ABRAFE

INVENTORY OF GREENHOUSE GAS EMISSIONS FOR THE FERROALLOYS AND SILICON METAL SECTOR

BASE YEAR 2022

22/09/2024

ABRAFE - BRAZILIAN INDUSTRY ASSOCIATION OF FERROALLOY AND SILICON METAL

BOZEL

DOW

FERLIG
FERRO LIGA LTDA

ELETROLIGAS LTDA.

FERMAR
Indústria de Ferro Ligas

Ferbasa

GRANHA LIGAS

LIBRA
LIGAS DO BRASIL S/A

grupo maringá

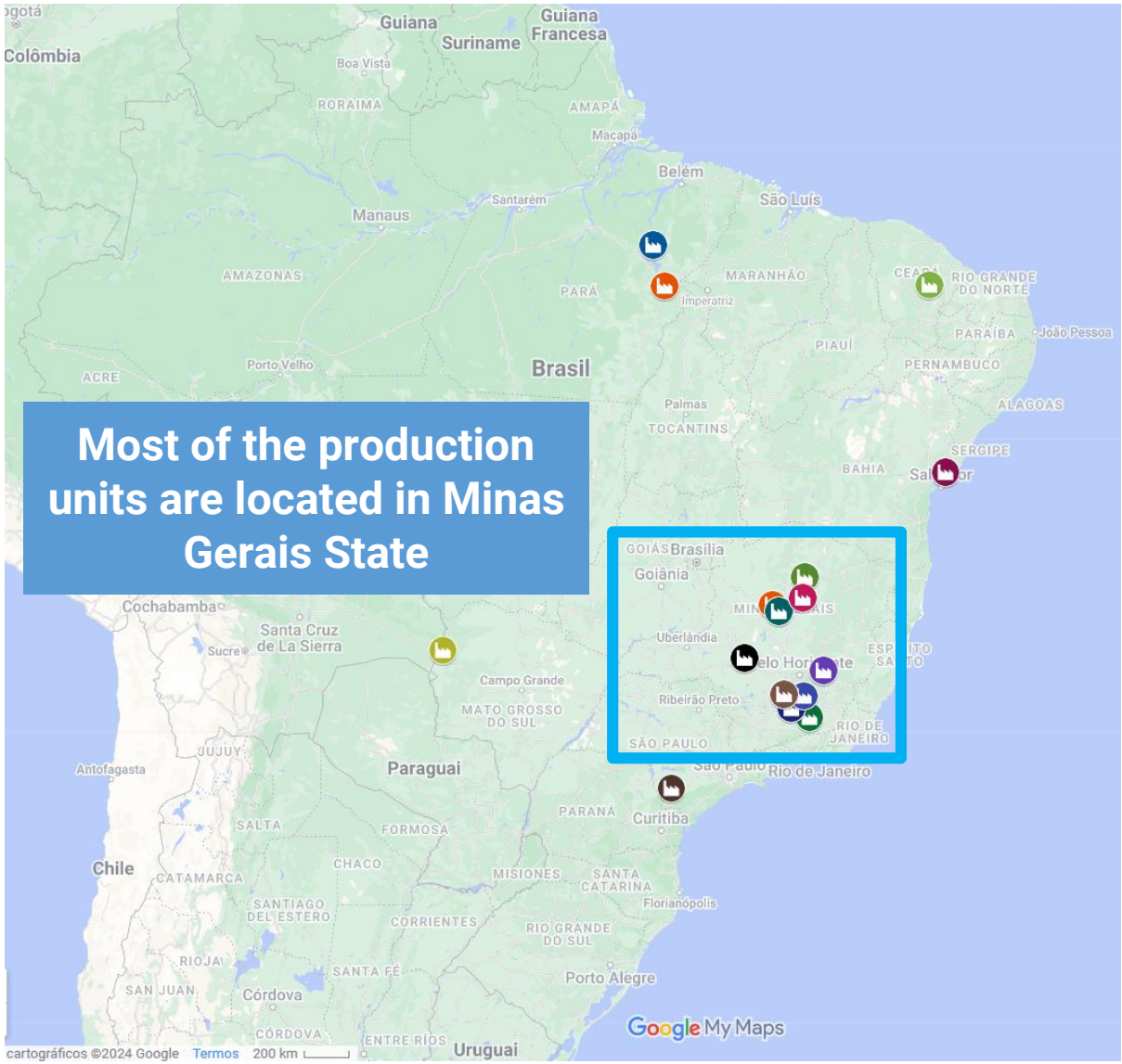
NOVA ERA SILICON S/A

LIASA

Inonibrás
Inoculantes e Ferro Ligas Nipo Brasileiros S/A

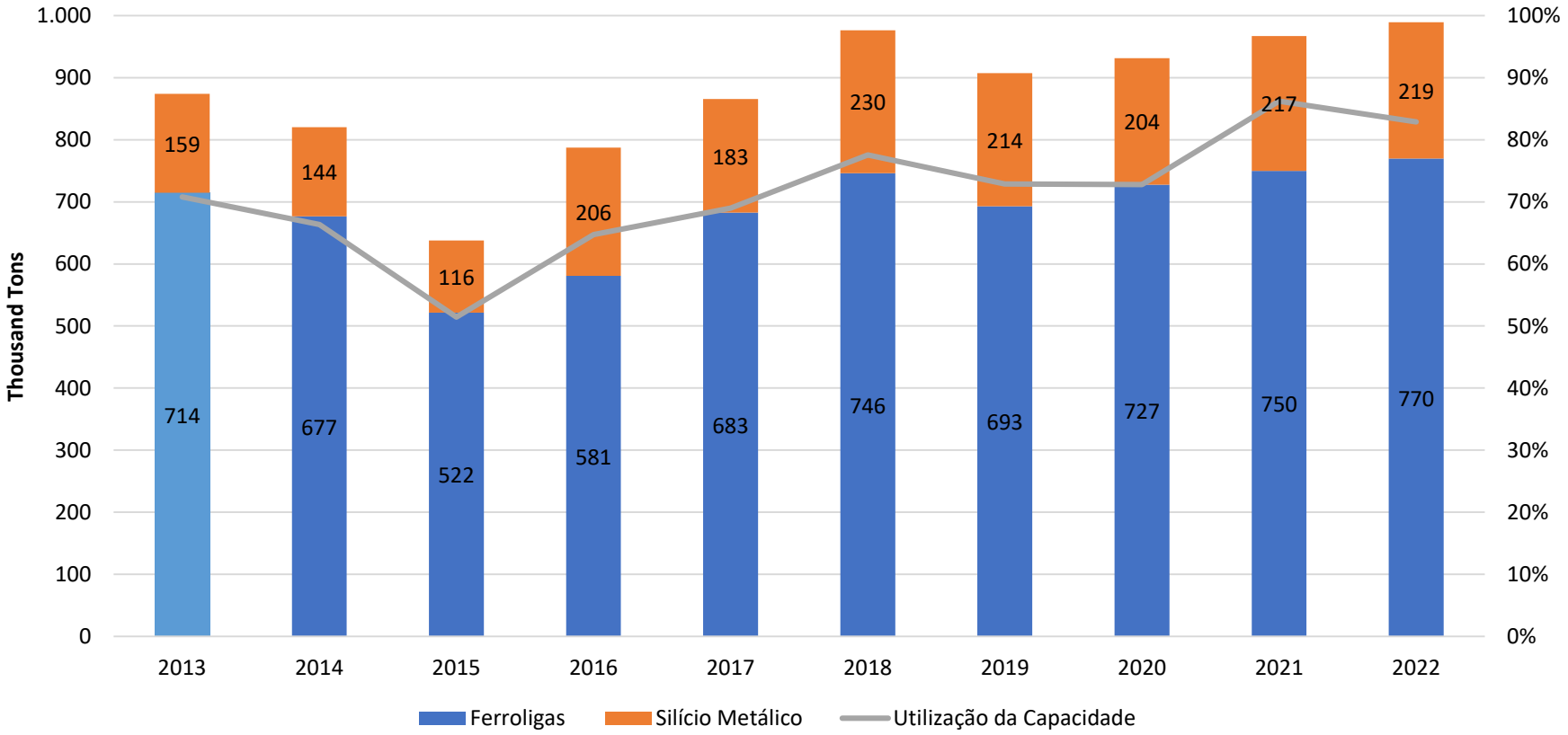
RIMA

MINASLIGAS
Comprometimento | Eficiência | Qualidade



https://www.google.com/maps/d/u/0/edit?mid=1zCjRmhrkdnwUlKIMSUei8BflZOmdImY&usp=sharing

