STRATEGIC RESEARCH REPORT

1st half-year 2023 (1H2023)

DISTRIBUTED GENERATION

Photovoltaic Solar Energy Market

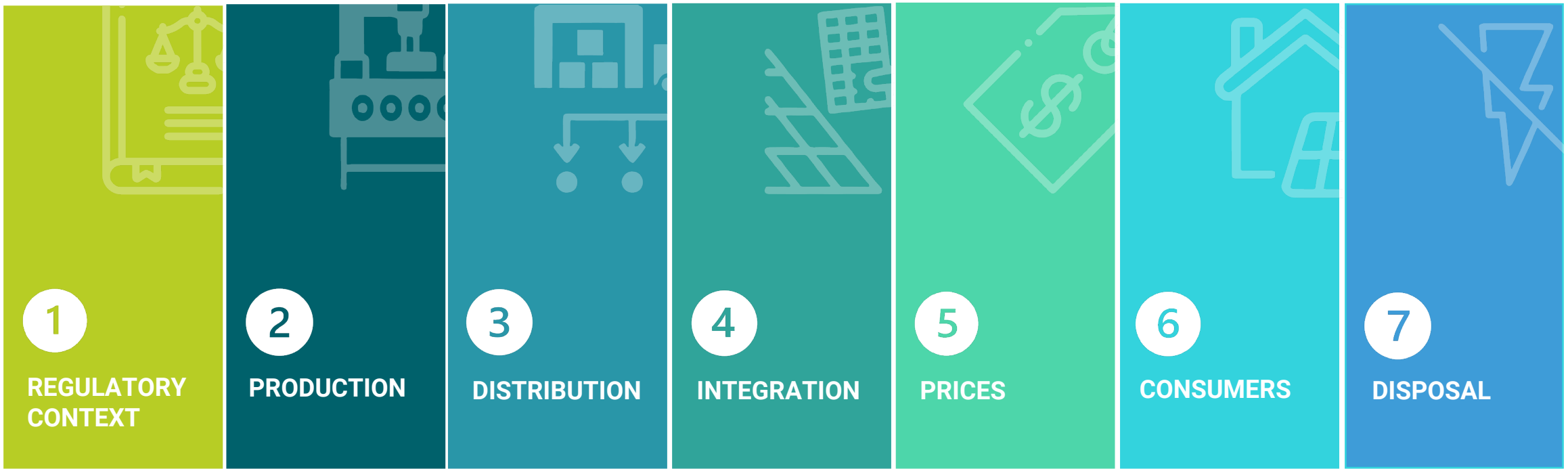
September 2023

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.

THE REPORT

Topics



01.
REGULATORY CONTEXT

CONTEXT

- **Normative Resolution No. 482 of April 17, 2012 (REN 482/2012)** regulated the Electricity Compensation System **(SCEE)** through Distributed Micro and Mini Generation **(MMGD).**

- **Between 2018 and 2019,** through public consultations involving different segments of the community and the electricity sector, there were several debates on the **proposal presented by Aneel to revise REN 482/2012**.

- As a result, the need to ensure that the MMGD market was **established by federal law** was identified, i.e. by creating a **Legal Framework for MMGD, through Bill No. 5.829/2019.**

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Órgão: Atos do Poder Legislativo

LEI Nº 14.300, DE 6 DE JANEIRO DE 2022

Institui o marco legal da microgeração e minigeração distribuída, o Sistema de Compensação de Energia Elétrica (SCEE) e o Programa de Energia Renovável Social (PERS); altera as Leis nºs 10.848, de 15 de março de 2004, e 9.427, de 26 de dezembro de 1996; e dá outras providências.

- On **August 18, 2021, Bill 5.829/2019 moved forward in the National Congress**, receiving approval from the Chamber of Deputies and then, on December 16, 2021, passing through **the Federal Senate** approval process.

- On January 5, 2022, the President of the Republic sanctioned Bill No. 5,829/2019, which establishes the **Legal Framework for Distributed Microgeneration and Minigeneration through Law No. 14,300/2022**. The law was created on **January 6, 2022** and was published in the Official Gazette (becoming law) on January 7, 2022.

IMPORTANCE OF LEGAL FRAMEWORK FOR BUSINESS

- **Law 14.300/2022 represents a more robust legal and regulatory framework**, bringing not only more legal certainty but also **more stability and predictability to the market**.

Providing more legal certainty and regulatory stability

Preserving legacy investments and giving more predictability to the return on future projects

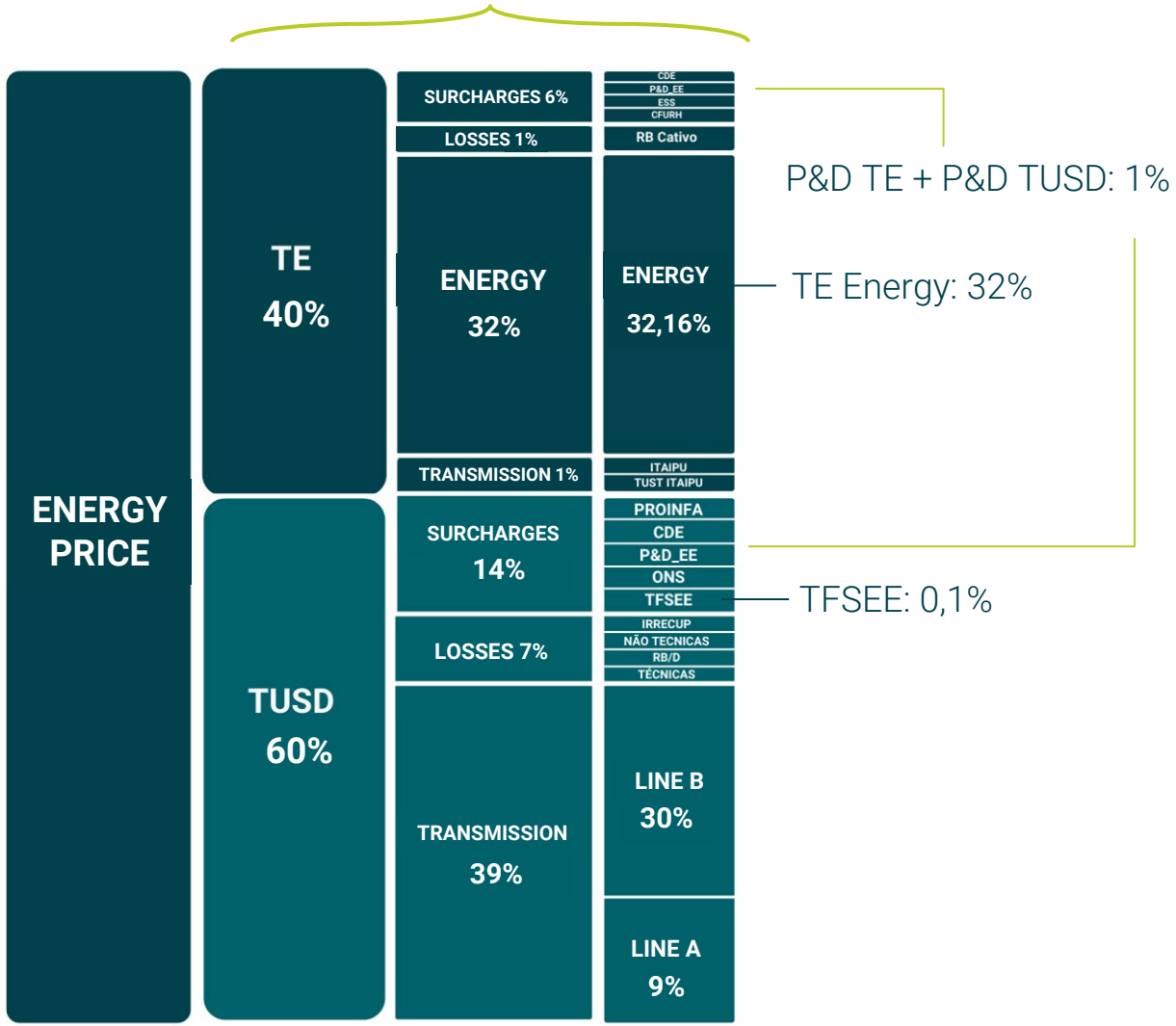
Guarantee consumers' rights to generate their own energy and reduce their electricity bills

Recognize MMGD as a strategic step forward for national energy policy

- For all the links in the MMGD value chain (**manufacturer, equipment distributor, integrator, consumer, financier, investor and others**) it is important to bear in mind that the **attractiveness of the PV market may be affected**. The effects of Law 14.300/2022 must be carefully measured so that your business is **prepared for the changes**.

WEIGHTS OF COMPONENTS MAKING UP THE ELECTRICITY PRICE

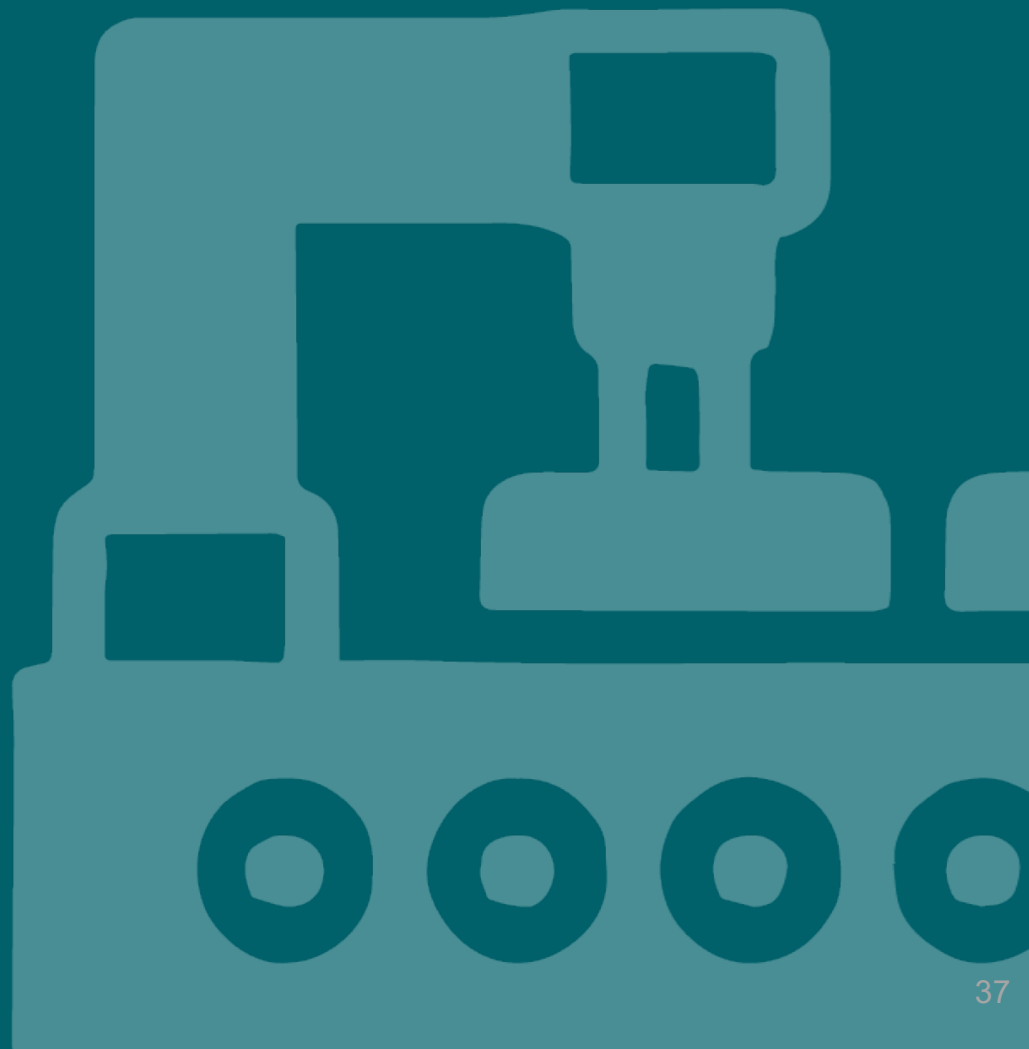
› PRICING COMPONENTS



- The percentages shown in the table represent the average weight of these components in the total energy price, considering the **country's 52 energy distributors** and their respective Group B - Conventional* tariffs.

