

ENERGY USE IN THE STEEL INDUSTRY

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IEAGHG/IETS Iron & Steel Industry CCUS and Process
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Disclaimer text

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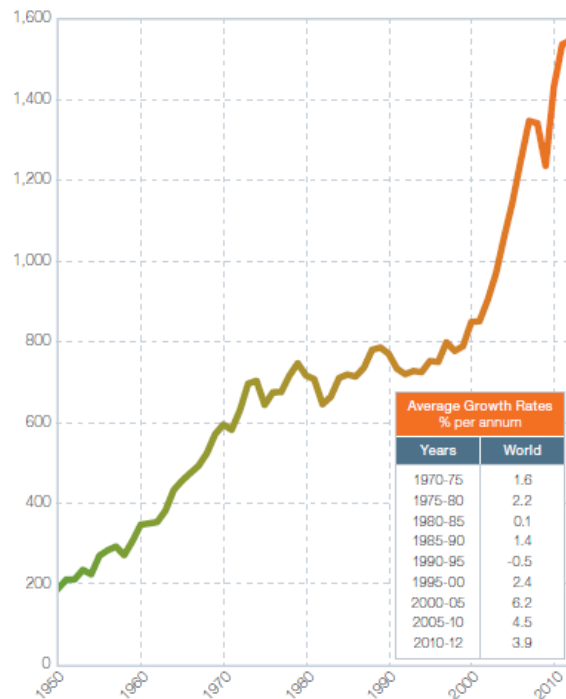
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Agenda

- Global Steel Industry Overview
- Energy use in the steel industry
 - *aims & goals*
 - *methodology*
 - *results analyzes*
- Technology survey
- worldsteel web based tool
- Other issues related to steel industry

The iron and steel industry – *where we are*

- Total world crude steel production in 2012: 1 542 Mt
- Energy costs represent around 20 to 25 % of the total input of steel producers and it becomes one of the most important topic of steel producers
- Coking coal accounts for more than 65% of primary source of energy



Average CO₂ Intensity: 1.8 t CO₂ / t_{CS}

Average Energy Intensity: 18.2 GJ / t_{CS}

BF / BOF: 69.6% EAF: 29.3 %

OHF: 1.1%

Energy use in the steel industry

Active Members of the Energy use Project:



United States Steel Corporation



Project objectives and background

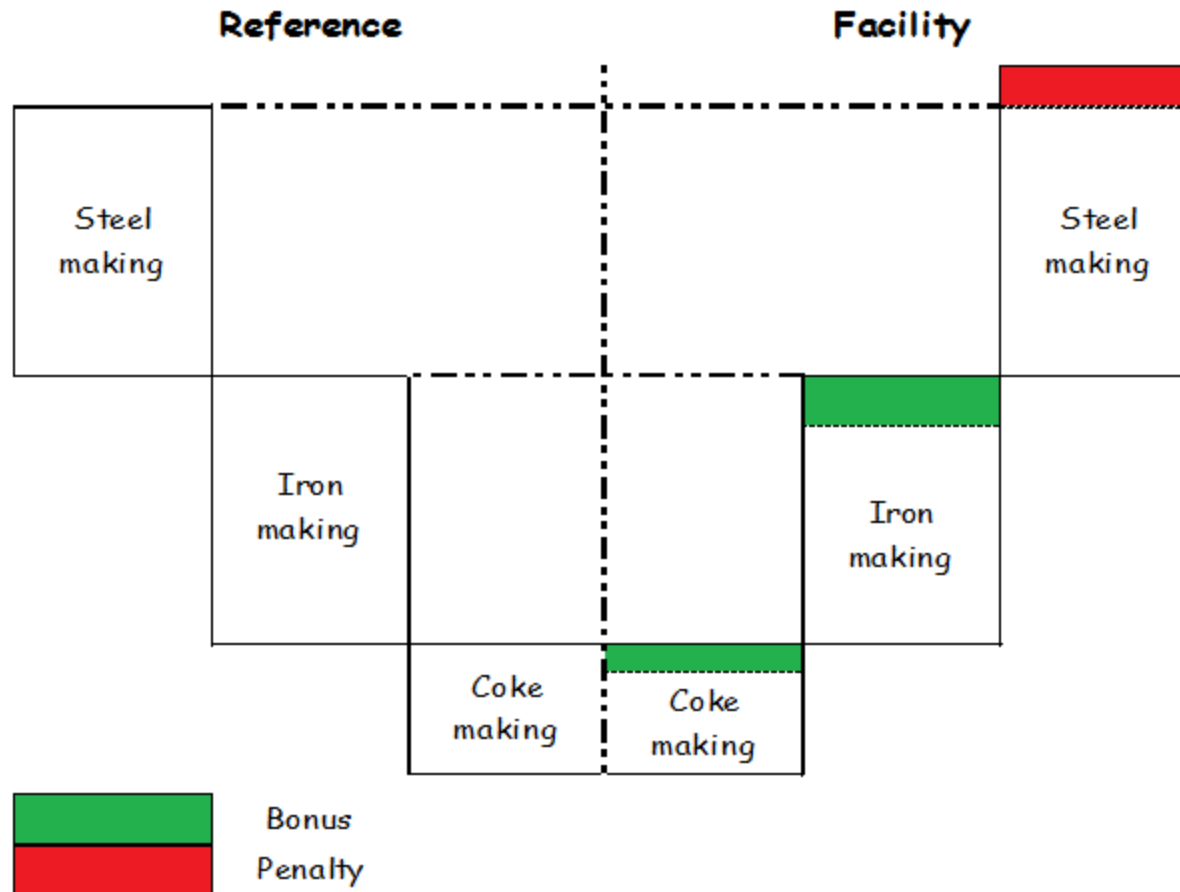
- Enable steel producers to make a fair comparison of their own energy consumption with a standard reference plant and their peers on a site and facility level
- Enable steel producers to analyze the performance gap between of their own performance, the reference and peers on a site and facility level
- Enable steel producers to monitor their trend of change of their energy performance taking into account all key factors, e.g. process production level, raw material selection, technologies.
- Provide an ongoing web based tool for the worldsteel members to measure their performance on an annual or ad-hoc basis.
- Be able to evaluate technologies and build a business case for implementation based on practical performance