Production of Ferroalloys and Silicon Metal ABRAFE Associates



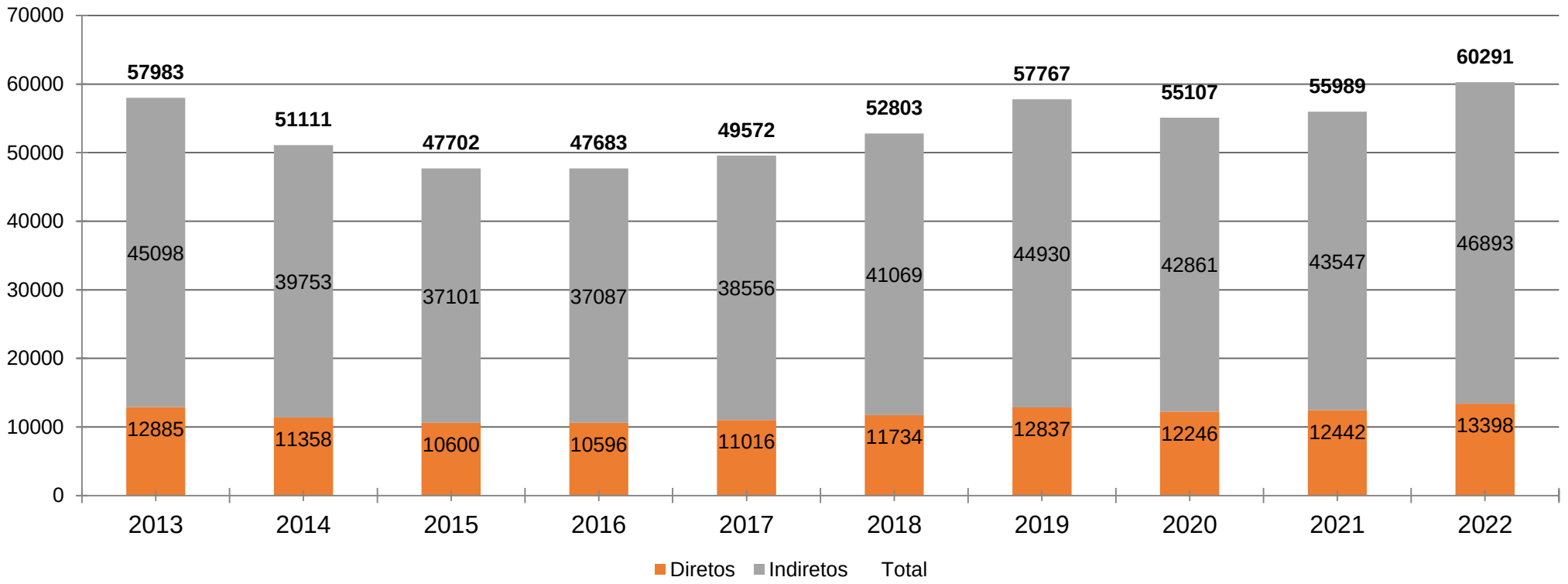
Ferroalloy production shows significant growth, reaching 770 thousand tons in 2022.

Silicon metal production was 219 thousand tons in 2022, representing an increase of 88% compared to 2015.

With capacity utilization at 86%, ABRAFE members together produced 989 thousand tons in 2022.

