INSTITUTO AÇO BRASIL

American Steel Experts' Dialogue
IEA Global Sustainable Technology Roadmap for Iron & Steel

Low-carbon alternative technologies in Brazilian iron & steel industry

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Context – Country

- Complex public governance to deal with climate change issues. Several public actors and non-governmental organizations influence mitigation strategies, with different prioritization criteria, in many cases presenting a disproportionality or lack of reasonableness on the policies under discussion.

- The capital cost and the tax burden have a strong impact on investments and cost of production, raising uncertainties about the feasibility of business expansion.

- Influence and copying of externally applied reduction models are perceived, despite significant Brazilian differences in the emissions matrix.

Context – Steel Sector

- Current production below installed capacity - 68% of capacity
- Stagnation of steel consumption in the last 37 years - 92 kg / year per capita (2017). Since 1980 it's been around 100 kg / year per capita
- Increased imports of steel and manufactured products. Carbon leakage from other countries are going up.

Challenges of the Brazilian Steel Industry

- Incentives for innovation research on technologies, particularly those with a potential positive effect on GHG reduction

- Criteria for accounting the efforts already made over the last few years with increasing energy efficiency

- Increase the participation of charcoal use on sustainable-basis, both environmentally and economically.

Brazilian Energy Matrix - Competitive Advantages

- Intense use of renewable biomass, such as: Charcoal, bio-diesel and ethanol
- Cleaner energy matrix, with 43.5% of renewable or non-emitting GHG.
- Among non-renewable energy generation, 12.3% is GN.
- The average energy emission factor since 2006 is 18.7 kg CO2 / GJ, even considering frequent water crises.
- Expectation of wind and solar power generation to increase from 5.4% in 2016 to 12% by 2026 (Source: EPE)

Brazilian Steel Sector - Competitive Advantages

- **Production of pig iron**
  - Research on improvements and increase of yield in the production of biomass. Training and certification efforts to guarantee production of pig iron with renewable and legalized biomass.
- **Reuse integrated plant gases in thermoelectric plants**
  - 49% of the electric energy used by the sector in 2017 comes from the reuse of steel gases in thermoelectric plants
- **Aggregate value to waste / co-products**
  - Significant increase in the use of co-products in the Coke oven, Sinter plant, Blast Furnace and Steelmaking processes.
  - Search for partnerships and development in the use of co-products in other economic activities. Slag standardization in quality and destination.

GHG Reduction Potential - Brazilian Steel Industry

Preliminary Survey

- Identify and evaluate technologies with potential to mitigate GHG emissions
- Evaluate the resources needed to be implemented both in the sector and in companies, in particular.
- Assess the potential gains, costs related to avoided GHGs and the cost-effectiveness of these measures.
- Assess the economic, environmental and social gains and process risks of these measures.
- Compare the opportunity cost with the selected investments and identify price levels that may compete and / or inhibit these measures.

Technologies - Technical Feasibility and Cost-Benefit

Assumptions

- **Site-specific variables** affect costs and / or practicality;
- Energy efficiency can be improved and reduce GHG emissions, but **other pollutants may increase**;
- The technologies that already have a **significant number of installations**;
- **Only feasible for new units**;
- Technology / **specialized processes**, only technically suitable for some production configurations
- **Immature technology** and/or practice because they are still under research, pilot, or installed in very few steel mills.
- **Pay-back** should be at the same conditions that usually is practiced by companies

Most commonly used and adopted technologies

Mesures / Technology	TM	CI	TC
Cokemaking			
Coal Moisture Control	⏳	$$	💻
Coke Dry Quenching	⏳⏳⏳	$$$	💻💻
Heat Recovery Coke Oven	⏳⏳⏳	$$$	💻💻
Furnace Pressure and Losses Control	⏳⏳	$	💻
COG Recovery	⏳⏳⏳	$$$	💻💻
Sintering:			
Heat Recovery	⏳	$$$	💻💻💻
Reduction Air Leakage	⏳⏳⏳	$	💻
Increasing Bed Depth	⏳⏳⏳	$$	💻
Use the waste fuels	⏳⏳	$	💻
Blast Furnace:			
Top Pressure Recovery Turbine (TRT)	⏳⏳⏳	$$$	💻💻
Pulverized Coal Injection	⏳⏳	$$$	💻💻💻
NG Injection	⏳⏳	$$	💻💻
Recuperator Hot-Blast Stove	⏳	$$$	💻💻💻
BF gas recicling	⏳⏳⏳	$$$	💻💻