The study covers these plant types

- Sintering
- Pelletizing
- Direct Reduced Iron
- Coking
- Iron making (BF/SR)
- BOF
- EAF
- Continuous Casting
- Hot Rolling Mill
- Air Separation Unit
- Power Plant
- Flares

**GJ / t of Crude Steel /
Cast Steel or process
Product
or / and
GJ / t of HR Coil**

Principle of performance assessment for multi-step production routes



worldsteel reference plant definition

Reference plant #1: This Reference Plant values were developed on the base of the Energy specialist data and core group experience and data collected from more than 60 sites all around the world over a 5 year period. The energy intensity of analyzed steel facilities will be compared with the Reference Plant #1 values.

Energy survey top quartile results: *In the future further reports will use worldsteel reference plant direct data from an average of the best 25 % data of member's sites in the future.*

Reference plant vs. site energy intensity

Coke Plant (RP)

		Unit	Flow	Energy (MJ)
In	Coking coal	kg/t	1,267.5	40,725
	Light oil	l/t	2.6	91
	CO gas	MJ/t	489.6	490
	BF gas	MJ/t	2,224.9	2,225
	BOF gas	MJ/t	550.7	551
	Electricity	MWh/t	38.3	375
	HP Steam	kg/t	81.7	310
	Oxygen	m ³ N/t	1.1	8
	Nitrogen	m ³ N/t	5.4	11
	Compressed air	m ³ N/t	7.3	8
	Out	Coke	kg/t	1,000.0
CO gas		MJ/t	7,652.2	7,652
Tar		kg/t	34.5	1,286

Heating fuels	3,265
Utilities	712
(Coal+Oil)	40,816
Coke + Tar	31,421
Coke oven gas	7,652
Total energy	5,719
Processing Energy	3,977

Coke Plant (Analyzed plant)

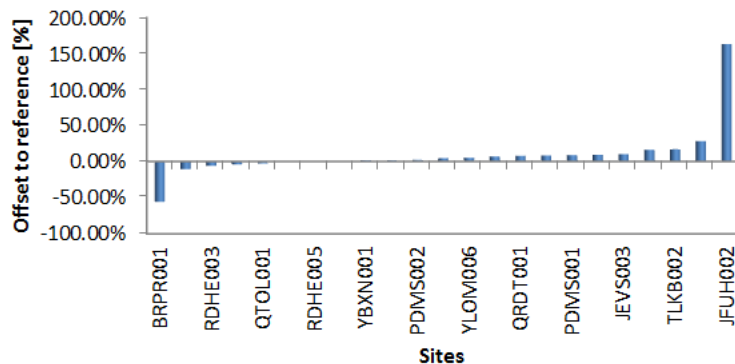
		Unit	Flow	Energy (MJ)	
In	Coking coal	kg/t	1,245.93	40,119	
	CO gas	MJ/t	1,172.00	1,172	
	BF gas	MJ/t	2949.6	2949.6	
	Natural gas	MJ/t	1.7	1.7	
	Electricity	MWh/t	0.1	360.4	
	HP Steam	kg/t	0	0	
	Oxygen	m ³ N/t	0	0	
	Nitrogen	m ³ N/t	3.57	7	
	LP Steam	kg/t	196.6	680.2	
	Compressed air	m ³ N/t	11.2	12.1	
	Out	Coke	kg/t	882.4	26,561
		Coke Breeze	kg/t	117.6	3,539
CO gas		MJ/t	7,952.00	7,952	
Benzole		kg/t	4	163	
Naphtalenic oil		kg/t	0	0	
Tar		kg/t	36.7	1357.7	

Heating fuels	4,124
Utilities	1,059
Coking blend	40,119
Products	31,621
Coke oven gas	7,952
Recovered Energy	0
Total energy	5,729
Processing Energy	5,183

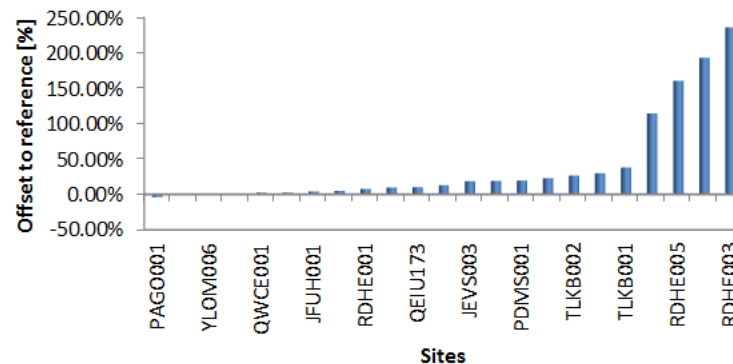
Roll up Methodology of EI assessment

1	Roll-up Primary Metal level	Sinter Plant + Coke Oven Plant + + BF Plant
2	Roll-up Crude Steel level	(1 + Steel Shop)
3	Roll-up Hot Rolled level	(2 + Hot Rolling Mill)
4	Roll-up site level	(3 + Power Plant + ASU + Flares)