Source: ABRAFE

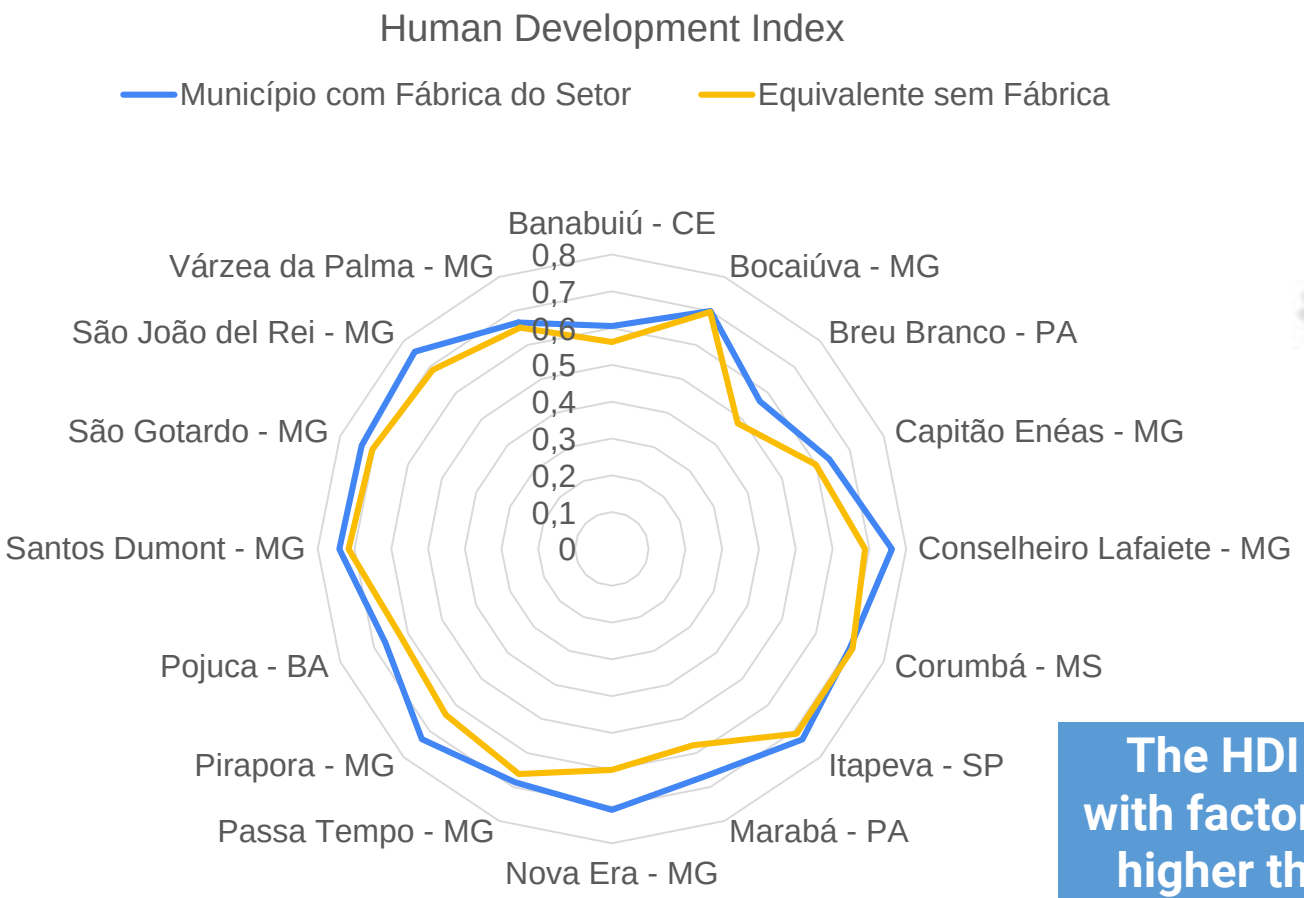
Job Generation – ABRAFE Associates

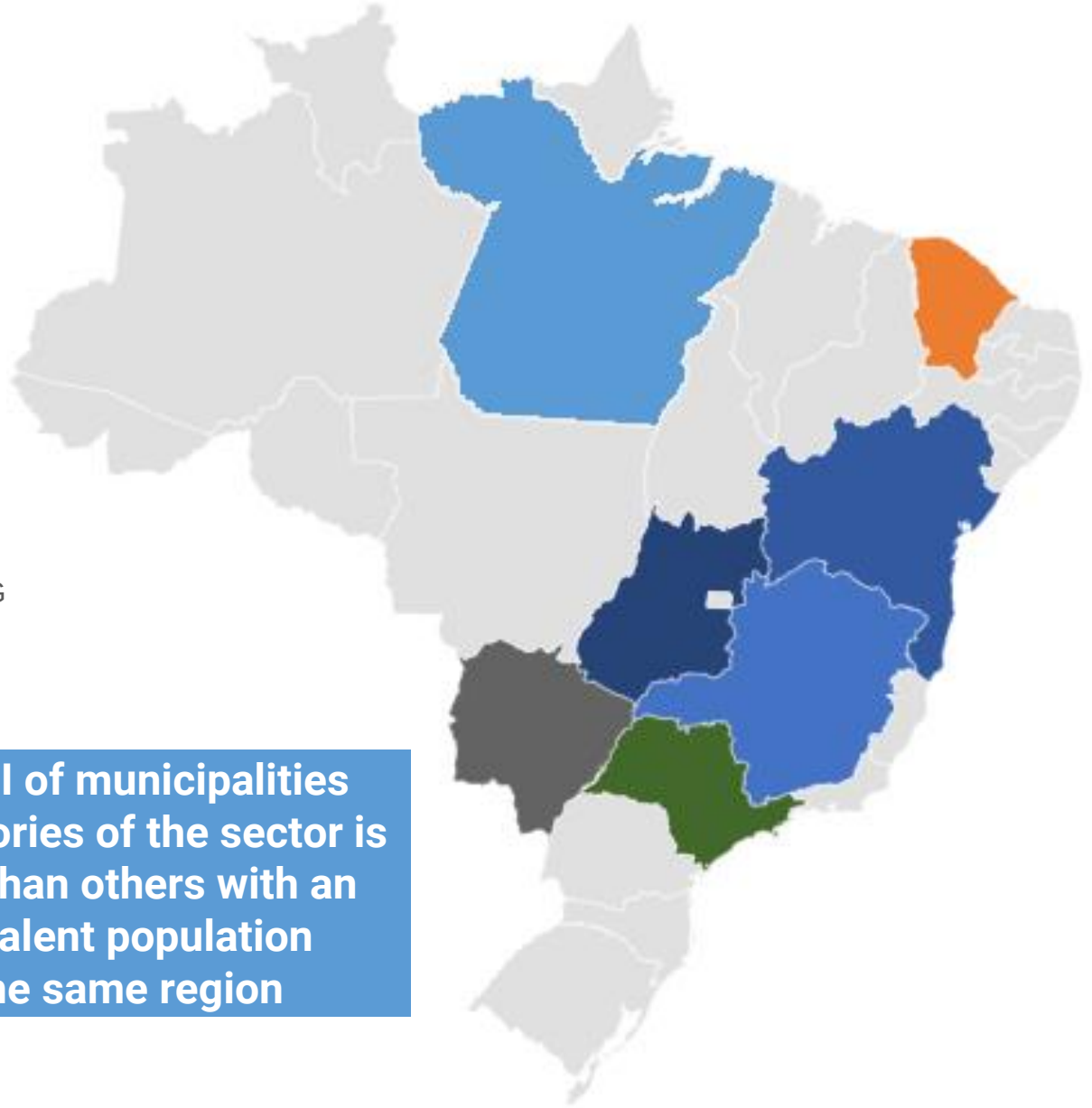


Companies directly and indirectly employ over 60,000 people, surpassing pre-pandemic employment levels.

Source: ABRAFE

Contribution to Regional Development



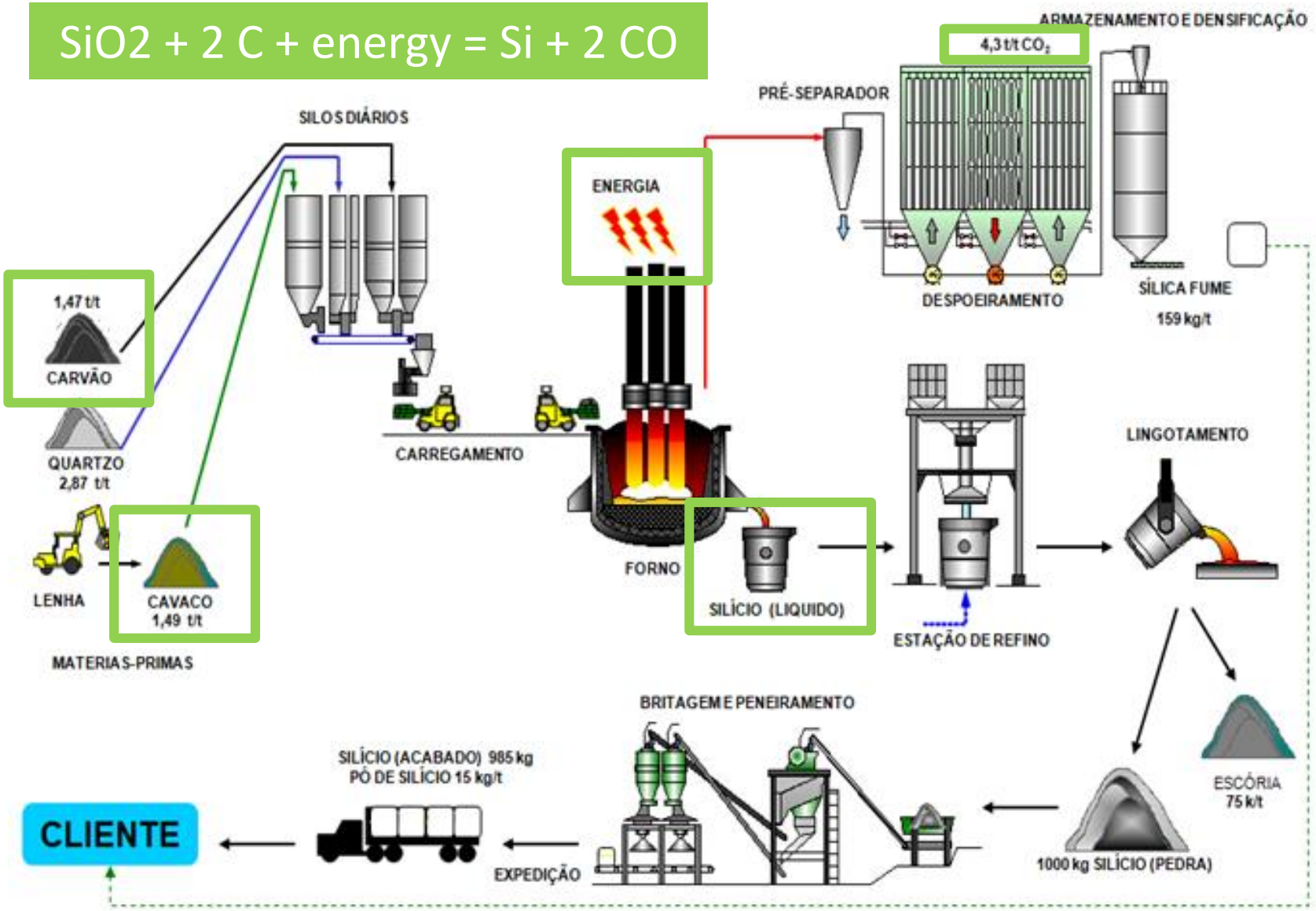


The HDI of municipalities with factories of the sector is higher than others with an equivalent population in the same region

Source: IBGE (2010) https://www.ibge.gov.br/cidades-e-estados.html

Silicon Metal Production

$$SiO2 + 2\,C + energy = Si + 2\,CO$$



Consumption of Charcoal and Electric Energy in the Manufacturing of Ferroalloys and Metallic Silicon