⏳ **TM** - Technology Maturity

$ **CI** - Cost of Investment

💻 **TC** - Technological Complexity

Most commonly used and adopted technologies

Mesures / Technology	TM	CI	TC
BOF:			
BOF heat recovery	⌛	$$$	💻💻💻
BOF Gas Recovery	⌛⌛	$$	💻
Variable Speed Drive on Fans	⌛⌛⌛	$$	💻
Scrap Use	⌛⌛⌛	$	💻
Near Net Shape	⌛	$$$	💻💻💻
Rolling Mill			
Hot Charging	⌛⌛	$$	💻💻💻
Recuperative Burners	⌛⌛	$$	💻
Insulation of Furnaces	⌛⌛⌛	$$$	💻💻
Controlling O2 Levels	⌛⌛	$	💻💻
General:			
Process Control Improvements	⌛⌛⌛	$	💻💻💻
Variable Speed Drive on pumps	⌛⌛⌛	$$	💻
Cogeneration Efficiency	⌛⌛	$$$	💻💻💻
Reducing Flare Emission	⌛⌛	$$	💻💻💻
Management System / Energy Efficiency Program	⌛⌛	$	💻💻

⌛ **TM** - Technology Maturity

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💻 **TC** - Technological Complexity

Most commonly used and adopted technologies

Mesures / Technology	TM	CI	TC
Electric Arc Furnace:			
Processed Scrap	⏳⏳⏳	$$	💻
Furnace Pressure Control	⏳	$$	💻💻💻
Caster sequence	⏳⏳⏳	$$	💻💻
Tires and other carbon waste charge	⏳	$	💻💻💻
Adjustable speed drives	⏳⏳⏳	$$	💻
Foaming Slag	⏳⏳⏳	$	💻💻
Eccentric Bottom Tapping	⏳⏳⏳	$$	💻💻
Oxi-Fuel Burners	⏳⏳⏳	$	💻💻
Supersonic Lances	⏳⏳⏳	$$	💻💻
Scrap Preheating	⏳⏳	$$$	💻💻💻
Flue gas monitoring and control	⏳	$$	💻💻💻
Thin Slab	⏳	$$$	💻💻💻

⏳ **TM** - Technology Maturity

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💻 **TC** - Technological Complexity

Ranking

- **Level of technology maturity -** Technology already widely used and with good penetration or immature process, depends on more research.
  - Consolidated - ⌛⌛⌛
  - Intermediate (few examples) - ⌛⌛
  - Insipient - ⌛
- **Cost -** Applicable to new plants, high capital cost and long return on investment.
  - High - $$$
  - Medium - $$
  - Low - $
- **Technological Complexity –** Complex process, raw material dependency, local specific variables, trade-off with other pollutants, very specialized technology.
  - High - 💻💻💻
  - Medium - 💻💻
  - Low - 💻

From a technical and operational point of view

- A **bottom-up approach** focused on the companies, given the great sector diversity. There is no standard measure or technology easily to apply.

- Have to consider that the **technological impacts** of changes can spread throughout the **industries value chain**, up stream and down stream.

- Do a more realistic **assessment of the GHG reduction potential** for each technology, in order to avoid over appreciation of emission reductions or undervaluation of mitigation costs based on a quite small and particular sampling.

- **None technology performance occurs at time zero and constantly**, at the limit of its scale. Must have to consider learning time, technology maturity, operational adjustments, production and maintenance issues.

- **The use of biomass is limited** due to logistic issues, land use rules, technologic development, costs over the production chain and several other externalities.

From the point of view of deployment strategies

- **Achieve balance in the management of emission** abatement technologies, in order to avoid carbon leakage and / or massive import substitution.
- **Harmonize climate change policies** and measures with energy generation planning, to maintain growth, coherence and competitiveness of the country's activities.
- **Redeem the GHG reduction measures** already implemented. Measurement and comparison of the theoretical indications with the actual situation.
- **Increase experiences exchange and knowledge** by consolidating or revising technologies/ measures for GHG reductions.
- **Development of measures to support strategic** activities in the country.

From a market and shareholders point of view

- There are important costs that are often not considered in technology assessment, such as **social and environmental costs.**

- The level of **indebtedness versus EBITDA** is significant,

  - **Intense investments** in production and process quality in the recent past.

  - Impact of strong **currency exchange rate** variation in this period.