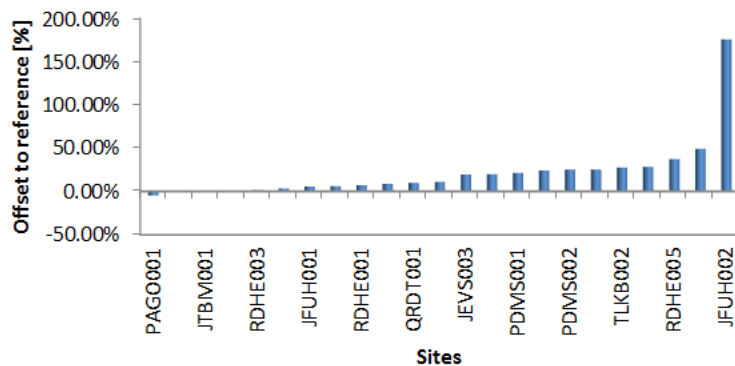
Hot metal production (Iron ore based steel), Year:2010



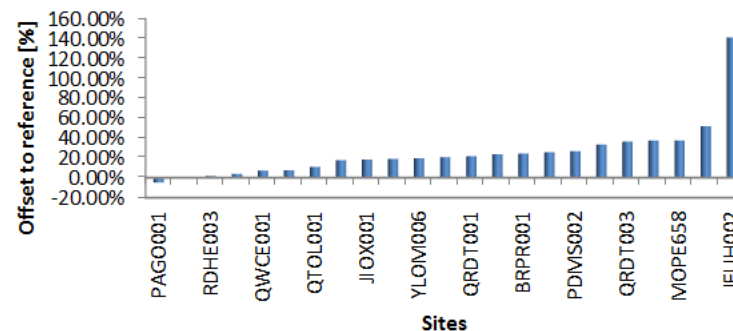
Crude steel (Iron ore based steel), Year:2010



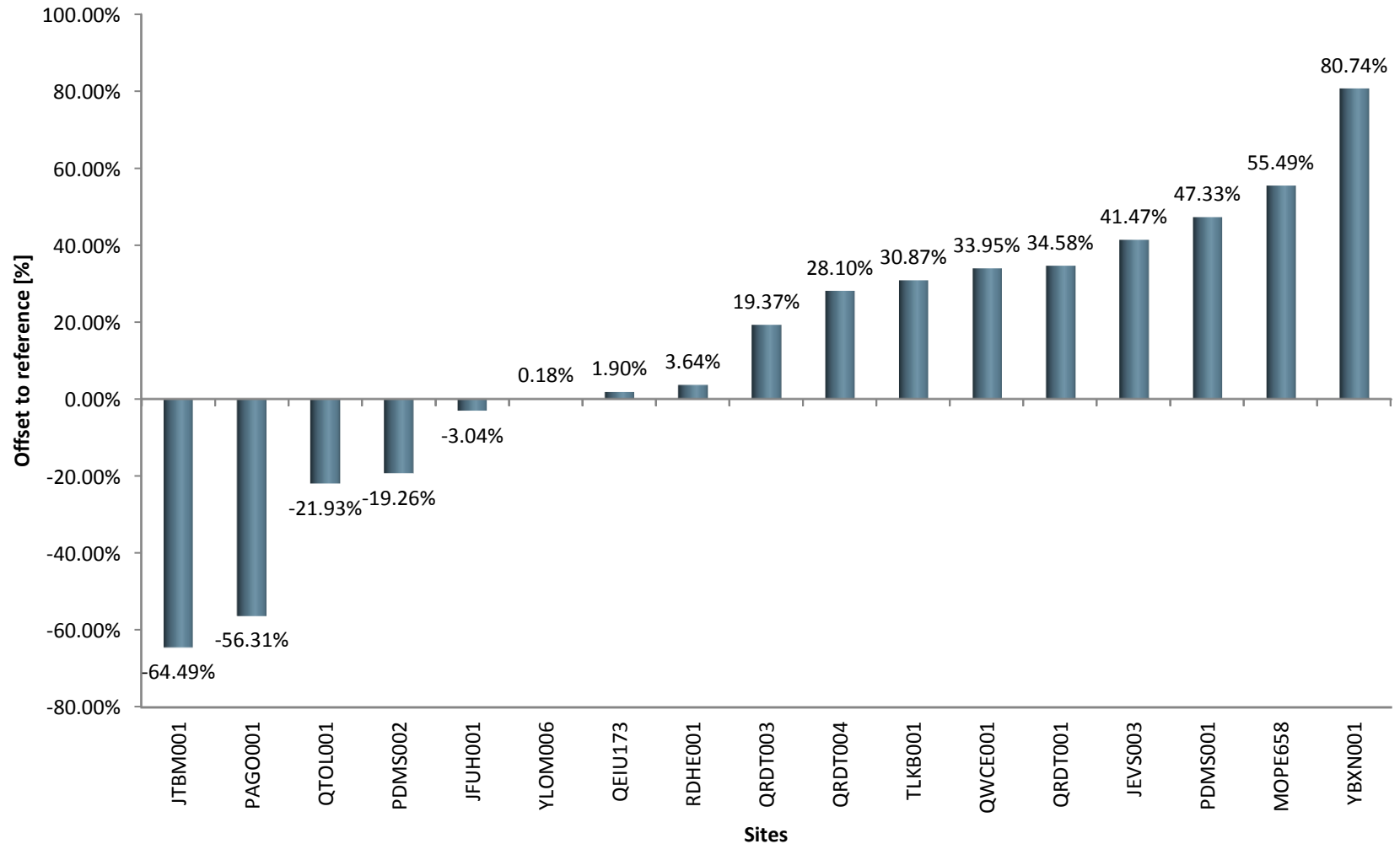
Hot rolled products (Iron ore based steel), Year:2010