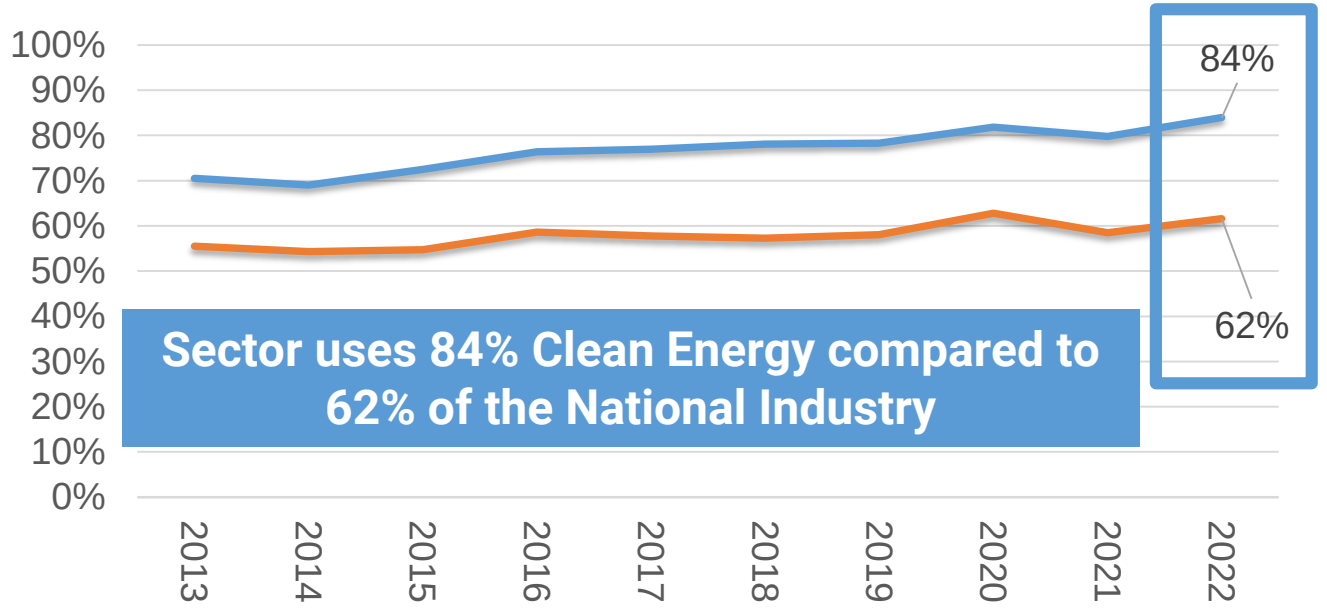
Production and Consumption

YEAR	PRODUCTION	ELECTRICITY	CHARCOAL	
	(thousand tons)	(GWh)	(thousand tons)	(thousand m3)
2017	**1,159**	**9,381**	**1.005**	**4.022**
2018	**1,270**	**10.135**	**1,247**	**4,987**
2019	**1.214**	**9,887**	**1.210**	**4,840**
2020	**1.222**	**10.284**	**1.309**	**5.236**
2021	**1,273**	**10.122**	**1,400**	**5,600**
2022	**1,396**	**11.016**	**1,534**	**6.138**

Charcoal 6.1 million m3 increased 52% in 5 years

Source: ABRAFE

Participation of Renewable Energy Sources



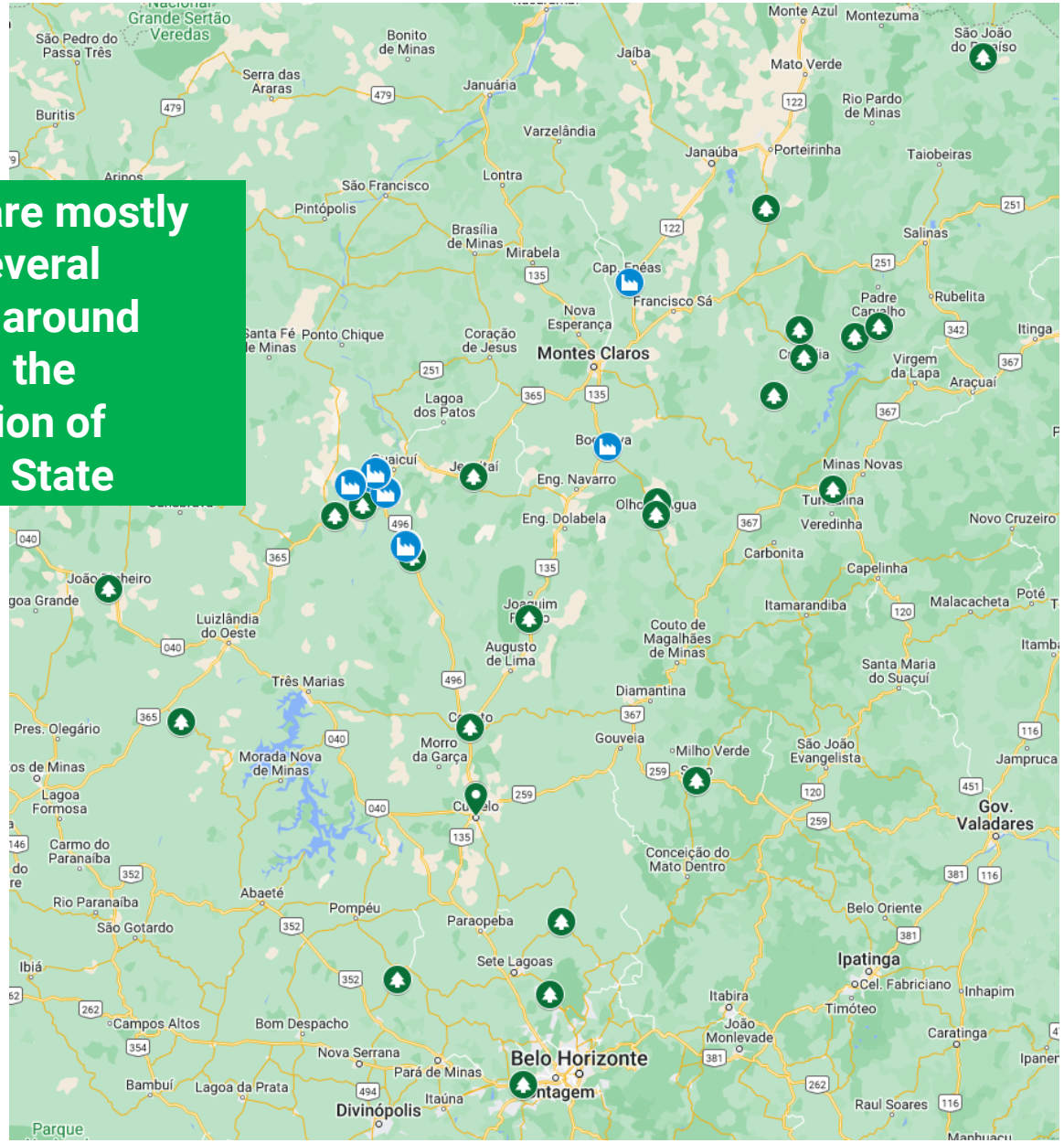
Source: EPE

Scope of Activities in the Northern Region of Minas Gerais

. Factories in the Northern Region of Minas:

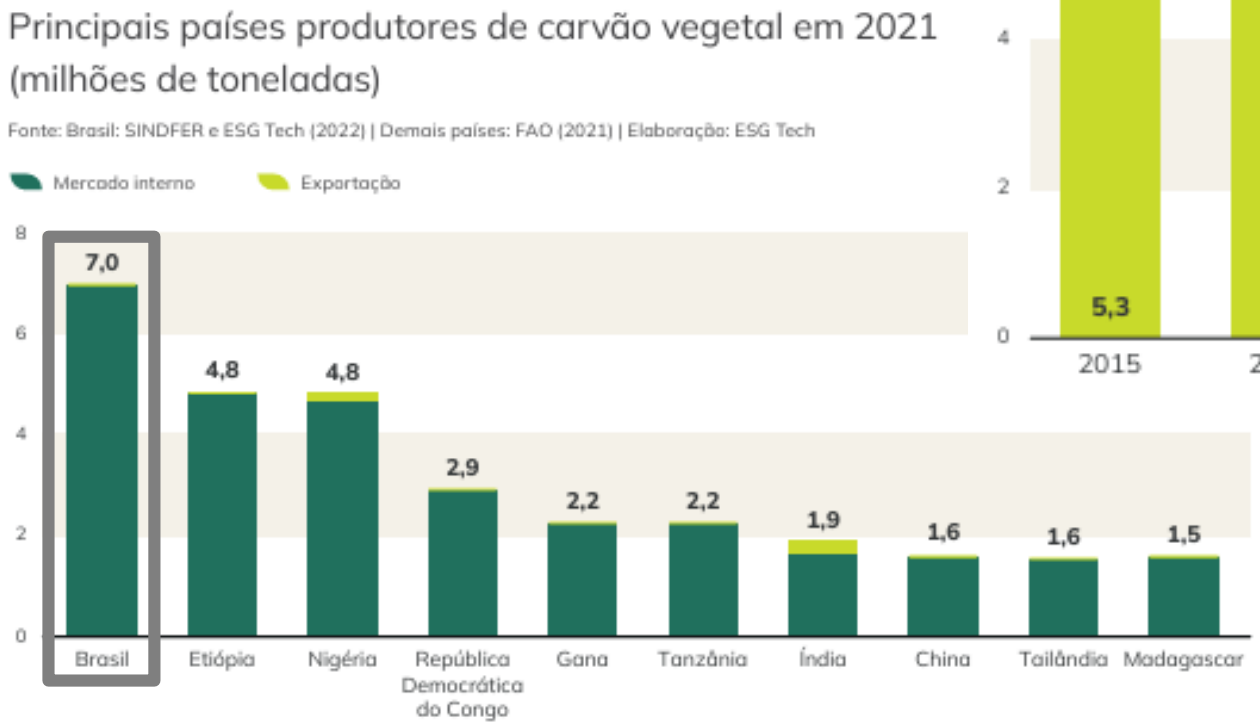
- LIASA – Pirapora
- MINASLIGAS – Pirapora
- INONIBRAS – Pirapora
- INDUSTRIAL RHYME – Captain Enéas, Várzea da Palma and Bocaiuva

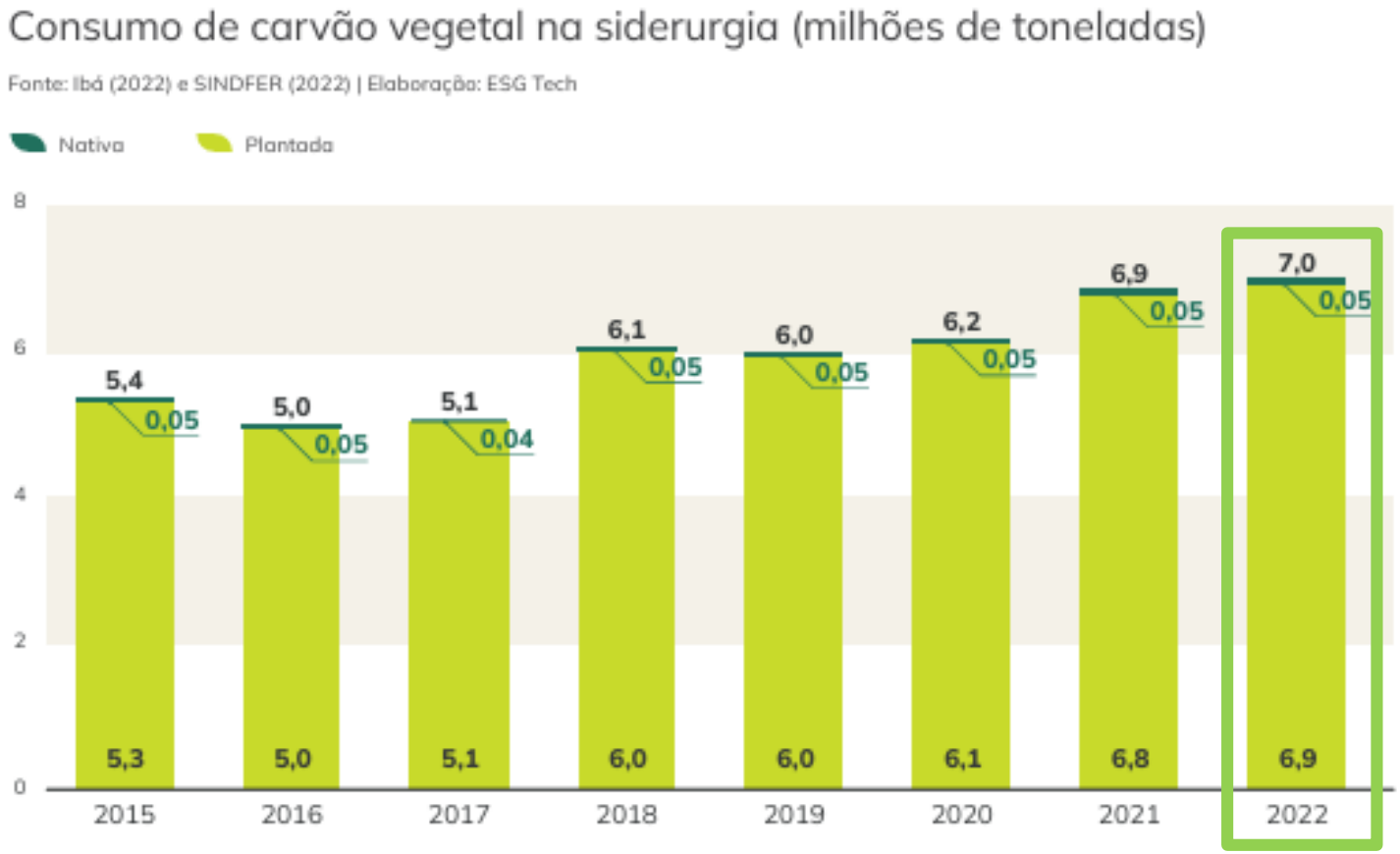
Planted forests are mostly located in several municipalities around factories in the northern region of Minas Gerais State



Production and Consumption of Charcoal in the Steel Industry

Brazil leads the global ranking of charcoal producers, reaching 7.0 million tons in 2022





Over 99% of charcoal is obtained from planted forests

Source: IBÁ Annual Report 2023

Planted Forests in Minas Gerais

Forestry activity is present in 803 of the 853 municipalities in Minas Gerais

GHG Emissions Inventory for the Ferroalloys and Silicon Metal Sector FIEMG CIT-SENAI SINFERSI Partnership (2022 base year)

Accounting for greenhouse gas emissions is the first step towards contributing to the fight against climate change when used as a management tool. The information generated from the preparation of the inventory can fulfill the following objectives:

- Historical data recording;
- Setting goals;
- Assessment of risks and opportunities;
- Competitive advantage;

with stakeholders *;*

- Participation in GHG emissions disclosure programs;
- Conditions for participating in carbon markets.
- Assessment of the contribution of different production sectors to national and global GHG emissions

GHG Emissions Inventory for the Ferroalloys and Silicon Metal Sector

Participating Company	Unit
BOZEL BRAZIL SA	Sao Joao Del Rei/MG
ELECTROLIGAS LTDA	Saint Gotthard/MG
FERLIG IRON ALLOY LTD	Pastime/MG
GRANHA LEAGUES LTDA	Corumba/MS
LIBRA LEAGUES OF BRAZIL S/A	Banabuiú/CE
ALUMINUM ALLOYS S/A - LIASA	Pirapora/MG
MARINGA IRON LEAGUE SA	Itapeva/SP
MINASLIGAS SA	Pirapora/MG
NEXUS MANGANESE SA	Pretoria/MG
NEW ERA SILICON S/A	New Era/MG
PALMYRA DO BRASIL INDUSTRY AND TRADE OF METALLIC SILICON AND NATURAL RESOURCES LTDA	White Pitch/PA Santos Dumont/MG

In this first inventory we had the participation of 11 units of associated companies, which represent more than 60% of ABRAFE.