* Prices updated on 05/09/2023 (ANEEL).

02.
MANUFACTURING



COST STRUCTURE

Solar PV Modules and Inverters

PV Modules

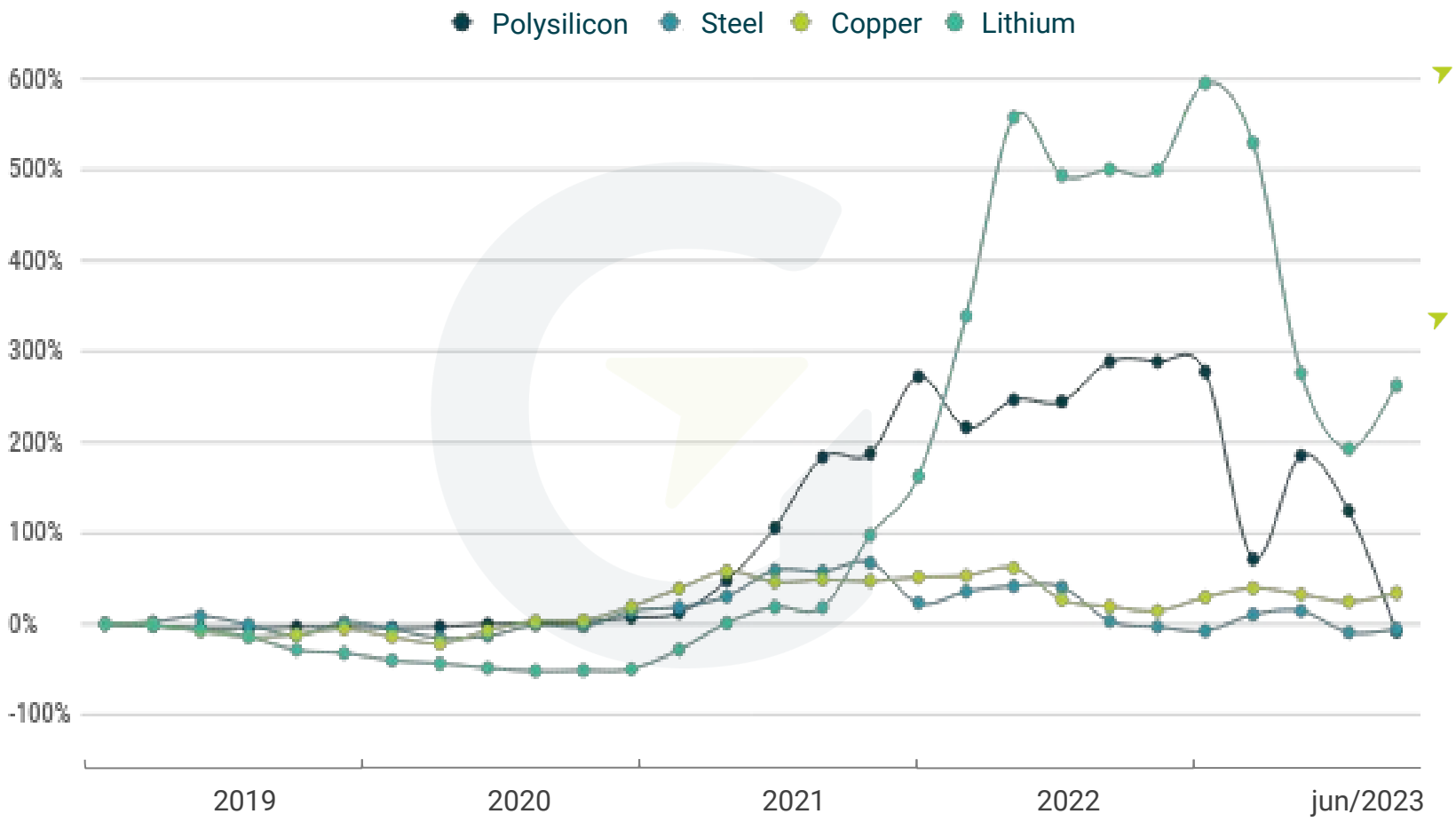
- PV **modules represent around 38% to 50% of the final price of a PV system**, making them an important component to be analyzed for market pricing.
- As the module's **main input is polysilicon, its price variation has a direct impact** on the price of PV modules. Other inputs are polymers, glass, aluminum and copper.

Inverters

- Semiconductors and **electronic components account for the largest share of the cost** of photovoltaic inverters.
- Other components of the inverter's cost structure are: passive components, interconnection, physical structure and thermal management.

VARIATION IN RAW MATERIAL PRICES

Using a US$ Base

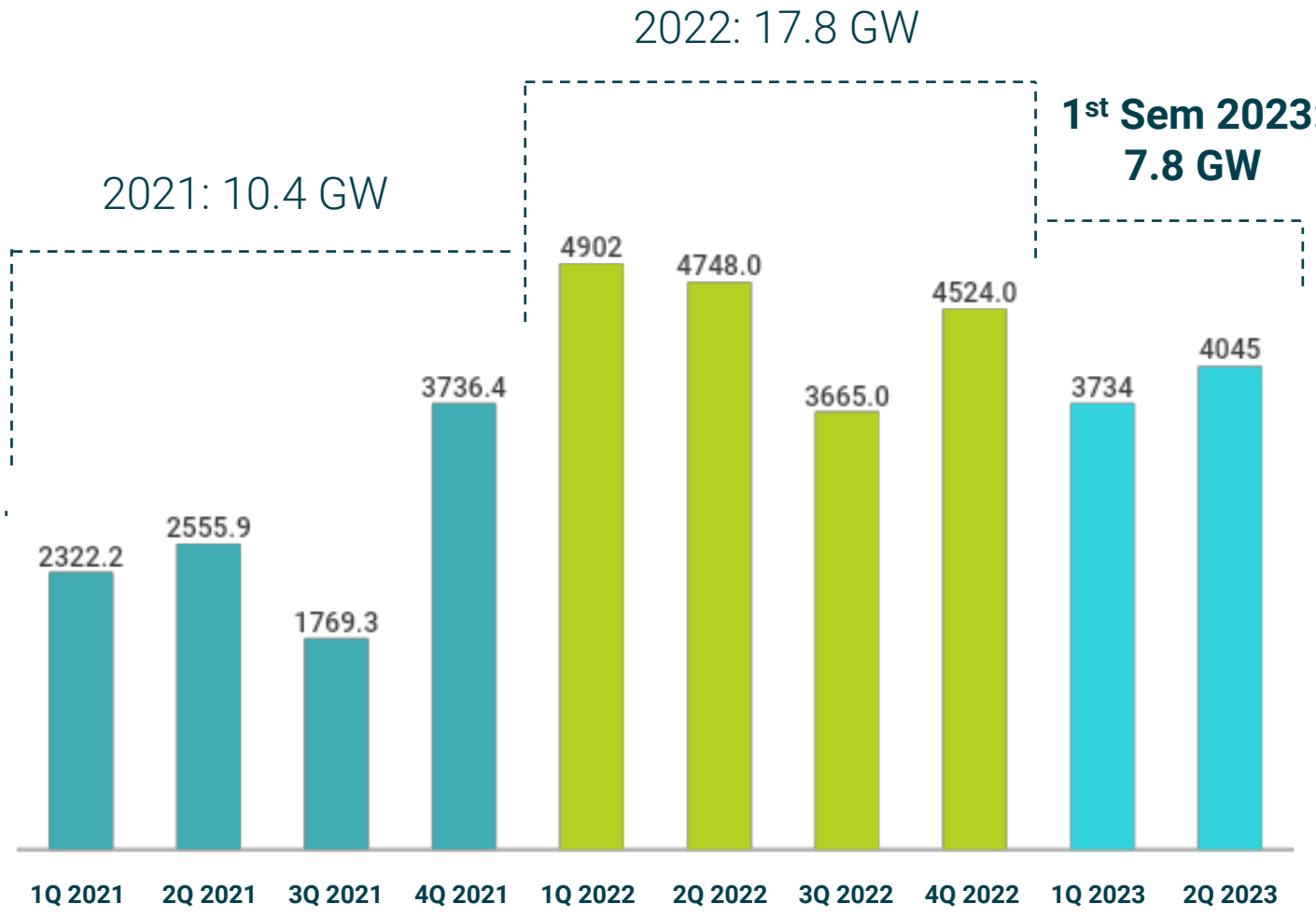


- The graph shows the **variation in the price of each input** over the same period of time.
- From 2019 to June 2023, **Lithium and Polysilicon showed the greatest variations**, increasing by more than 600% and 300% respectively.

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

PV Modules

Imported Volume: Distributed Generation and Centralized Generation



- **A 19% drop in the 1st half of 2023 when compared to the same period last year** and, when compared to the 2nd half of 2022, there was a 5% reduction in the volume of imported modules.
- The amount imported in the 1st half of 2023 **indicates solar investments of over R$25 billion** for DG and large-scale PV solar plants.
- **The 2nd quarter saw growth compared to the 1st**, driven especially by demand for DG and Centralized Generation projects.

03.
DISTRIBUTION

DISTRIBUTORS IN NUMBERS

1st Half of 2023

R$ 4.8 bi

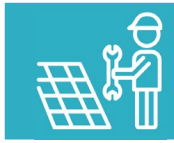
Total revenue* of the distributors interviewed, where **those with 5 years or more of operation accounted for 70%** of this amount.

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)

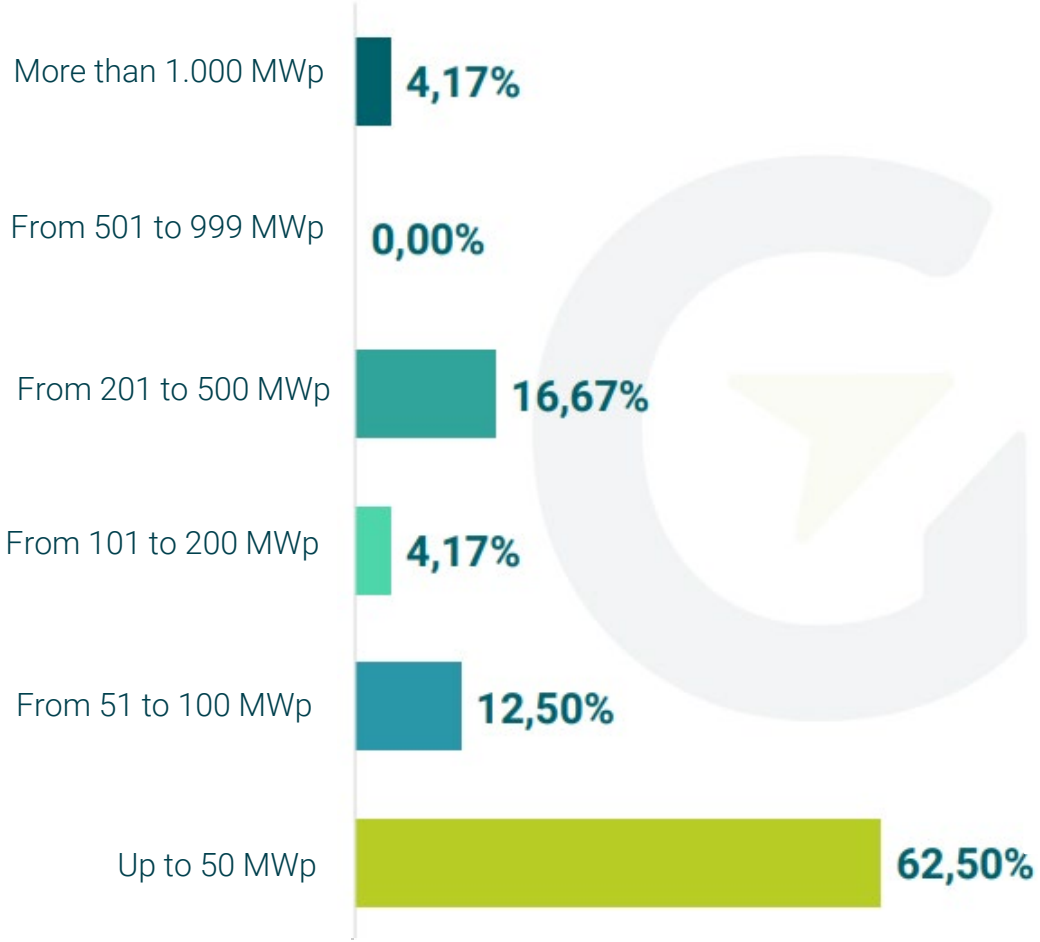
10 working days

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 VOLUME (MWp) FROM PV KITS

% of surveyed distributors of PV equipment



- **4% of distributors sold more than 1,000 MWp** in the first half of 2023, **representing 39% of the total** invoiced.
- As for the relationship between billing and the number of employees, **1.3 GWp were billed by distributors with up to 1,000 registered integrators and 976 MWp by those with more than 5,000 integrators**.