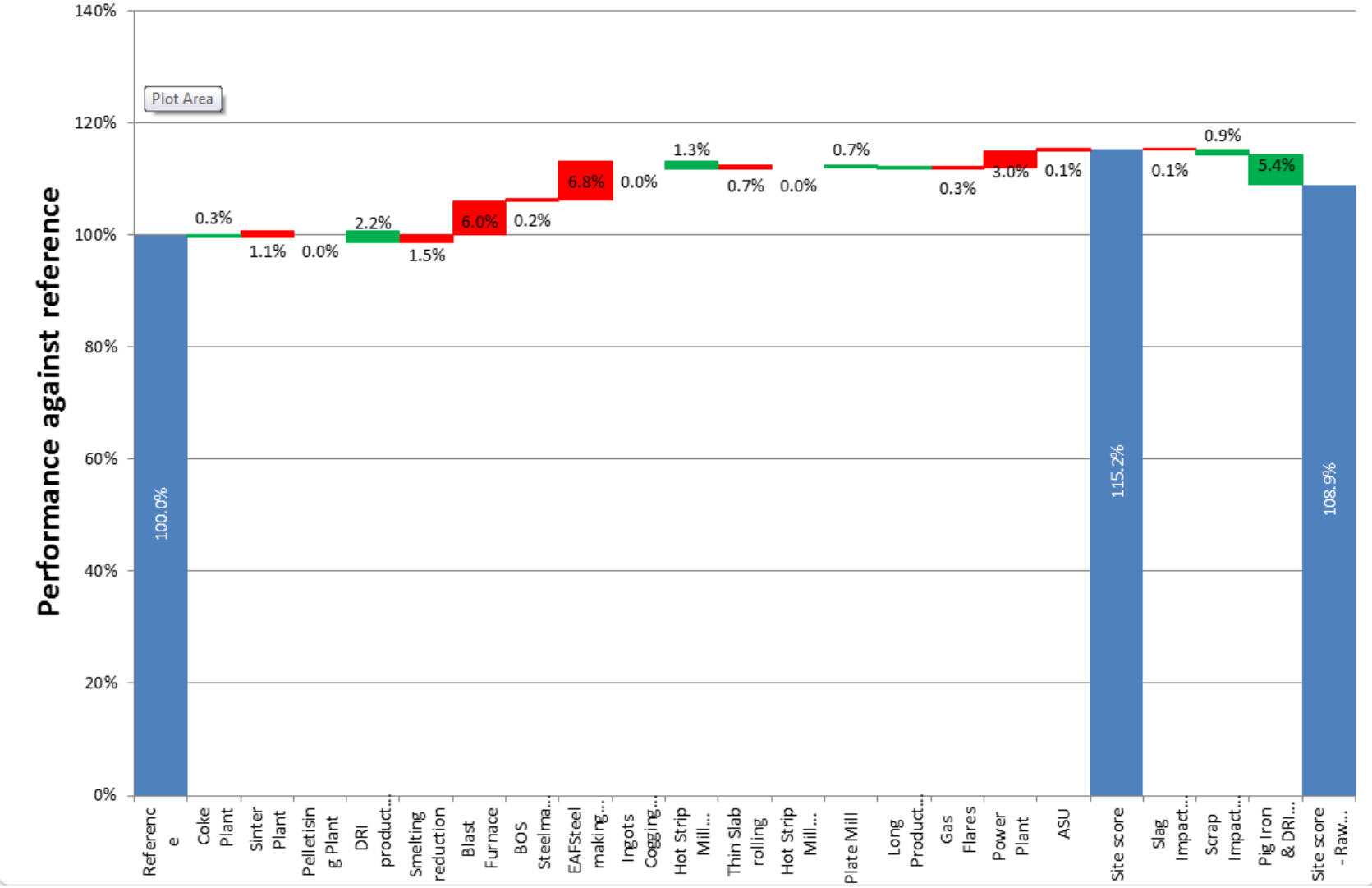
Site (including Power plant, Oxygen plant and Flares) (Iron ore based steel), Year:2010