The report was prepared in compliance with the five principles guided by the accounting methodology of the Brazilian *GHG Protocol Program* : relevance, completeness, consistency, transparency and accuracy.

Emissions were recorded and converted to tons of carbon dioxide equivalent (tCO2e) using the Brazilian GHG Protocol Program tool .

GHG Emissions Inventory for the Ferroalloys and Silicon Metal Sector

Table 1- Global Warming Potential (GWP) of the main greenhouse gases

Greenhouse Gas	GWP	Reference
Carbon dioxide (CO_2)	1	IPCC (2014
Methane (CH_4)	28	
Nitrous Oxide (N_2O)	265	
Sulfur hexafluoride (SF_6)	23,500	
Nitrogen trifluoride (NF_3)	16.100	
Hydrofluorocarbons (HFCs) [1]	2.213	
Perfluorocarbons (PFCs) [1]	9,562	

Figure 5 - Emission factors for reducers used in furnaces

Fuel type	Unit	Sector Emission Factors:		
Fossil fuels		**CO2 (kg/ unit)**	**CH4 (kg/unit)**	**N2O(kg/unit)**
Coal Coke	Tons	3.093	0.28889	0.04333
Petroleum Coke	m^3	3,563	0.10960	0.02192
Charcoal	Tons	2,886	5.40935	0.10819
Commercial Firewood	Tons	1,451	0.38937	0.05192

Source: Table 1 of calculation tool v2023.0.3 (Emission factors) – FGV/GHG (2023).

GHG Emissions Inventory for the Ferroalloys and Silicon Metal Sector

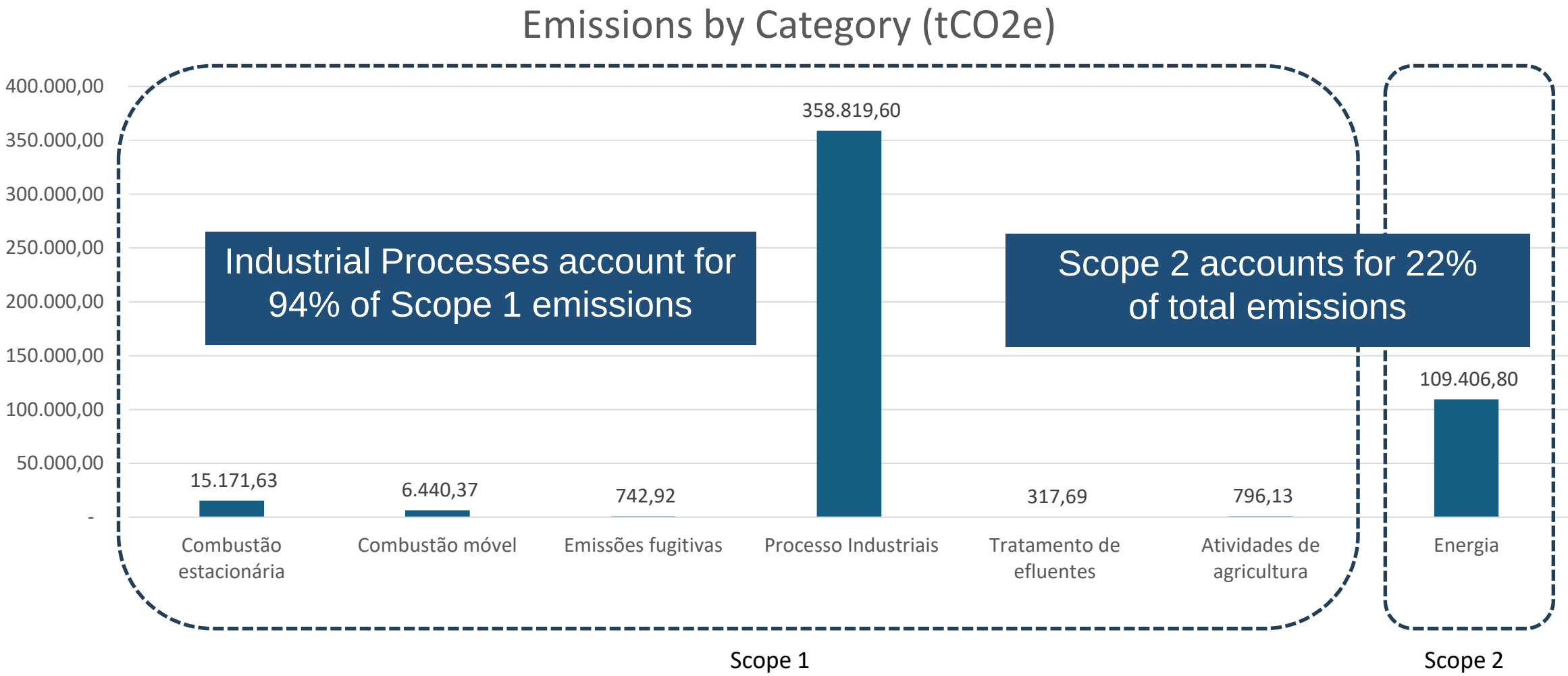
- The total emissions of the inventoried companies associated with ABRAFE, for the year 2022, were 529,212.67 tCO2e;

- The Industrial Processes category is responsible for the highest emissions rate, 358,819.60 tCO2e in E1;

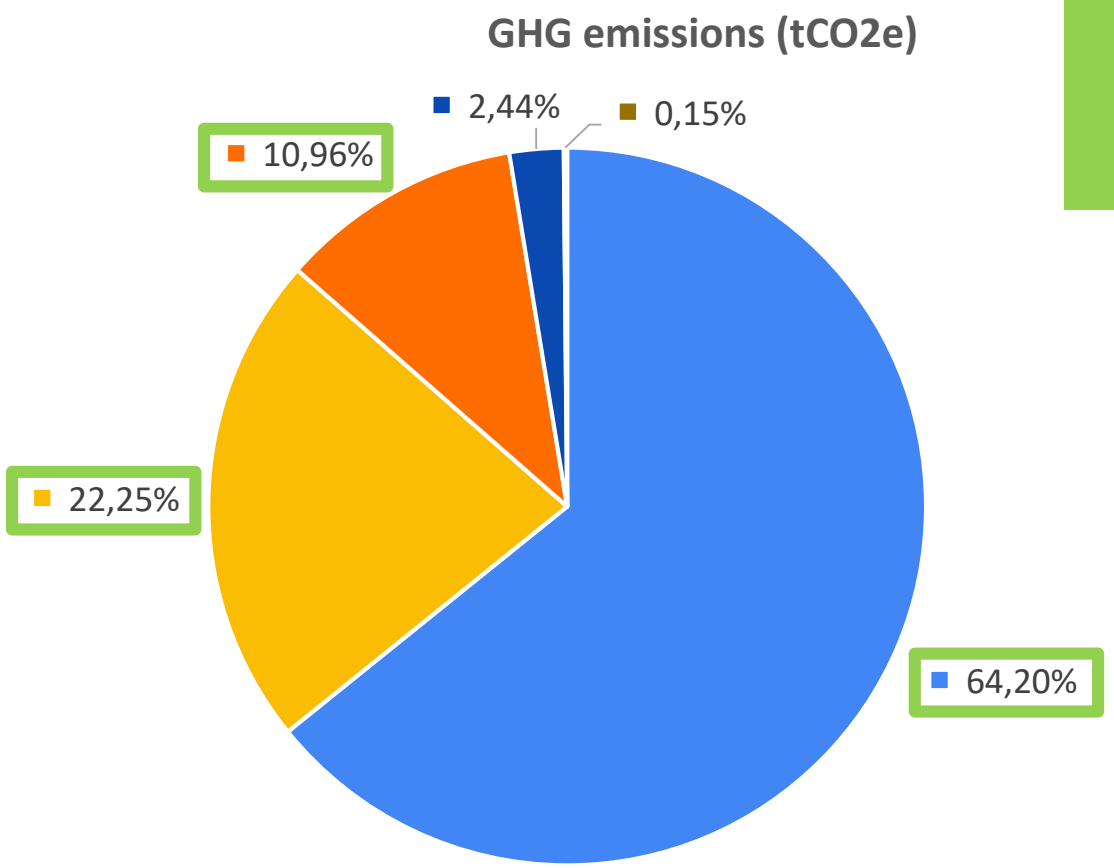
GHG (t)	Emissions in metric tons of CO2 equivalent (tCO2e)	
	Scope 1	Scope 2
CO2	315,674.72	109,406.80
CH4	53,893.92	---
N2O	11,978.27	---
HFCs	741.46	---
PFCs	---	---
SF6	---	---
NF3	---	---
Total	**419,805.87**	**109,406.80**