COMPANIES WITH RECURRING RESPONSES IN 2022 E 2023:

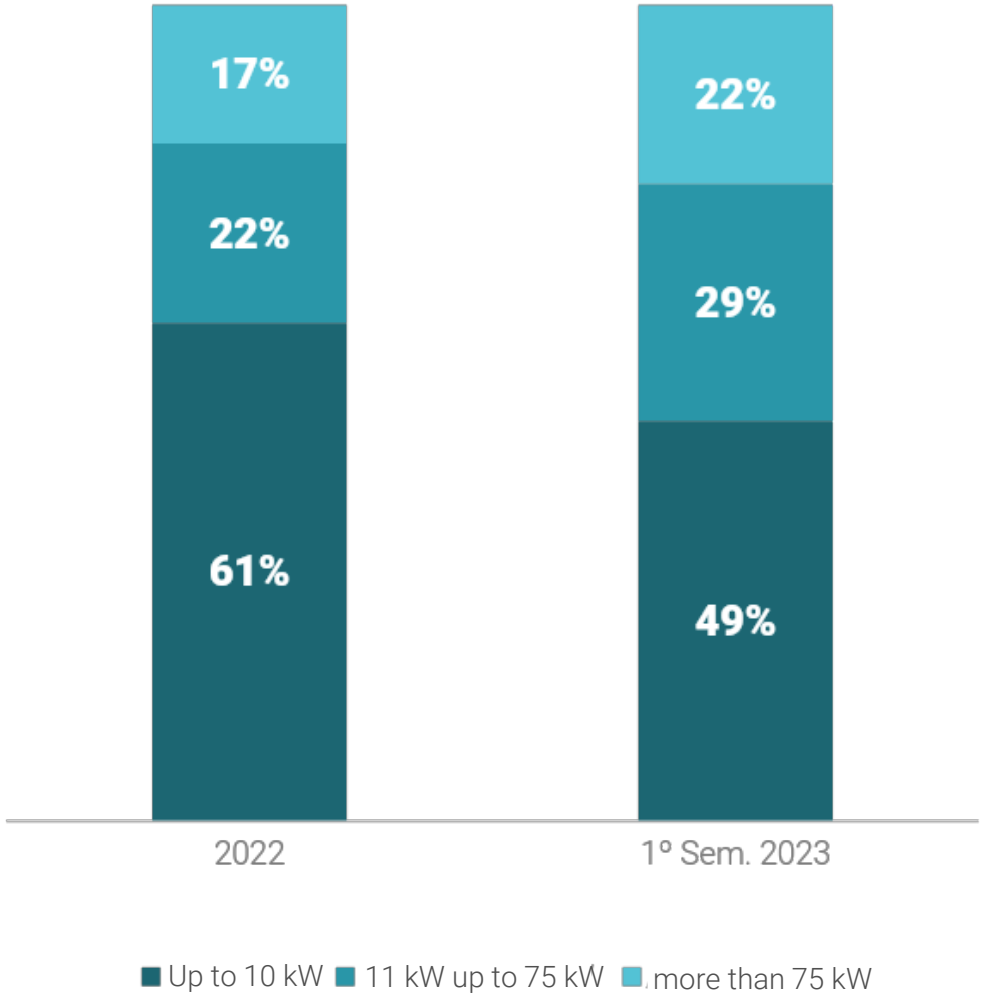
Average **change of -24% in the monthly volume (MWp) of kits invoiced and -38% in the number of kits sold.** A point to bear in mind is that this is billing and not sales, meaning that part of what was billed in the first quarter of 2023 refers to sales at the end of 2022.

***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.*

SIZE OF THE PV KITS

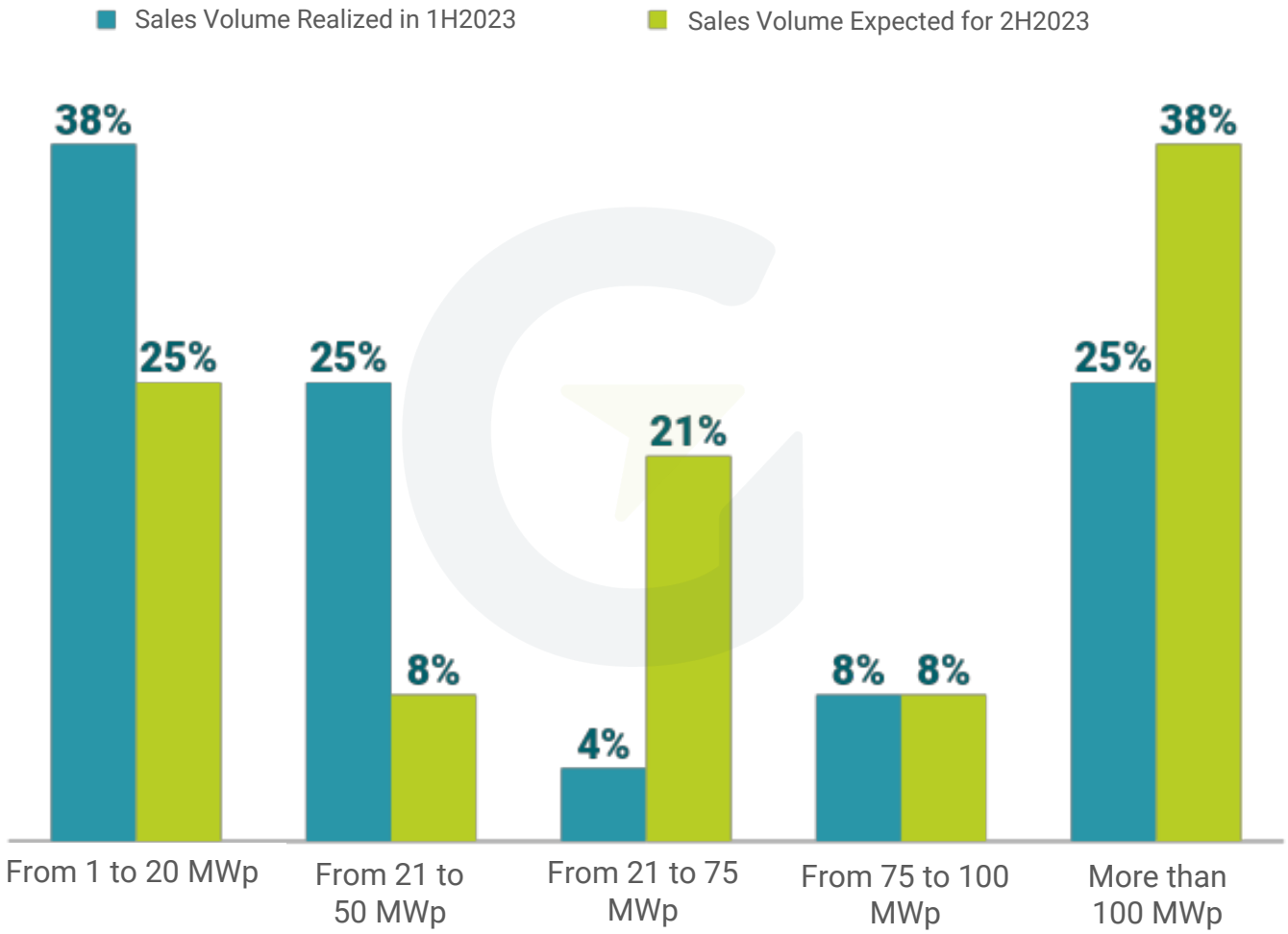
Percentage of kits invoiced

- **Small residential and commercial kits (up to 10kW) accounted for the majority** of kits billed by distributors in the first half of 2023, as they did in 2022.
- On the other hand, comparing the two periods, there was a **12% drop in the market share of the residential segment**, with an increase in the share of larger kits.
- The surveyed **companies that have been in business for more than 5 years sold 62%** of all kits.



SALES SCENARIOS FOR 2023

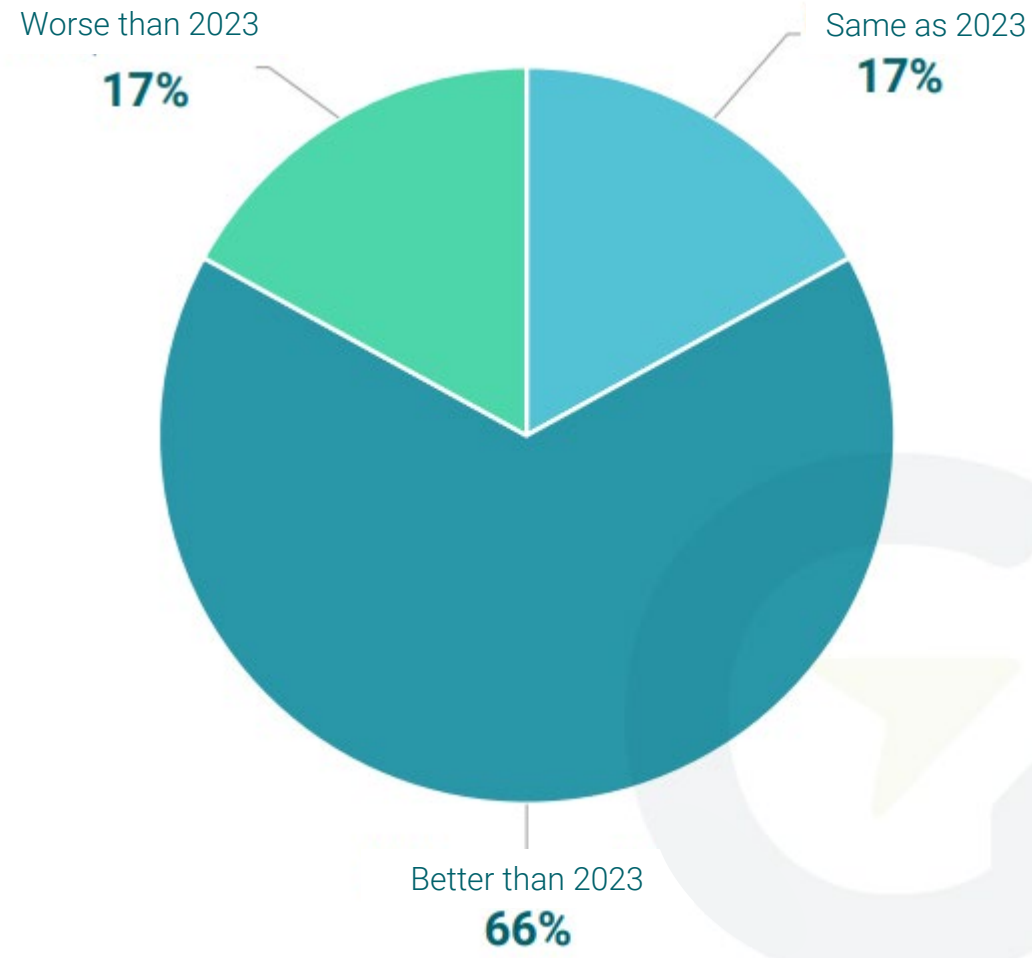
Sales Volume [MWp] vs Expectations for 2H2023 [MWp]



- **38% of distribution companies expect to exceed 100 MWp** in sales in the 2nd half of 2023, indicating **optimism,** given that in the 1st half only 25% of companies exceeded this volume.

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.

04.
INTEGRATION

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.

