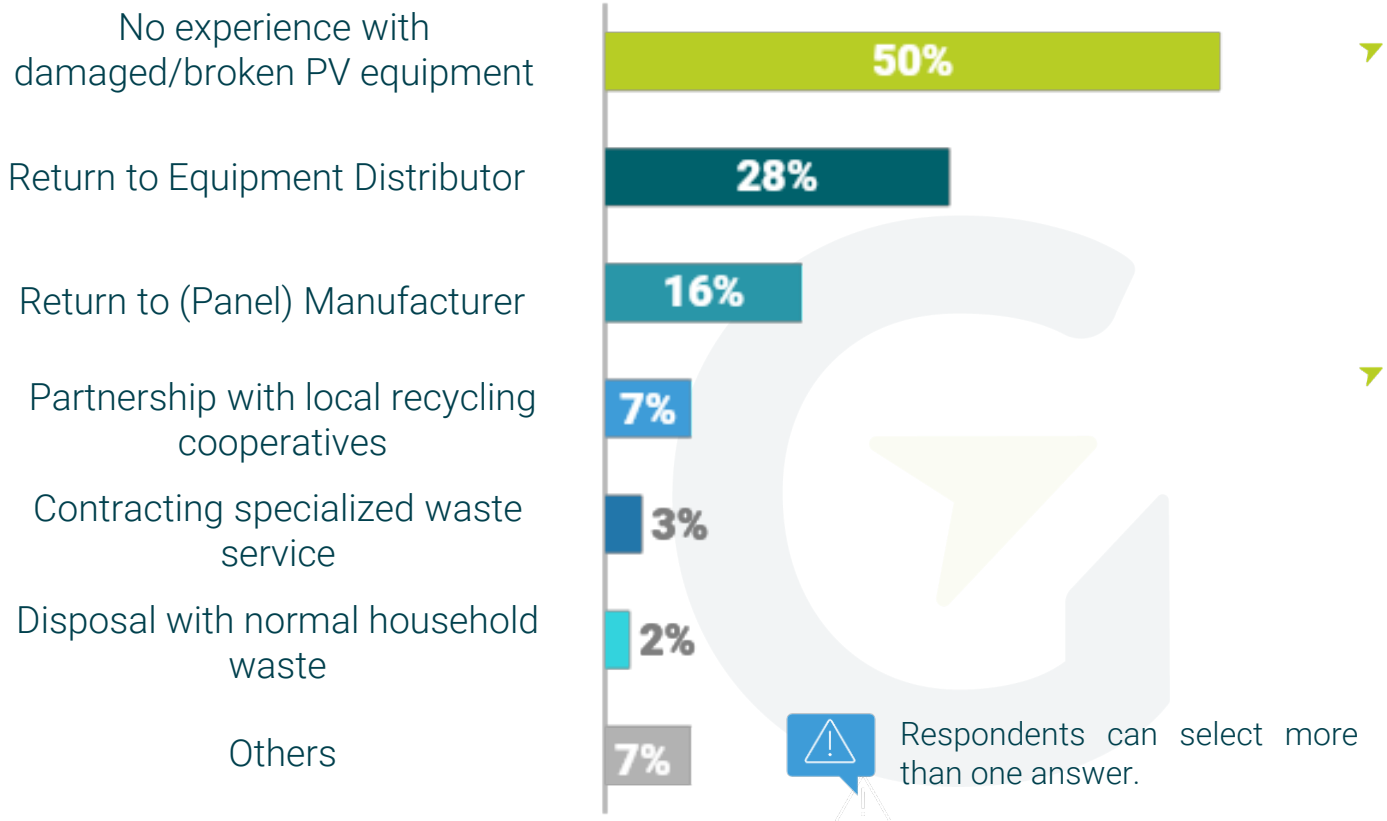
BRAZIL

- Although Brazil does not have legislation for the end-of-life treatment of solar photovoltaic plant components, **Law 12.305/2010 established the National Solid Waste Policy (PNRS**). It requires the public and private sectors to manage solid waste in order to prevent these materials from being disposed of incorrectly in landfill sites, and **provides incentives for reverse logistics and recycling**;
- **Talks are currently underway** between regulators and the market to discuss the **regulation of reverse logistics for solar panels** and energy storage systems, which is **expected to be enacted in 2024**. In addition, Bill Amendment **3.784/2023 was presented**, with the aim of **including item "VII - PV Solar Panels" in Law 12.305/2010**.

END OF USEFUL LIFE CYCLE

% in relation to **PV integrators' experience**

- The integrators were asked about **the disposal procedures adopted when PV equipment is damaged or broken,** as per 1H/2023.



- Among those **PV integrators who reported having no experience** with broken/damaged equipment (50% of total), **68% had started their activities in the solar market at least 5 years ago.**

- **"Other" procedures included: send to municipal recycling, in-house storage, reuse for exhibitions and training, etc.**

Source: Greener, 2023.

Insights & conclusions

1. Brazil demanded **7.8 GW of PV modules in the first half of 2023**, of which 70% for distributed generation and 30% for centralized generation. The total is **down 19%** on the same period in 2022.

2. **PV equipment prices fell by an average of 23% in the first half of 2023**. The fall in the price of polysilicon, driven by the expansion of global production capacity, coupled with the appreciation of the Real against the US Dollar, directly influenced the reduction in the cost of PV modules in 2023.

3. The **price for PV systems for end users fell by 17% on average in the first semester,** from January to June 2023. A decrease in module costs, a devaluation of the US$ and high stock levels at wholesalers were factors that contributed to this drop.

4. Furthermore, although **the start of the transition rule** establishes the gradual payment of the TUSD Line B surcharge, remunerating the grid operators, **PV systems showed an improvement in payback period** compared to January 2023, with the **reduction in CAPEX (PV equipment prices) being the main factor** for this variation.

Insights & conclusions

Thus, from the point of view of return on investment, **PV systems remain attractive to the end consumer for on-site generating** projects, which account for 75% of installed power. For remote generation projects, the law's impact on financial attractiveness is greater.

5. On the other hand, **high interest rates and a higher perception of risk** on the part of financing agents contributed to **credit market restrictions**. Given the scenario of difficulty with accessing credit and doubts about the upcoming regulatory changes, there was **a 60% drop in sales in the first half of 2023** compared to the same period in 2022.

6. In this context, with the significant reduction in total sales, **bank-financed sales are becoming more significant, accounting for 48% of the total**. For a better understanding of the comparison with 2022, see the full explanation in the Financing section in Chapter 4 - Integration.

OUR
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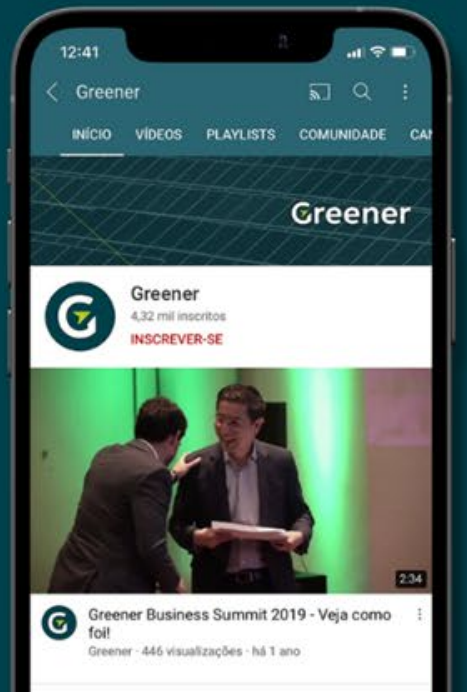

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