Category	Emissions (tCO2e)	Biogenic CO2 emissions (t)	Biogenic CO2 removals (t)
Stationary combustion	15,171.63	175.77	---
Mobile combustion	6,440.37	716.18	---
Fugitive emissions	742.92	---	---
Industrial Processes	358,819.60	1,042,245.75	---
Effluent treatment	317.69	---	---
Land use change	---	---	3,004.63
Agricultural activities	796.13	---	---
Total	**419,805.87**	**1,043,137.69**	**3,004.63**

GHG Emissions Inventory for the Ferroalloys and Silicon Metal Sector



GHG Emissions Inventory for the Ferroalloys and Silicon Metal Sector



64.20% of CO2 emissions in Scope 1;
22.25% of CO2 emissions in Scope 2;
10.96% CH4 emissions.

GHG Emissions Inventory for the Ferroalloys and Silicon Metal Sector

Fossil Scenario (if all companies used thermal energy and coal)

Current Scenario presents 79.5% less emissions than the Fossil Scenario

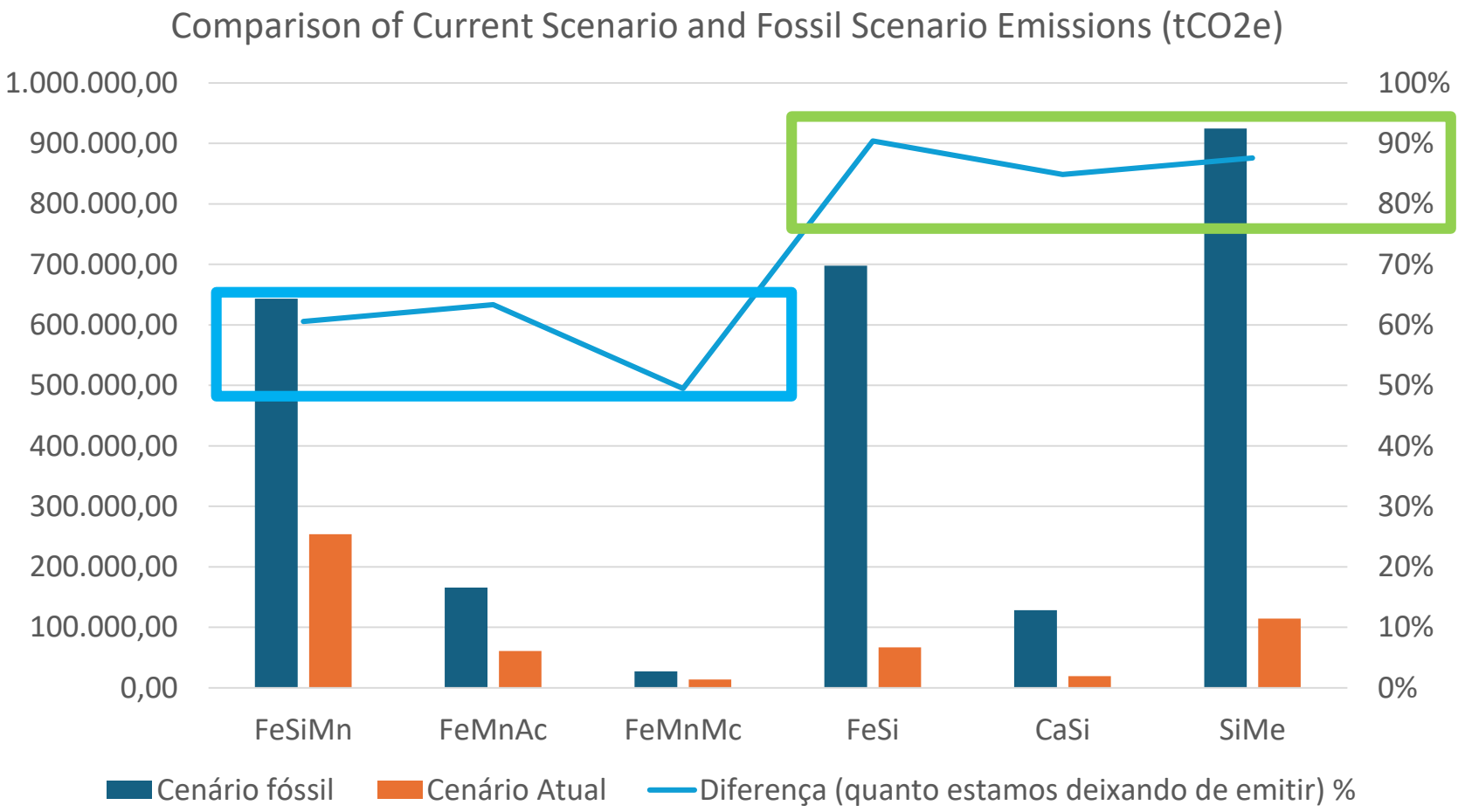
Decarbonization Scenario (using 100% charcoal and renewable energy)

SCENARIO	Ecopo 1 (t CO_2e)	Ecopo 2 (t CO_2e)	Total (t CO_2e)
Fossil scenario	1,450,430.67	1,136,690.13	2,587,120.80
Current scenario	**419,805.87**	**109,406.80**	**529,212.67**
Decarbonized scenario	224,212.59	0.00	224,212.59
Quicklime scenario	199,428.23	0.00	199,428.23

Product	Emissions of t CO_2e (E1 + E2) per t of alloy		
	Fossil scenario	**Current scenario**	Decarbonized scenario
FeMn (FeSiMn + FeMnAC + FeMnMc)	3.01	1.18	0.37
FeSiMn	2.98	1.17	0.37
FeMnAC	3.16	1.16	0.38
FeMnMc	2.99	1.51	0.30
FeSi	7.11	0.68	0.47
CaSi	7.61	1.15	0.72
YesMe	5.78	0.72	0.39
Total production	4.68	**0.96**	0.41

Source: CIT SENAI – Inventory base year 2022 (t CO2e / t alloy)