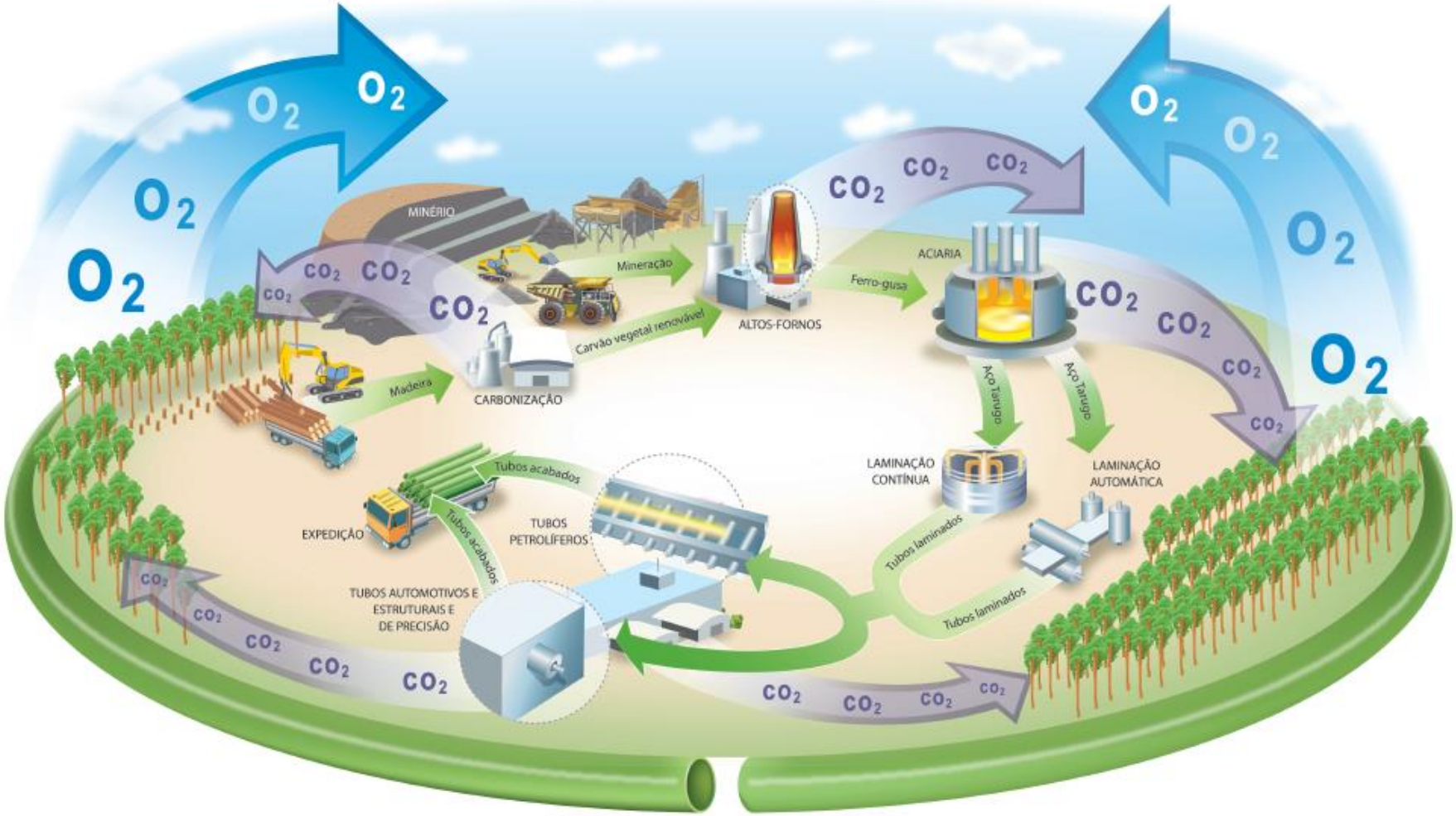
  - **Risk of new technologies and competitiveness impact.**

- The **uncertainties of the markets, internal and external**, are relevant factors in the investments decision, and as consequence in the emission reduction equation.

- A **technology to be considered in full use should have penetration** in a certain number of the countries and in the largest steel producing companies, and if possible, globally dispersed.

Development in Brazil

Carbon cycle in the charcoal production and use



Development in Brazil

Improvements in forest formation

Development in Brazil

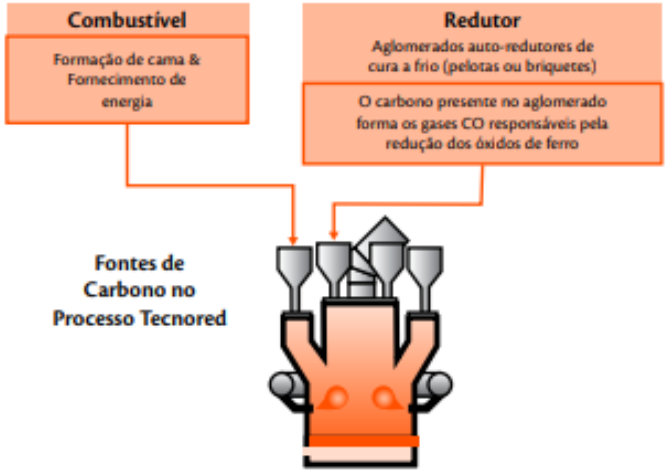
Development in Brazil

Carbonization Improvements

Fonte: CGEE

Development in Brazil

Tecnored



Conclusion

Good News

- Brazilian steelmaking sector is up to date on the technologies used.
- Despite the serious political and economic crisis, the sector made efforts to maintain the levels of energy efficiency
- The Brazilian steel industry has the charcoal route as differential in relation to the other countries in terms of GHG emission reduction, but there are technical and economical barriers that do not allow so far a high pig iron production volume.
- There are enormous potential for reducing emissions in the agriculture, forestry and energy sectors. The benefits in increasing clean energy generation will also be felt and used by the steel industry.
- The steel sector actively participates in the discussion of policies and measures to reduce GHG, with the public and private sector, remaining proactive but aware of the risks that these actions may bring to their activities if they do not consider equilibrium relations well balance between financial and environmental issues