Coke oven plants EI comparison with worldsteel reference

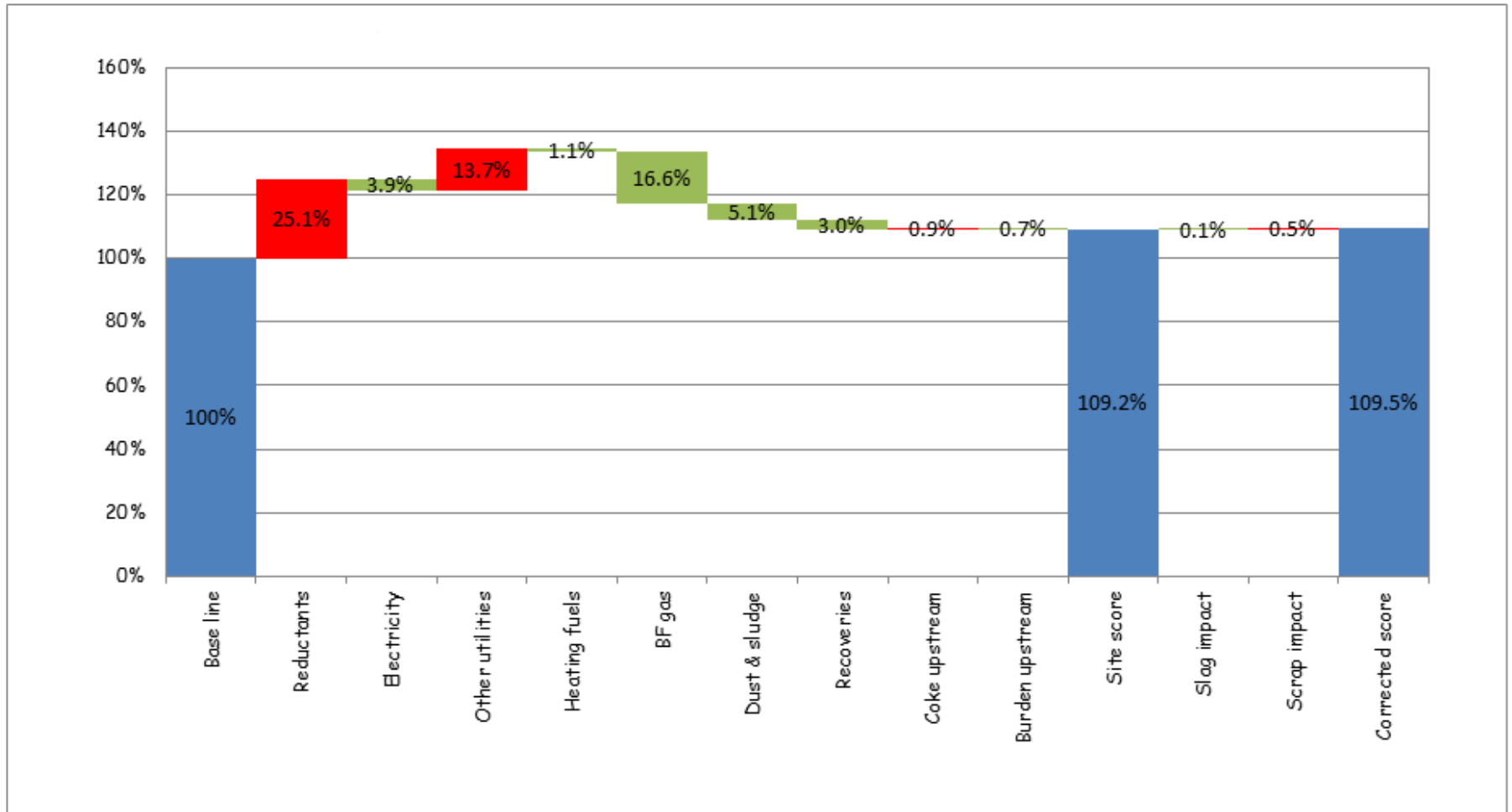


Analyzed site waterfall graph

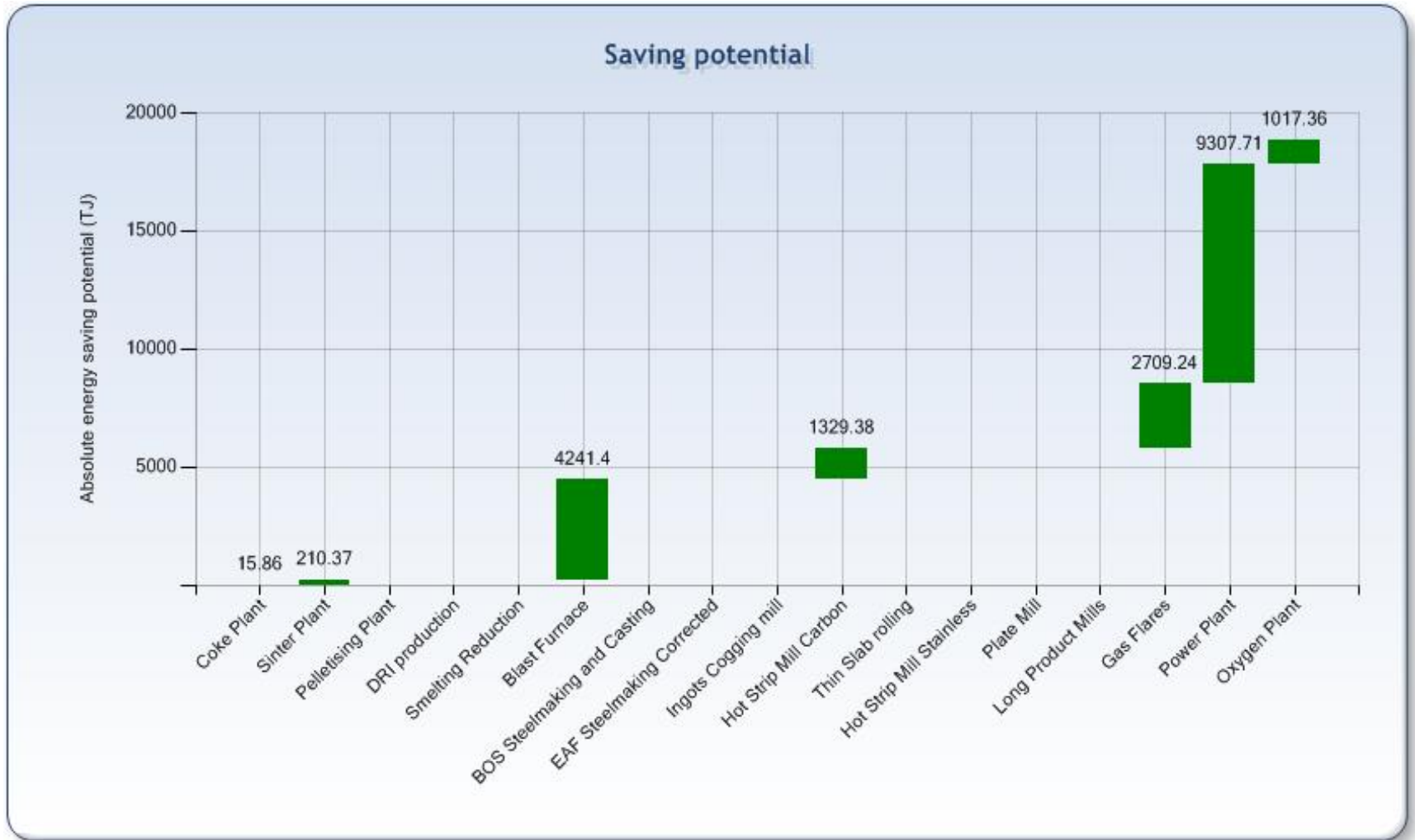


BF plant – process waterfall graph

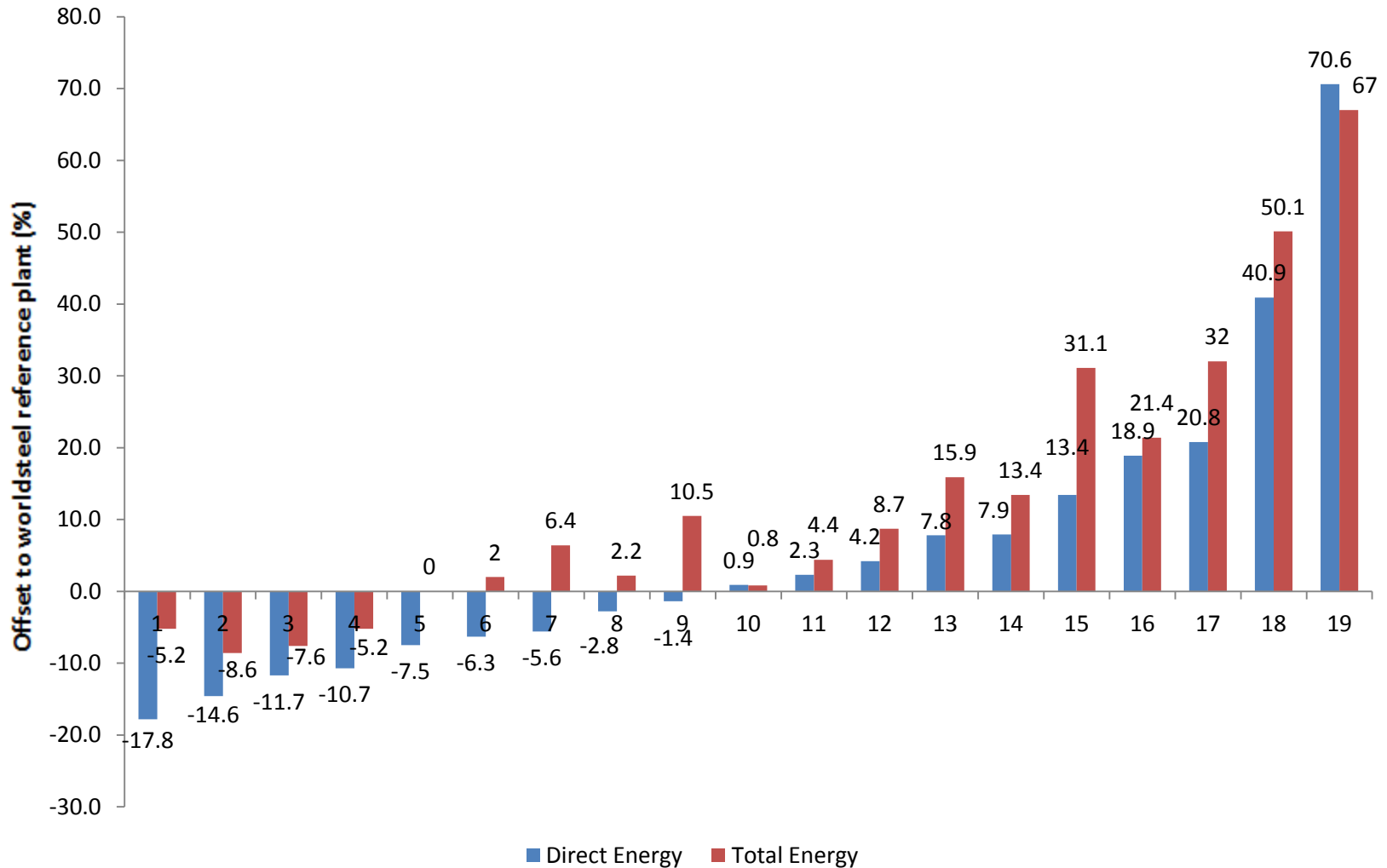
Process waterfall graph



Energy saving potential



Sinter plant direct energy vs. total energy intensity



Technology Survey

Technology survey

- A technology questionnaire was developed to analyze the gap between the energy intensity of plants and sites depending on equipment used.
- Contains more than 190 energy efficient techniques and technologies and analyze the impact of the energy efficient technologies on the totally energy intensity of plant.
- Each defined technology must be able to decrease the energy intensity of the steel production process or can increase the productivity or quality of the products.
- Project members analyzed the implemented technologies and determined the reason for implementing these technologies.