THE SURVEY

Estimated Number of Active PV Integrator Companies

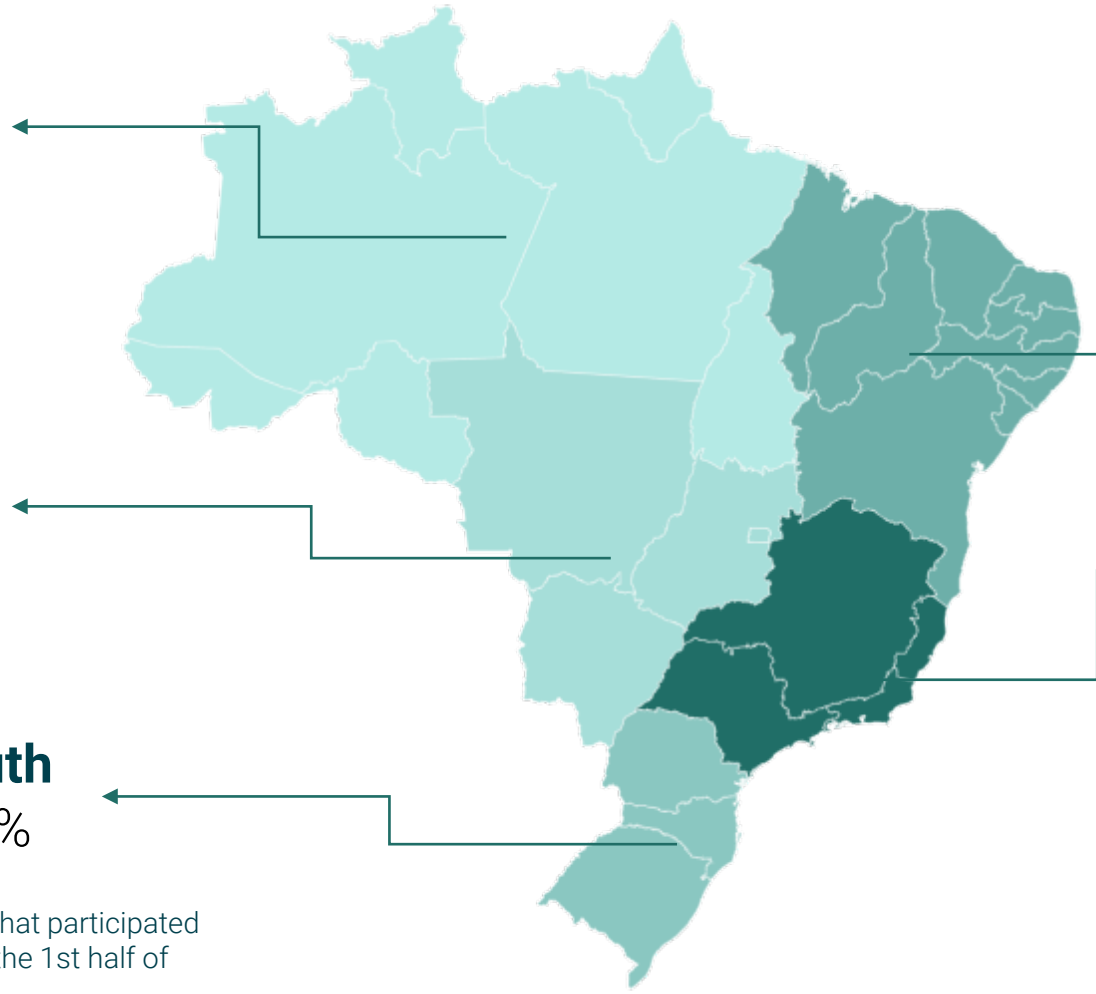
- **The total population of PV Integrator Companies** is estimated based on cross-referencing data with information provided by organizations and companies in the sector.

26,640

Actively trading PV Integrators *

THE INTEGRATORS

Percentage of PV Integrators * per Region



North
6%

Northeast
24%

Center-West
10%

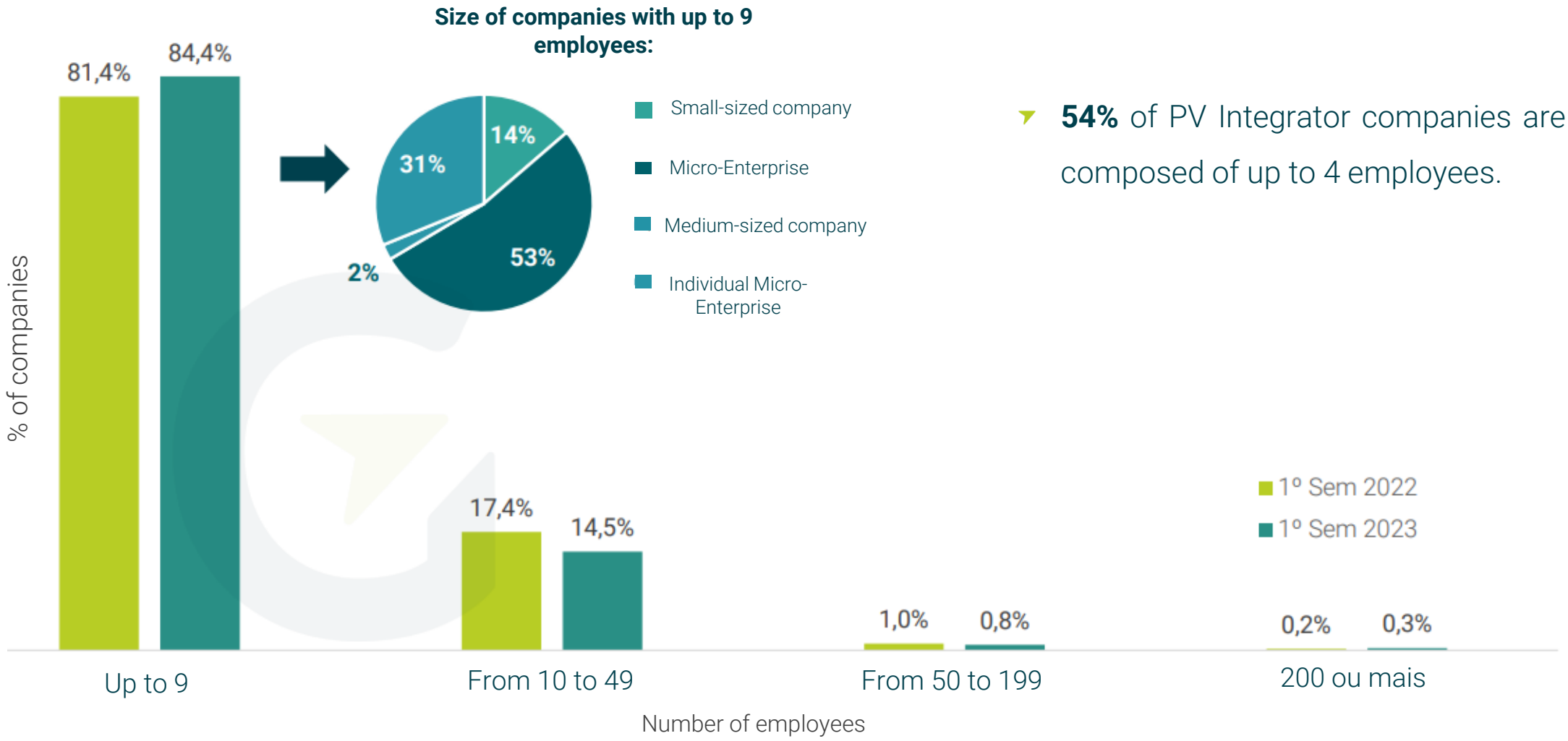
Southeast
43%

South
17%

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

PROFILE OF THE INTEGRATOR COMPANIES

Number of employees

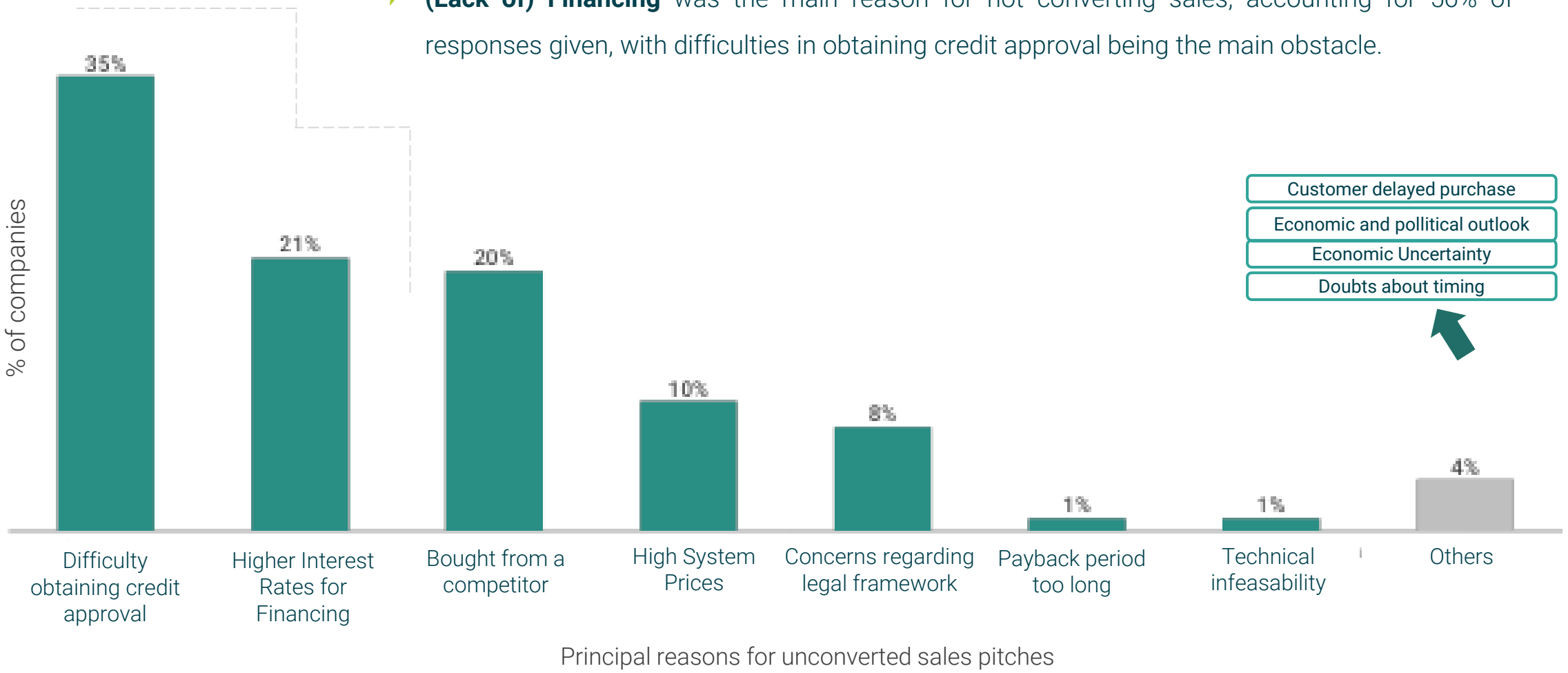


- **54%** of PV Integrator companies are composed of up to 4 employees.