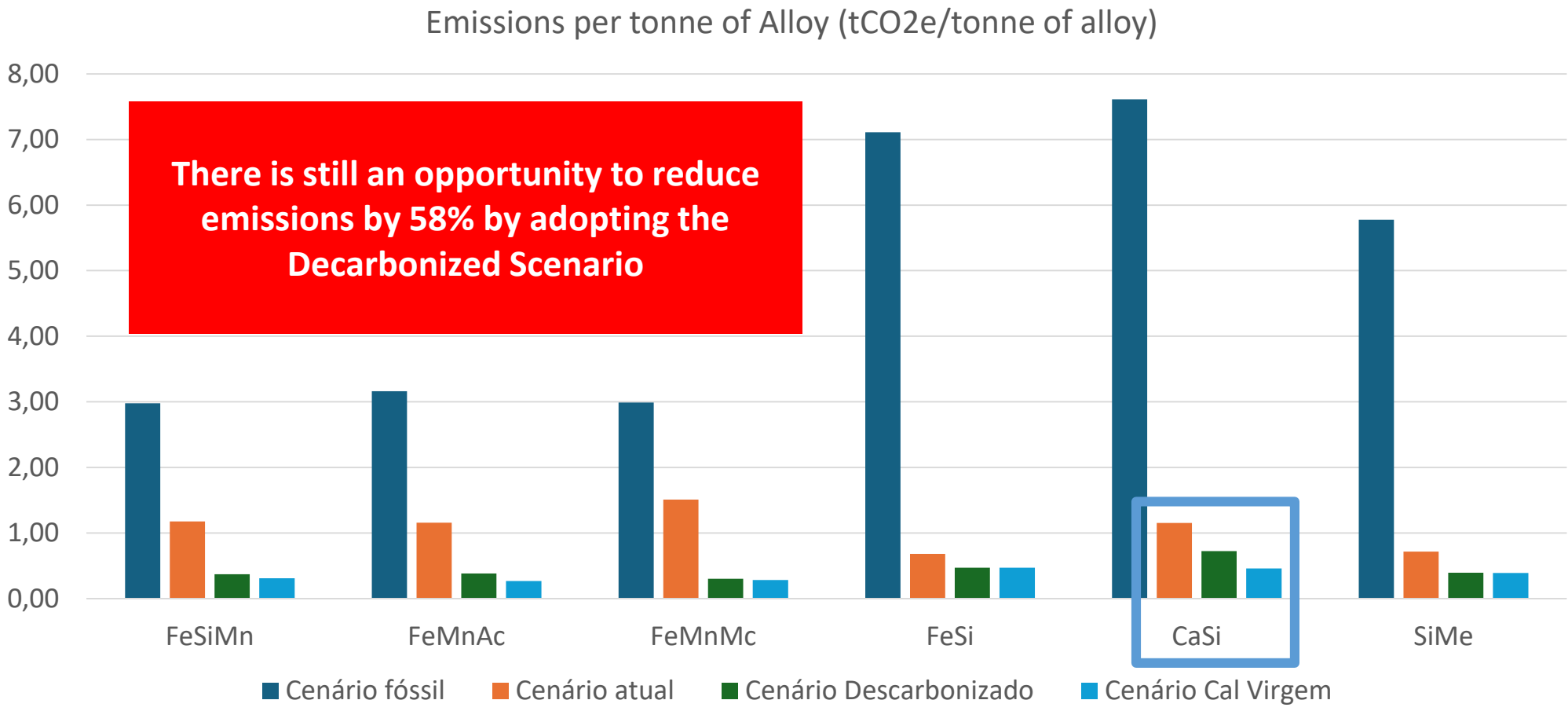
GHG Emissions Inventory for the Ferroalloys and Silicon Metal Sector



Silicon-based alloys emit 80 to 90% less than the Fossil Scenario

Manganese alloys emit 50 to 65% less than the Fossil Scenario

GHG Emissions Inventory for the Ferroalloys and Silicon Metal Sector



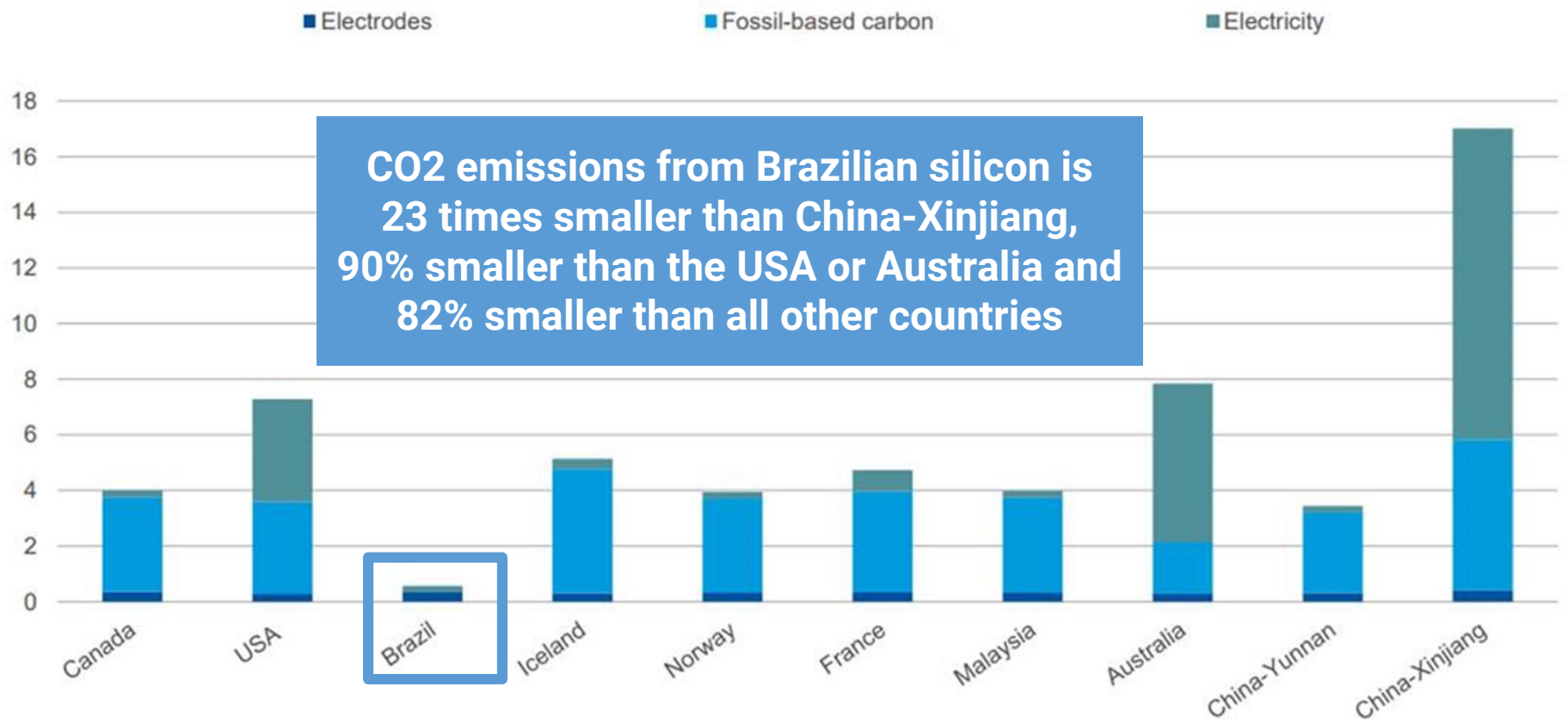
CaSi can have a reduction of more than 36% with the use of Quicklime

Carbon Footprint in Silicon Metal Production

CRU Sililicon Market Virtual Forum 2020

Carbon footprint depends on the power source and the reductant mix

Indicative emissions from electricity, fossil-based carbon and electrodes per t of silicon, t CO_2



CO2 emissions from Brazilian silicon is 23 times smaller than China-Xinjiang, 90% smaller than the USA or Australia and 82% smaller than all other countries

Data: CRU

Report Observations

- The Brazilian scenario, in which charcoal is used as a reducer in furnaces and electrical energy comes from hydroelectric sources, brings benefits to Brazilian production when compared to the reducers and fossil energy matrices used in other countries.
- In emissions associated with electricity consumption, the Brazilian scenario is more sustainable than other parts of the world, since it has a predominantly hydroelectric matrix, in contrast to other countries, where thermoelectric power based on fossil fuels predominates.
- It is estimated that an area equivalent to 52,839.81 ha of Eucalyptus is capable of meeting the additional consumption needs of charcoal and firewood in the Decarbonized Scenario in relation to the year 2022.
- This area will be able to remove 81,373.30 tons of CO2 from the atmosphere over the 7 years of the cutting cycle, which would be equivalent to 40.80% of the total emissions in the decarbonization scenario with the use of quicklime replacing limestone.

Final considerations

- The Ferroalloys sector uses 84% renewable energy sources compared to the national industry average of 62%.
- The consumption of Charcoal in the Ferroalloys and Silicon industry increased 52% in 5 years, reaching 6.1 million m3.
- Charcoal, which in Brazil comes from 99% of planted forests, is a renewable energy source unlike sources based on Fossil Carbon.
- Brazil leads the global ranking of charcoal producers, reaching the mark of 7.0 million tons in 2022.
- The Inventory of emissions from the Ferroalloys and Silicon sector has demonstrated that the Current Scenario presents 79.54% fewer emissions than the Fossil Scenario.
- Brazilian Silicon CO2 emissions are 23 times lower than China-Xinjiang, 90% lower than the USA or Australia and 82% lower than all other countries.

ABRAFE

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