List of techniques and technologies

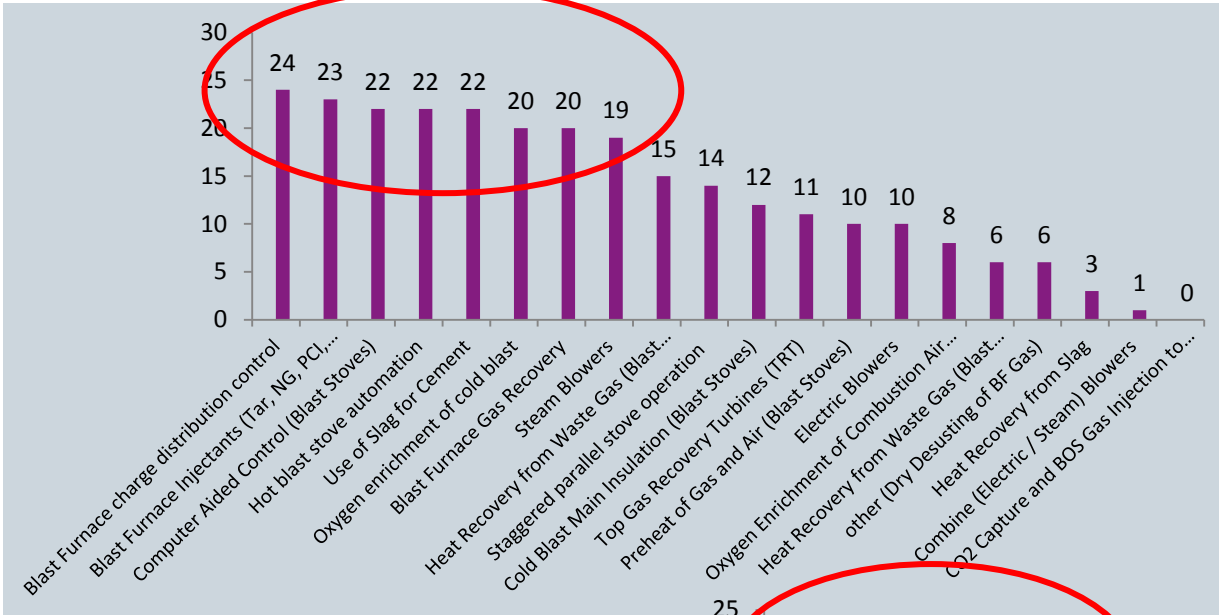
- Based on the IISI report from 1998
 - *100 Energy Efficiency Techniques & Technologies were identified*
- On the base of other reports
 - *90 Energy Efficiency Techniques and & Technologies were identified*

Basic questions in the list:

- Are these techniques and technologies used in your plant?
- The main drivers / reasons for implementation.
- Years of experience with these technologies.
- Did the technologies deliver the expected performance or improvement?
- Do you have development plans to implement energy reducing technologies?