UNCONVERTED SALES

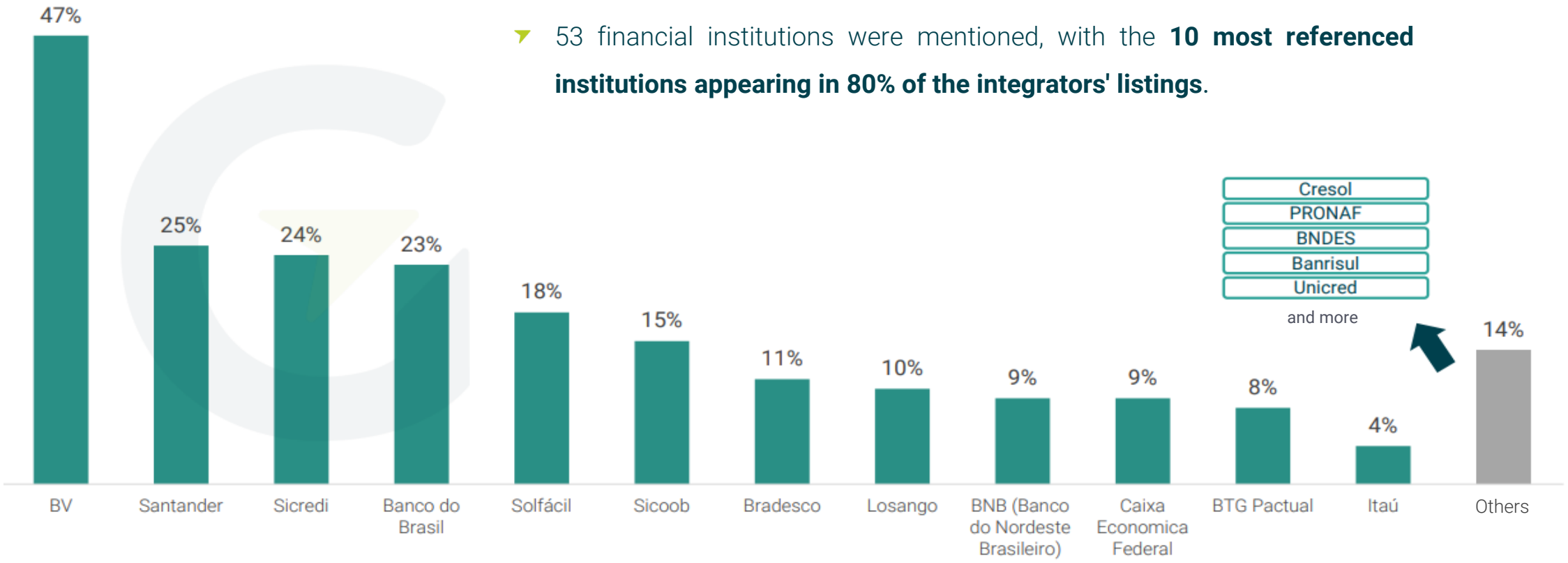
Principal reasons for lost sales

- **(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.



FINANCING OF PV SYSTEMS

Banks/financing lines used for bank-financed PV system sales

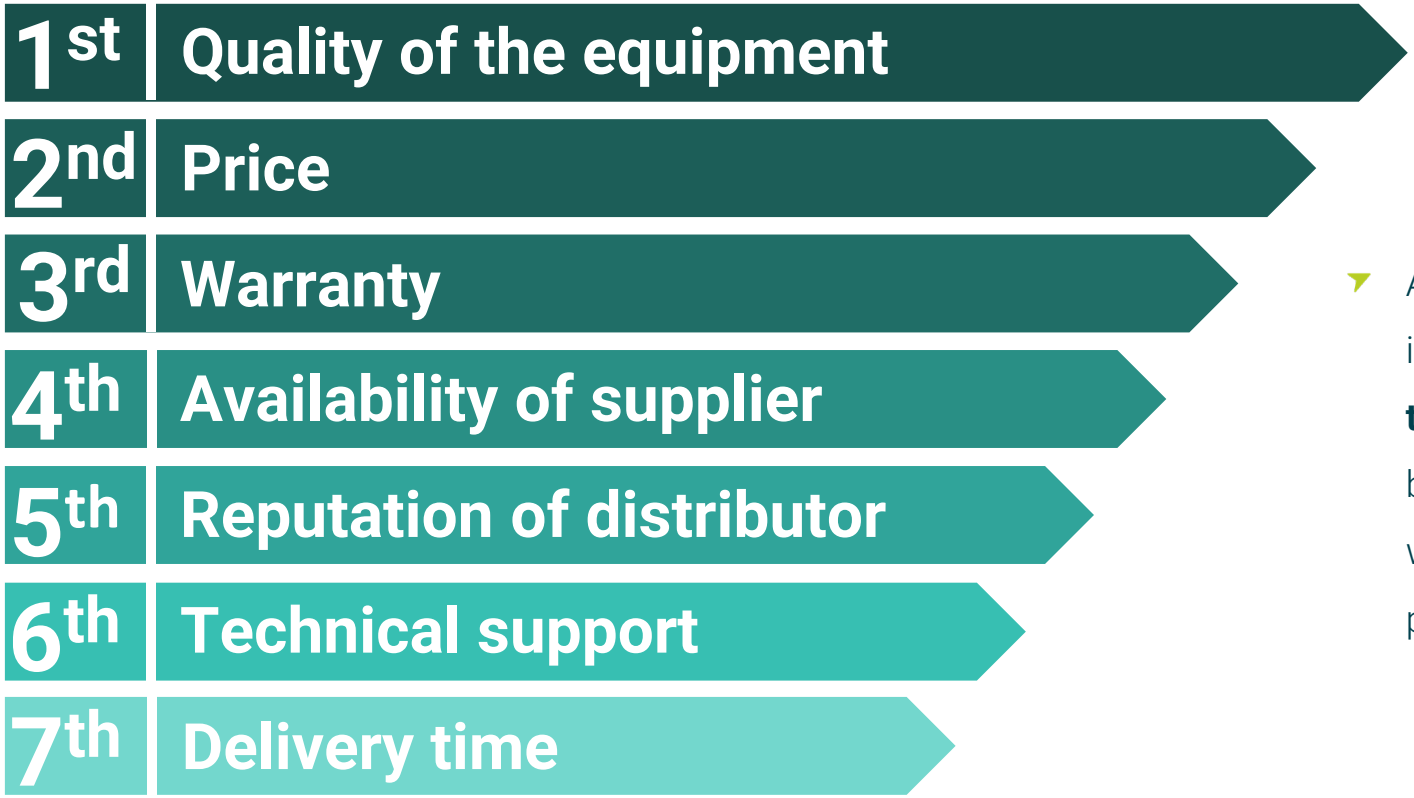


- 53 financial institutions were mentioned, with the **10 most referenced institutions appearing in 80% of the integrators' listings**.

*These figures are related to the distribution of financing agents, 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.

CHOICE OF MODULES AND INVERTERS*

The most important criteria for choosing suppliers according to the surveyed integrators

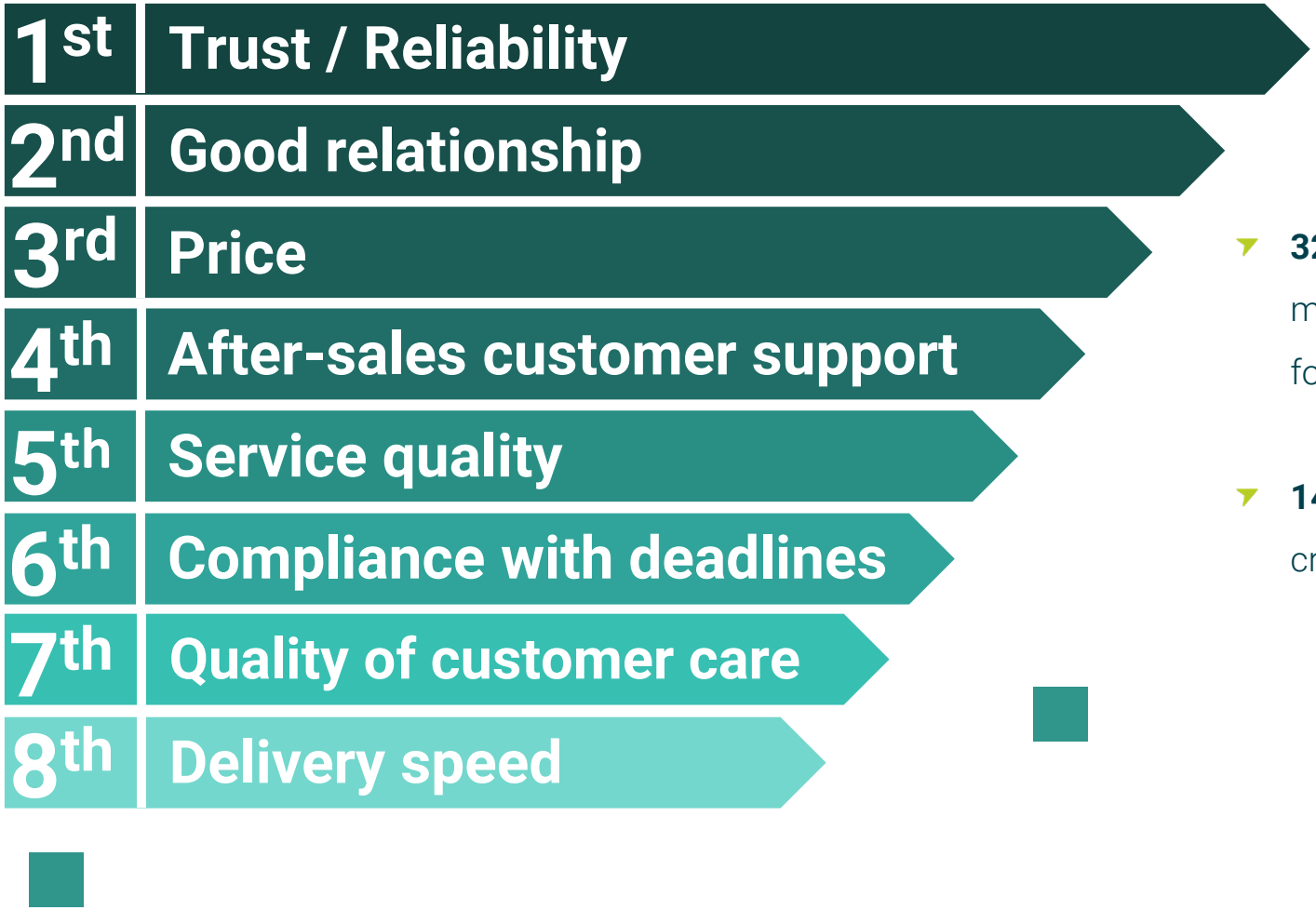


- Although the price of equipment is a very important criterion for integrators, **the quality of the equipment came first** when choosing brands and models for **39% of integrators** – whereas 21% of surveyed companies consider price to be the most important criterion.

*Each integrator ranked the most important criteria for choosing modules and inverters from 1 (most important criterion) to 7 (least important criterion).

CHOICE OF DISTRIBUTOR*

The most important criteria for choosing distributors according to the surveyed integrators

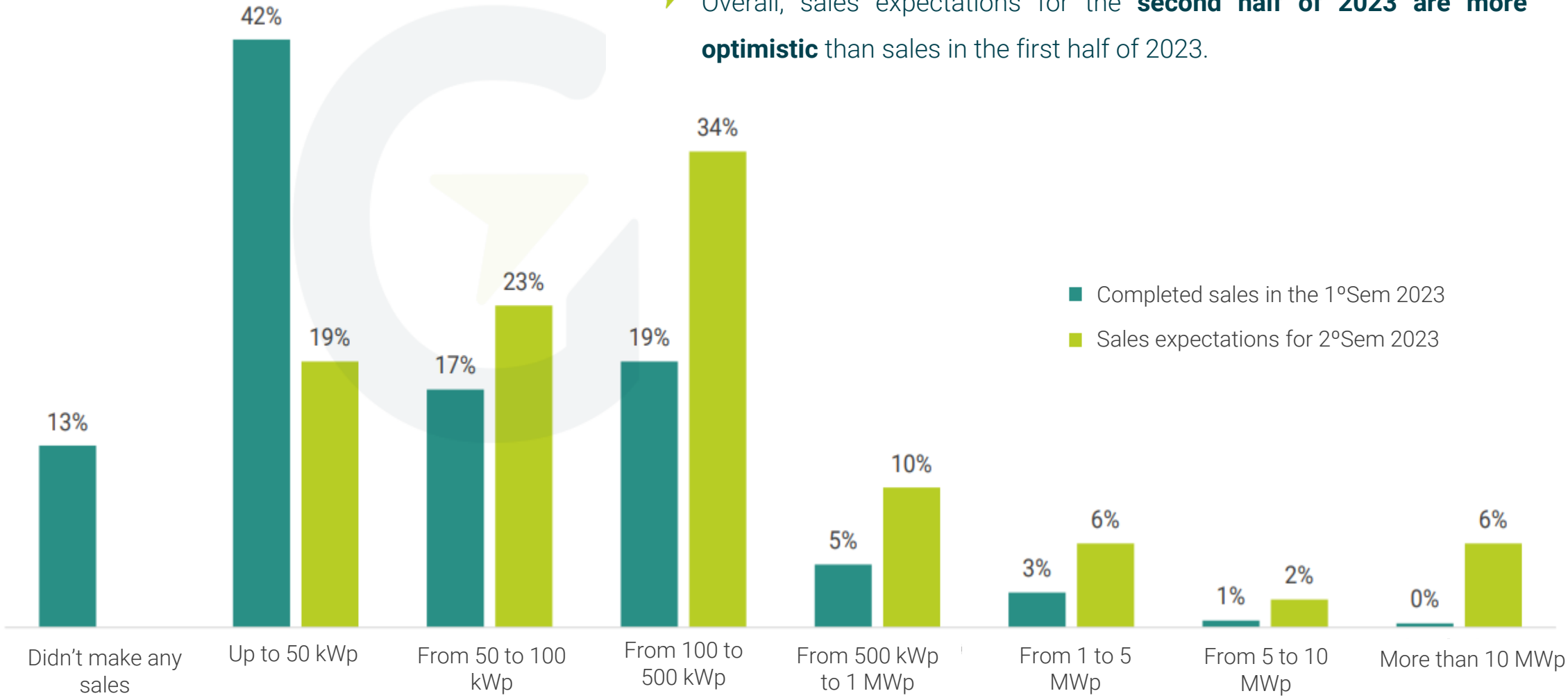


- **32% of integrators consider trust** to be the main criterion when choosing a distributor, followed by **good relationships with 18%.**
- **14% consider price** to be the most important criterion.

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.



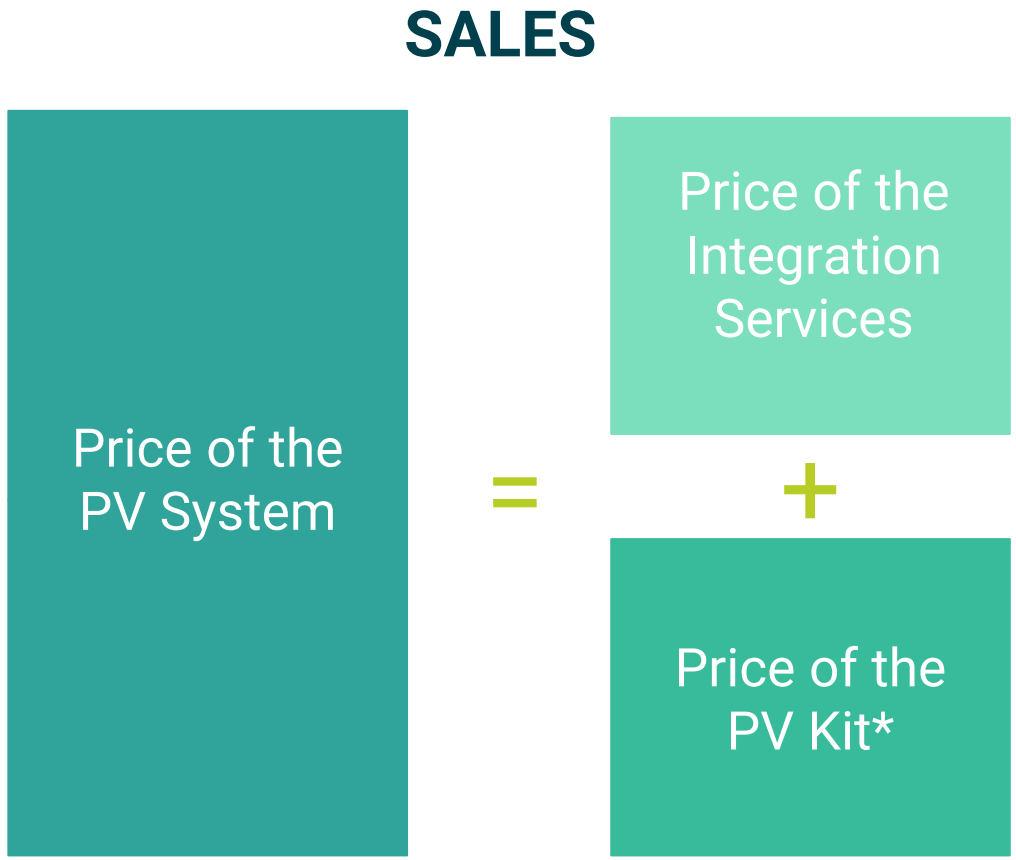
05.
PRICES

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.

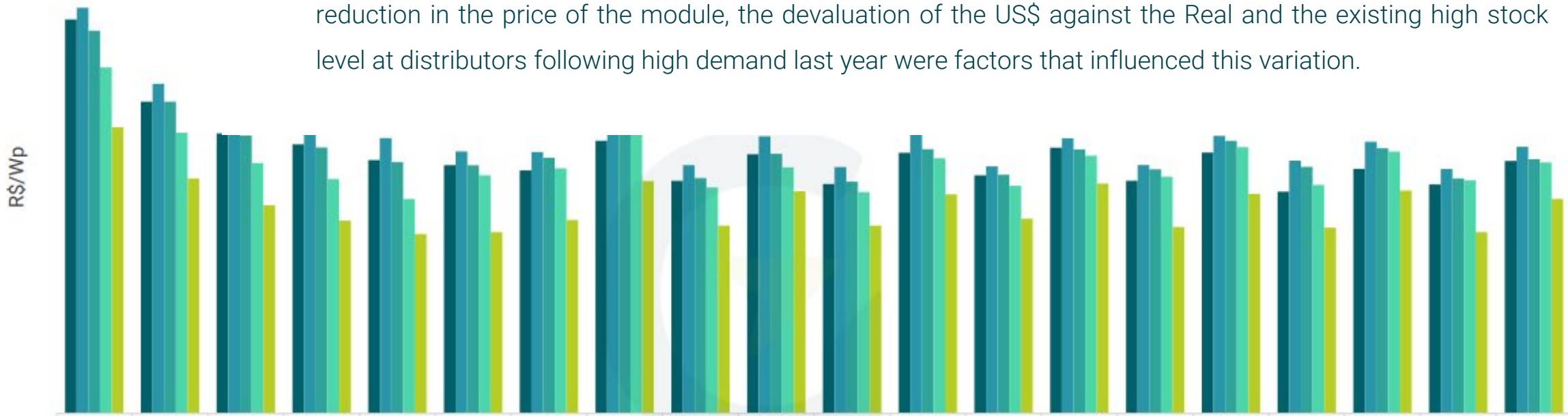
** PV Kit is composed of PV Modules + Inverter + Mounting System + Cabling System + Protection System*



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

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.

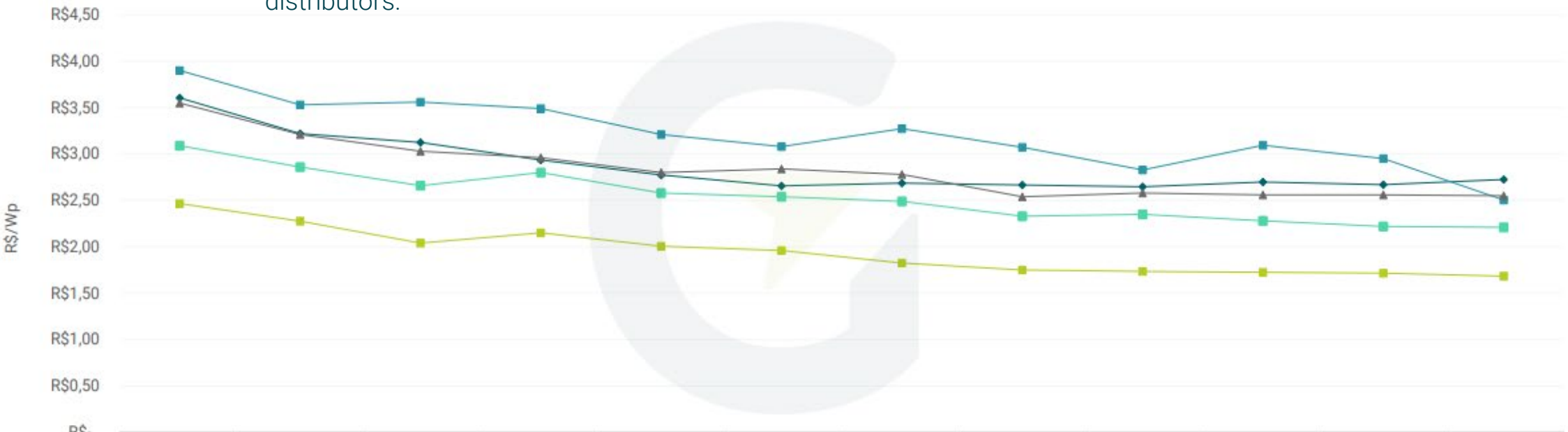


	2kWp	4kWp	8kWp	12kWp	30kWp	50kWp	75kWp	75kWp Solo	150kWp	150kWp Solo	300kWp	300kWp Solo	500kWp	500kWp Solo	1MWp	1MWp solo	3MWp	3MWp solo	5MWp	5MWp solo
jun/21	6,17	4,88	4,38	4,21	3,97	3,89	3,81	4,27	3,64	4,06	3,59	4,08	3,73	4,16	3,64	4,09	3,47	3,83	3,59	3,95
jan/22	6,35	5,16	4,66	4,52	4,31	4,10	4,09	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

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

PRICES OF PV INTEGRATION SERVICES

- The **average price of PV integration services fell by 7% in June 2023** compared to January of the same year. The slowdown in the market, reflected in the low demand for photovoltaic systems (mainly in retail), may have contributed to this behavior.

	2kWp	4kWp	8kWp	12kWp	30kWp	50kWp	75kWp	150kWp	300kWp	500kWp	1MWp	5MWp
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	R$0,86
jan/22	R$2,45	R$1,63	R$1,10	R$1,03	R$1,10	R$1,02	R$0,82	R$0,81	R$1,03	R$0,77	R$0,94	R$1,32
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$1,18	R$1,26	R$1,13
jan/23	R$2,33	R$1,53	R$1,26	R$0,87	R$0,78	R$1,19	R$1,35	R$1,21	R$1,12	R$1,28	R$1,49	R$1,44
jun/23	R$2,01	R$1,40	R$1,22	R$0,87	R$0,80	R$0,88	R$1,21	R$1,19	R$1,20	R$1,32	R$1,20	R$1,16

AVERAGE PAYBACK PERIOD PER STATE

Industrial (300 kWp) – Medium Voltage

DG I in January 2023*

DG II in January 2023

DG II in June 2023

- The payback was **unchanged under the assumptions of Scenario 1**. However, **Scenario 2 showed an improvement in the return on investment,** with a **13% reduction in the payback period**. **The fall in CAPEX is the main cause** of the improvement in this comparison between 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.*

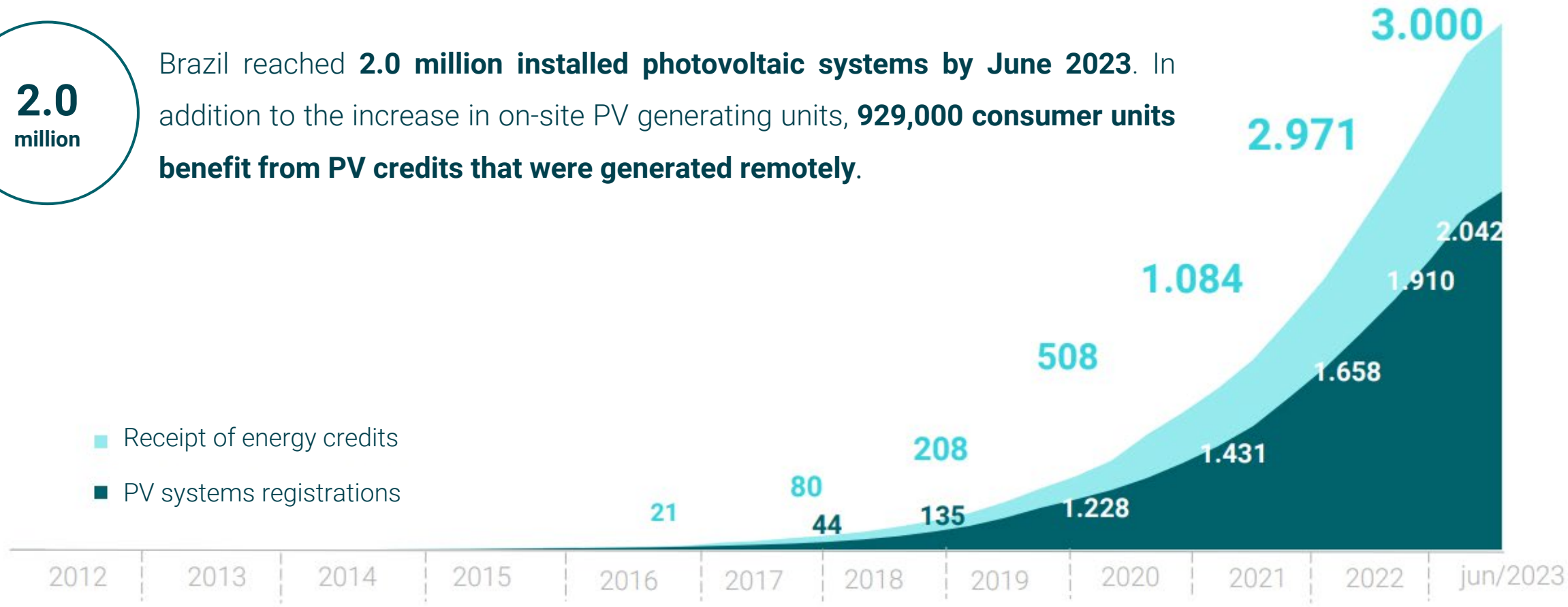
06.
CONSUMERS

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

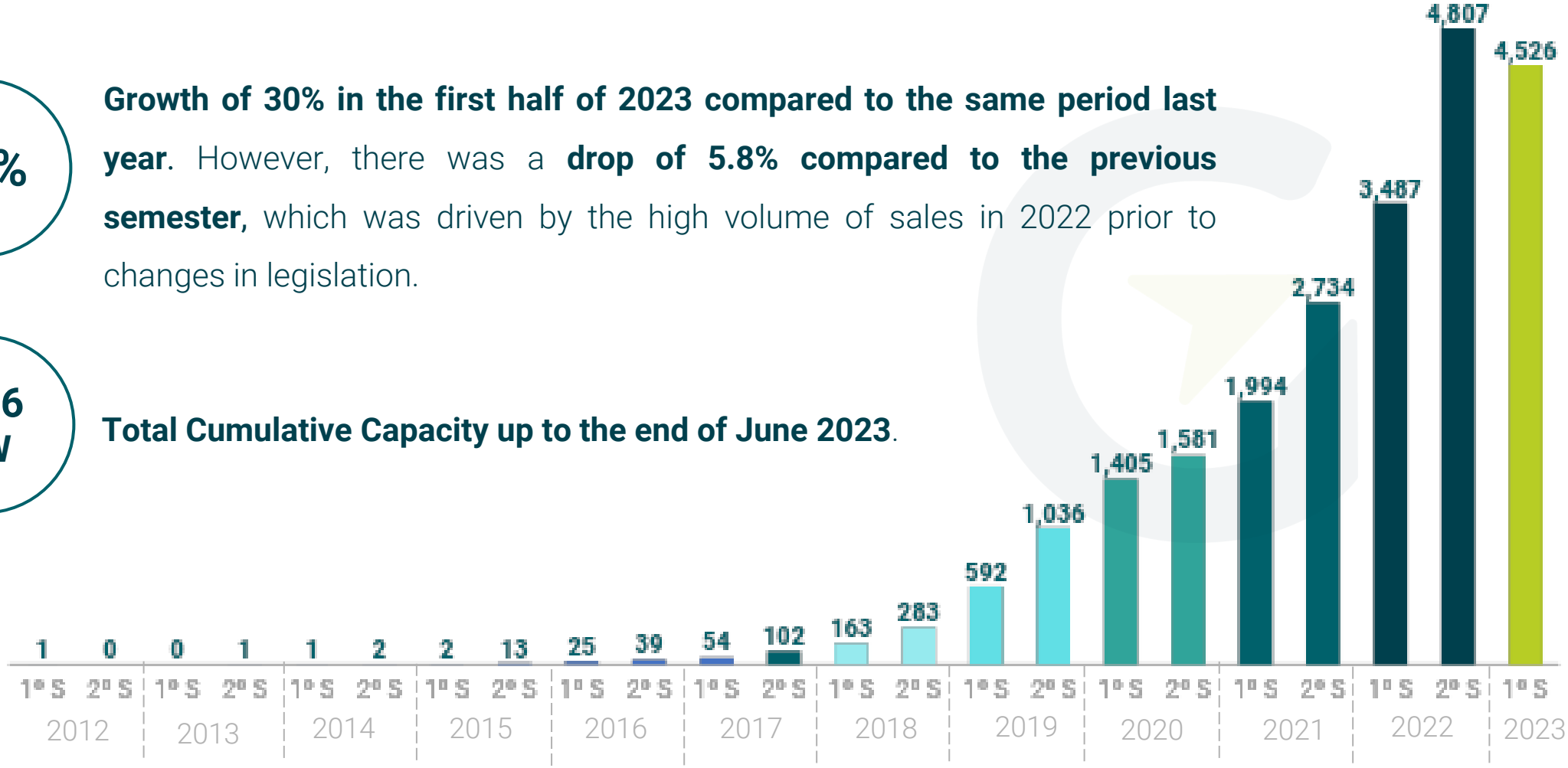
Additional Capacity [MW] installed at customers per semester

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

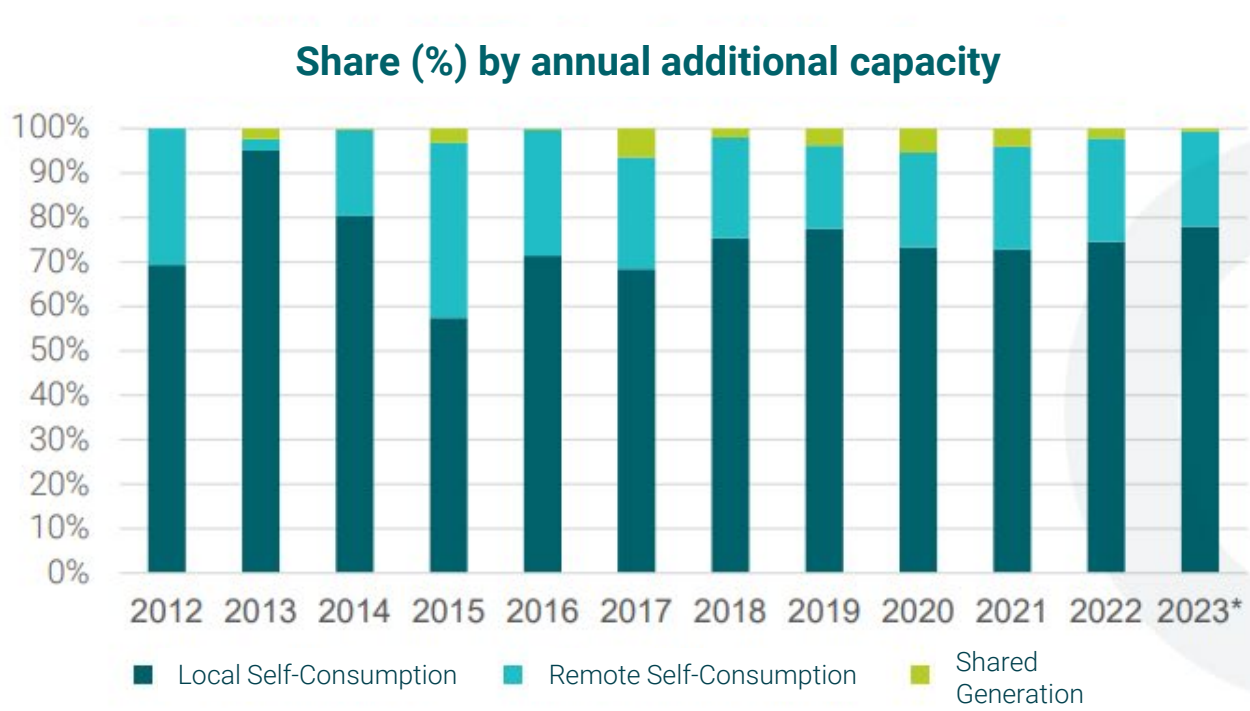
Total Cumulative Capacity up to the end of June 2023.

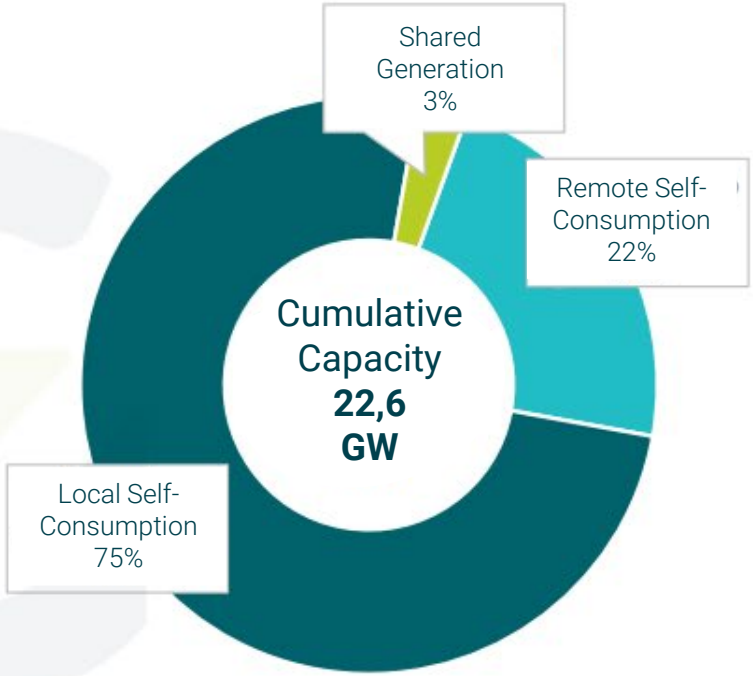


Source: ANEEL, 2023; Greener, 2023.

DISTRIBUTED GENERATION BUSINESS MODELS

Share (%) by annual additional capacity and cumulative capacity





- Local Self-Consumption continues to drive the growth of DG, accounting for 78% of installed power in the first half of 2023, followed by Remote Self-Consumption, with 21%, and Shared Generation, with 1%.

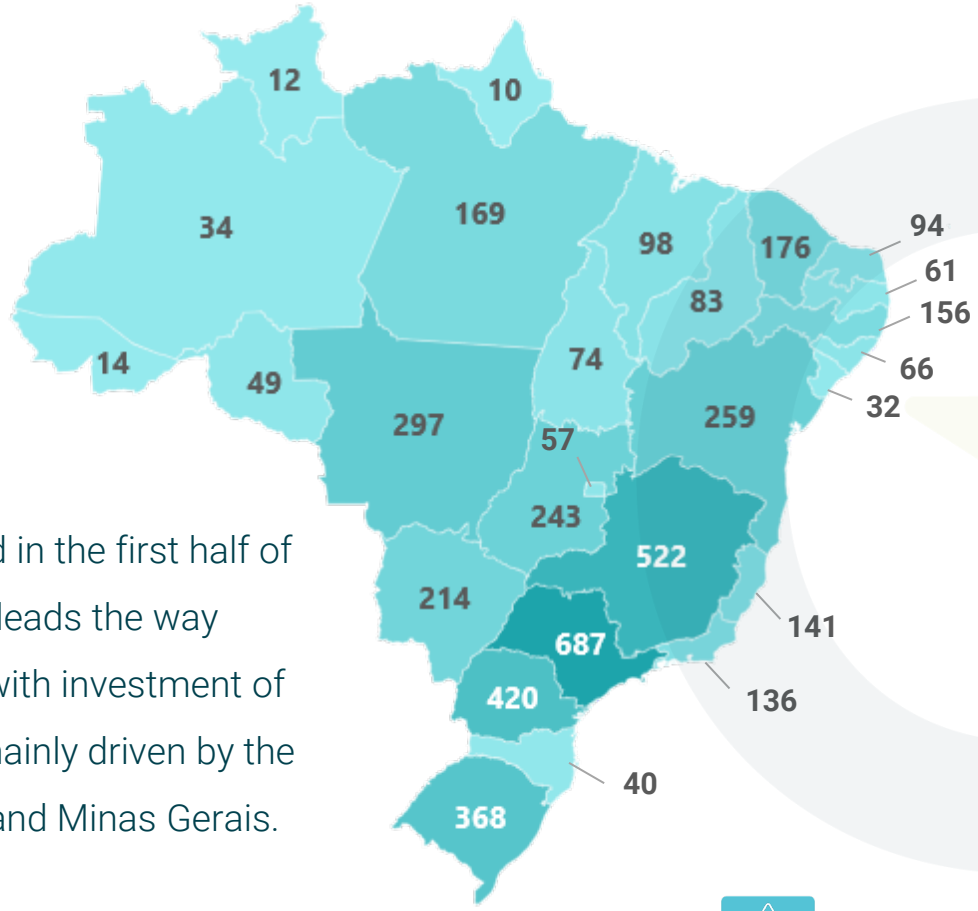
Source: ANEEL, 2023; Greener, 2023.

*Data collected up to end of June 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

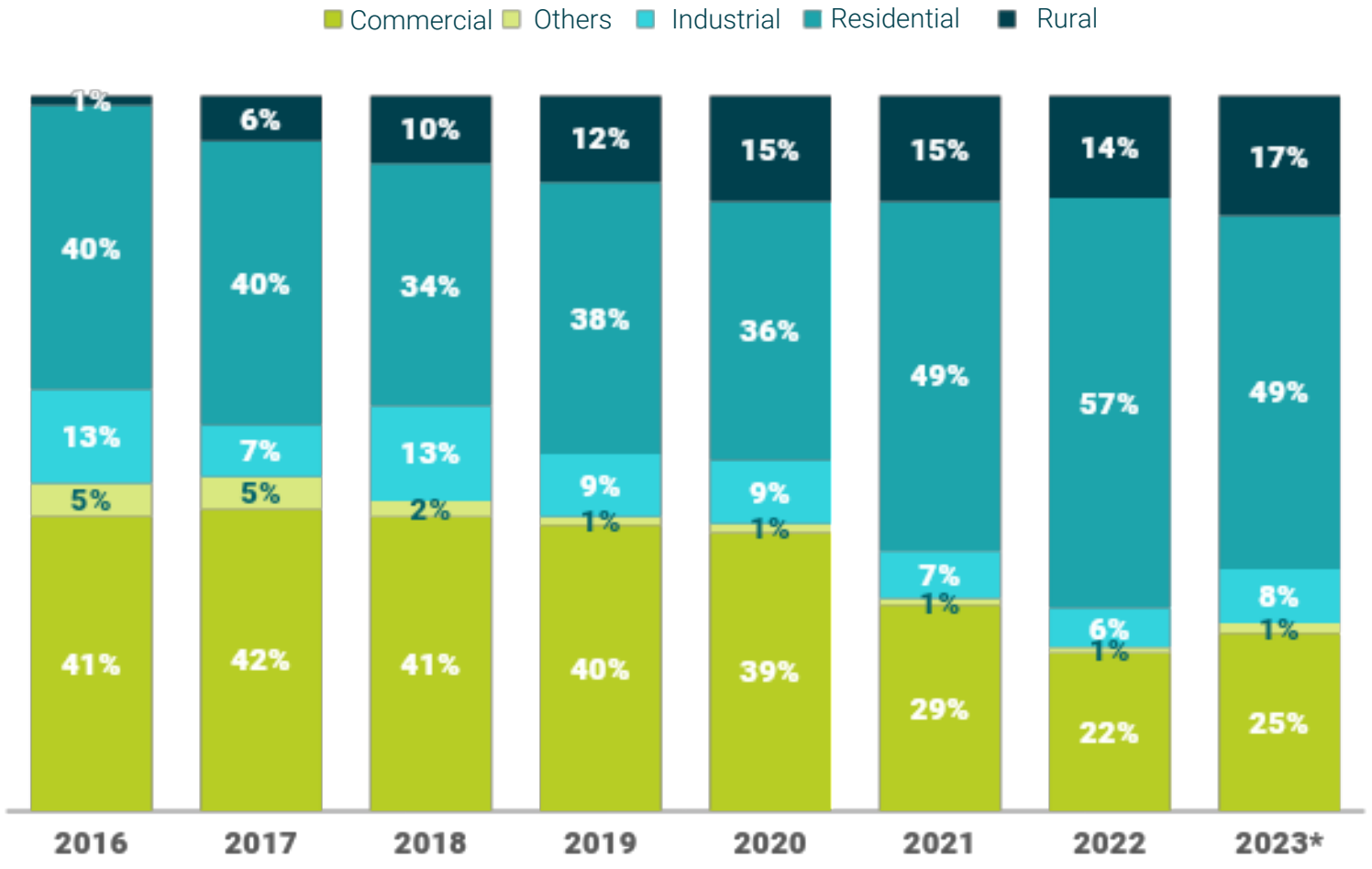
State	Additional Capacity (MW)	Estimated Investment (R$ Billions)
SP	687	2.3
MG	522	1.7
PR	420	1.4
RS	368	1.2
MT	297	0.9
BA	259	0.9
GO	243	0.8
MS	214	0.7
CE	176	0.6
PA	169	0.6

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



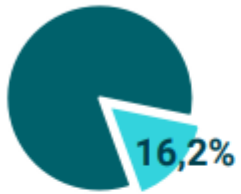
- **The Residential customer type saw an 8% decrease in its share of installed PV capacity,** while Rural and Commercial customers saw a share increase of 3% each in the first half of 2023 compared to 2022.
- The resumption of economic activity and the return to face-to-face work following the Covid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

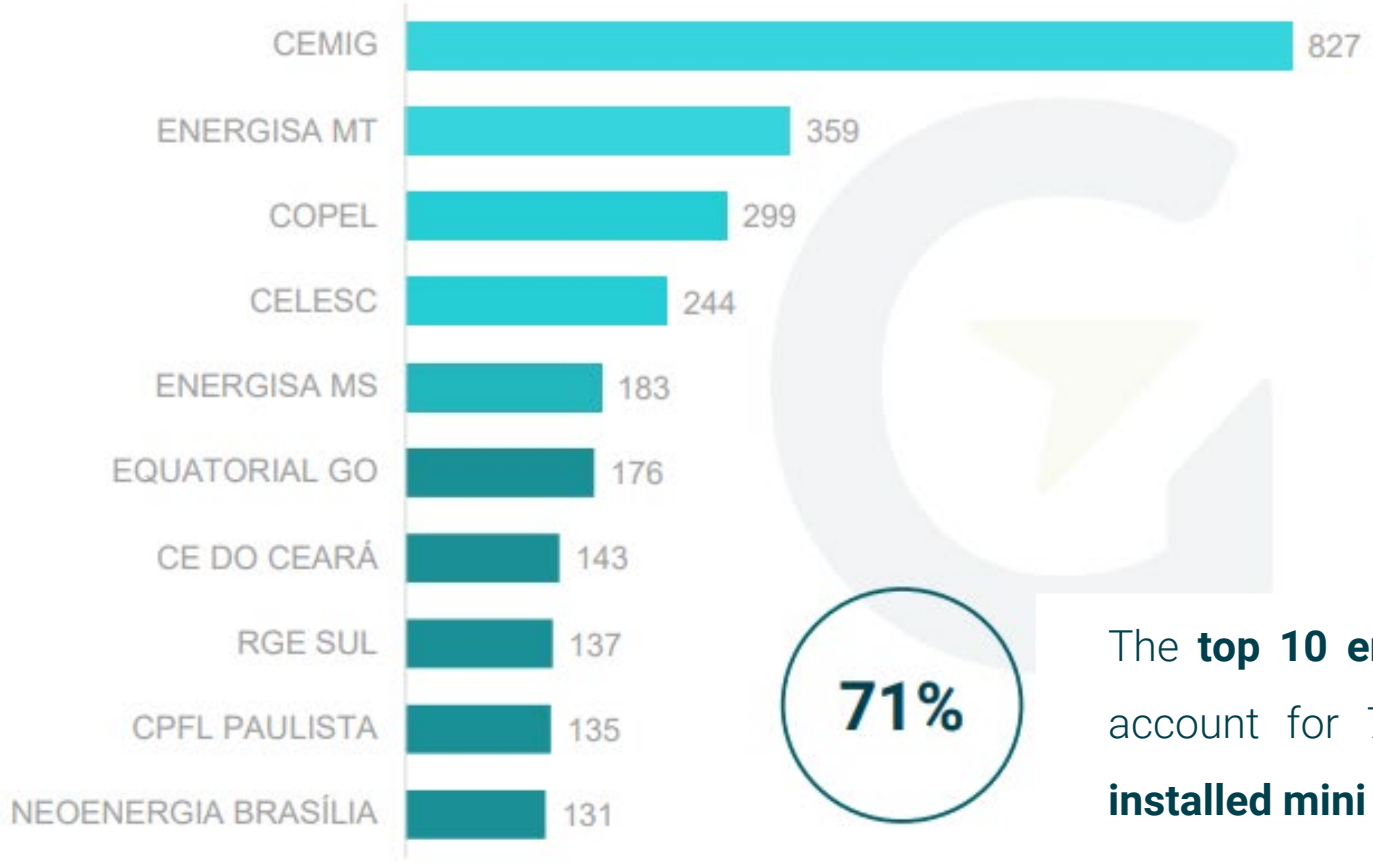
Source: ANEEL, 2023; Greener, 2023.

*Data collected up to end of June 2023

MINI DG PER STATE IN 2023

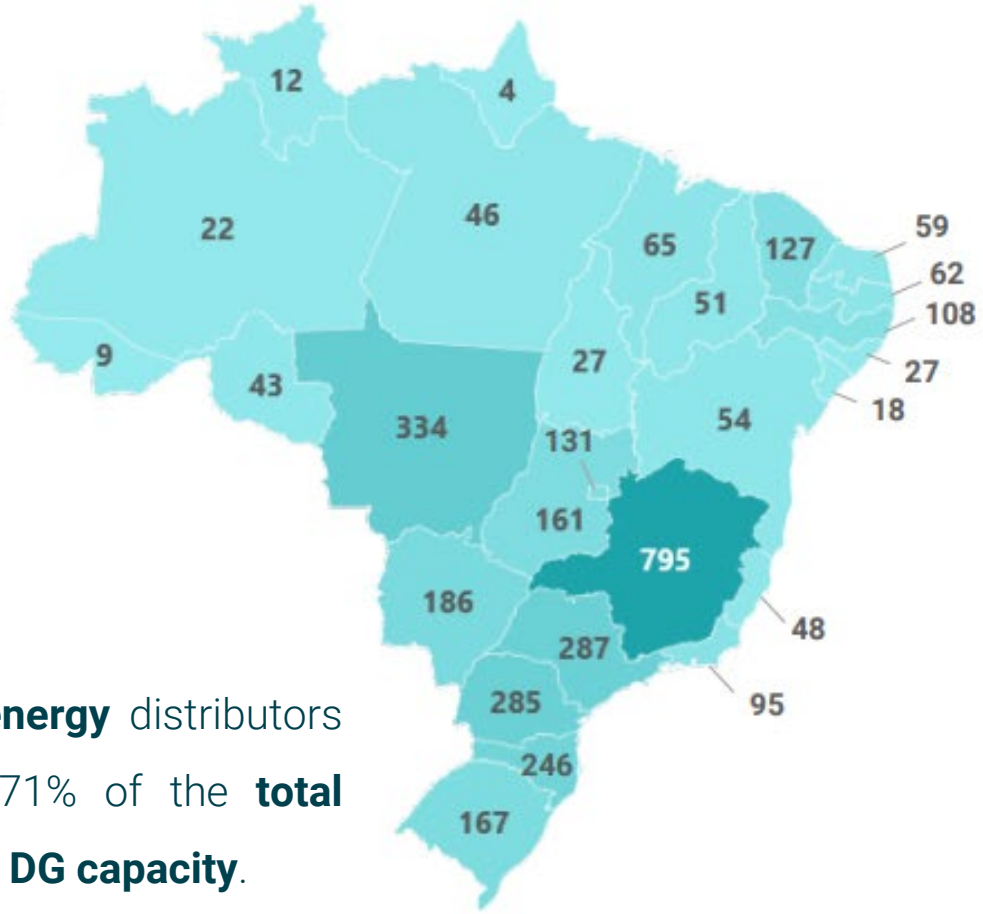
Cumulative Capacity (kW)

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

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.

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, there was **a 30% 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**.

Insights & conclusions