**Most widely implemented EST within
Energy use project members**

EST implemented at BF plant and BOF Shop

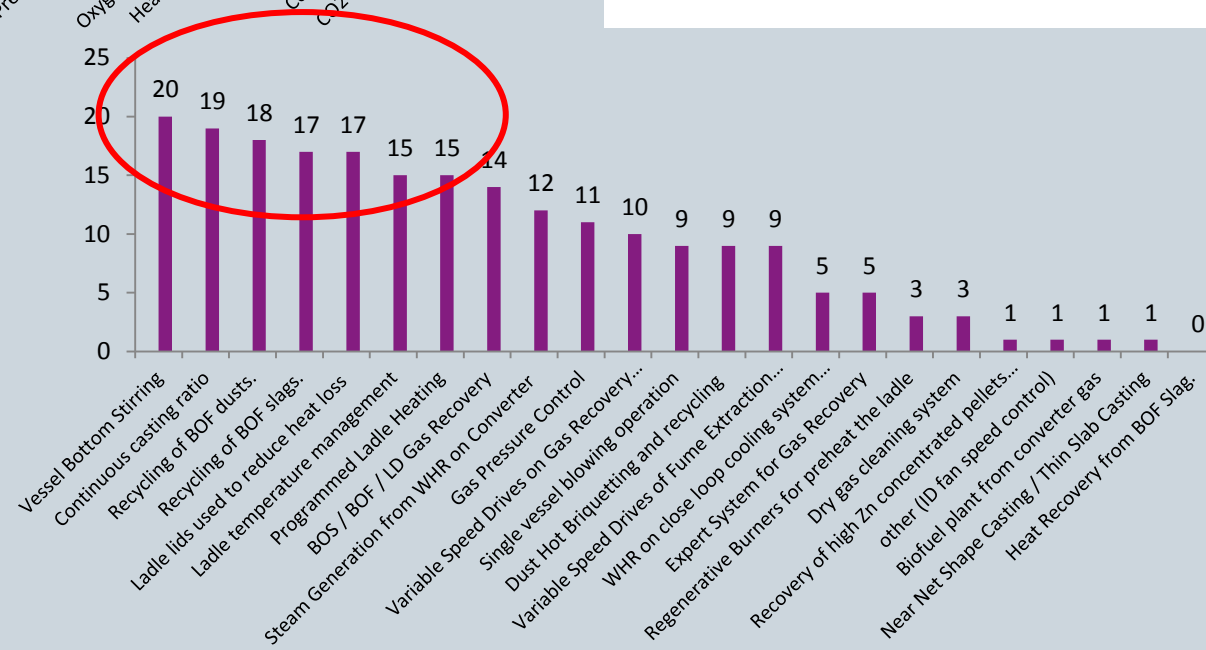


No. of analyzed energy saving technologies: **20**

40% of EST are widely implemented at BF plants

No. of analyzed energy saving technologies: **23**

30% of EST are widely implemented at BOF plants



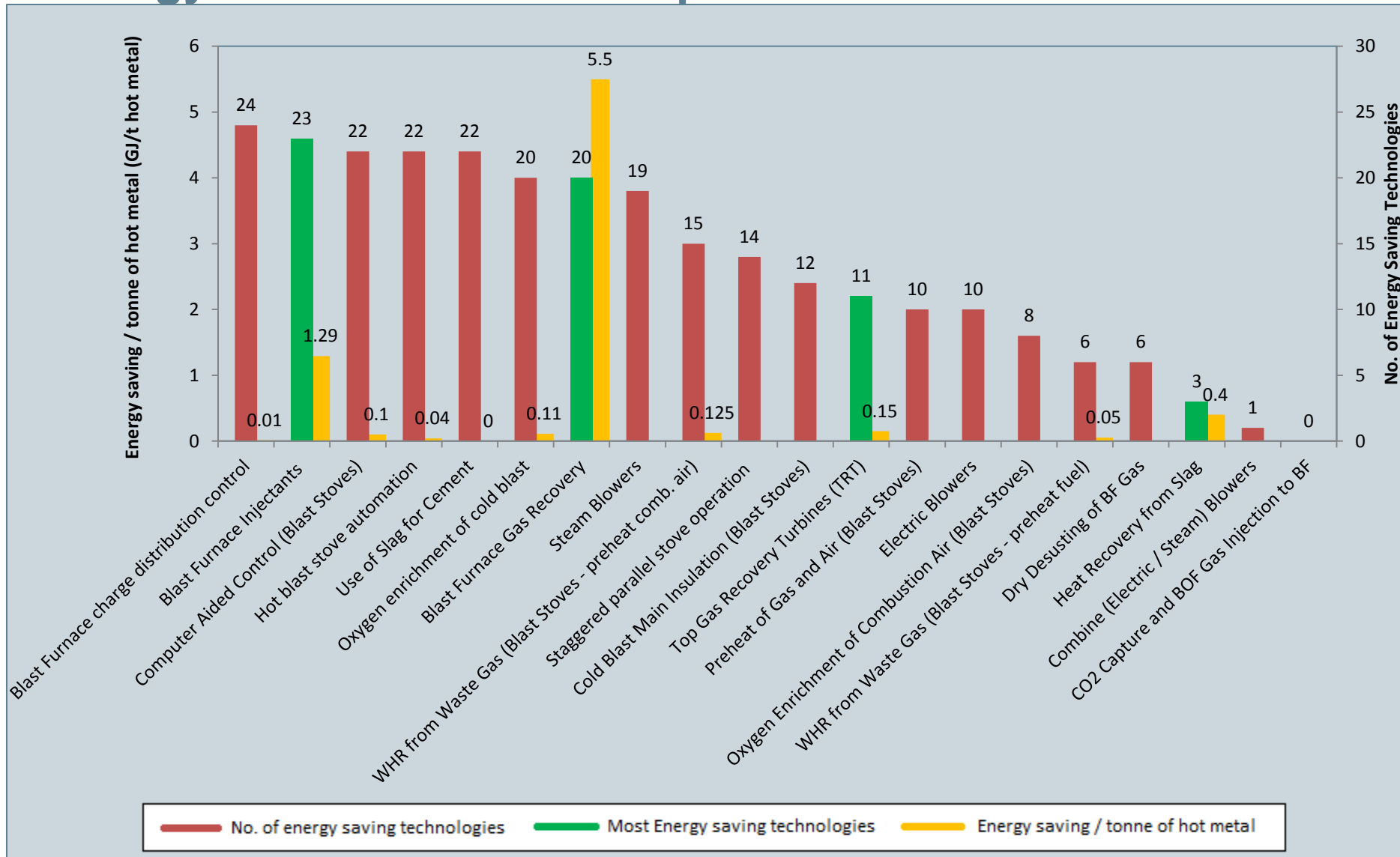
Top 4 Energy Saving technologies implemented at blast furnace plants

- **Blast furnace charge distribution control** (*reduce coke consumption*)
- **Blast furnace Injectants (Tar, NG, PCI, etc.)** (*reduce coke consumption / Saving energy (coke rate) and better control of raceway (heat level control) / Increased BF-productivity*)
- **Computer aided control (blast stoves)** (*monitoring and controlling the combustion process, improve energy Eff. / Heat demand software - better control and energy savings*)
- **Hot blast stove automation** (*Higher average blast temperature, lower coke consumption, lower energy intensity of hot metal production*)

Top 4 energy saving technologies that can save most energy at the blast furnace plant:

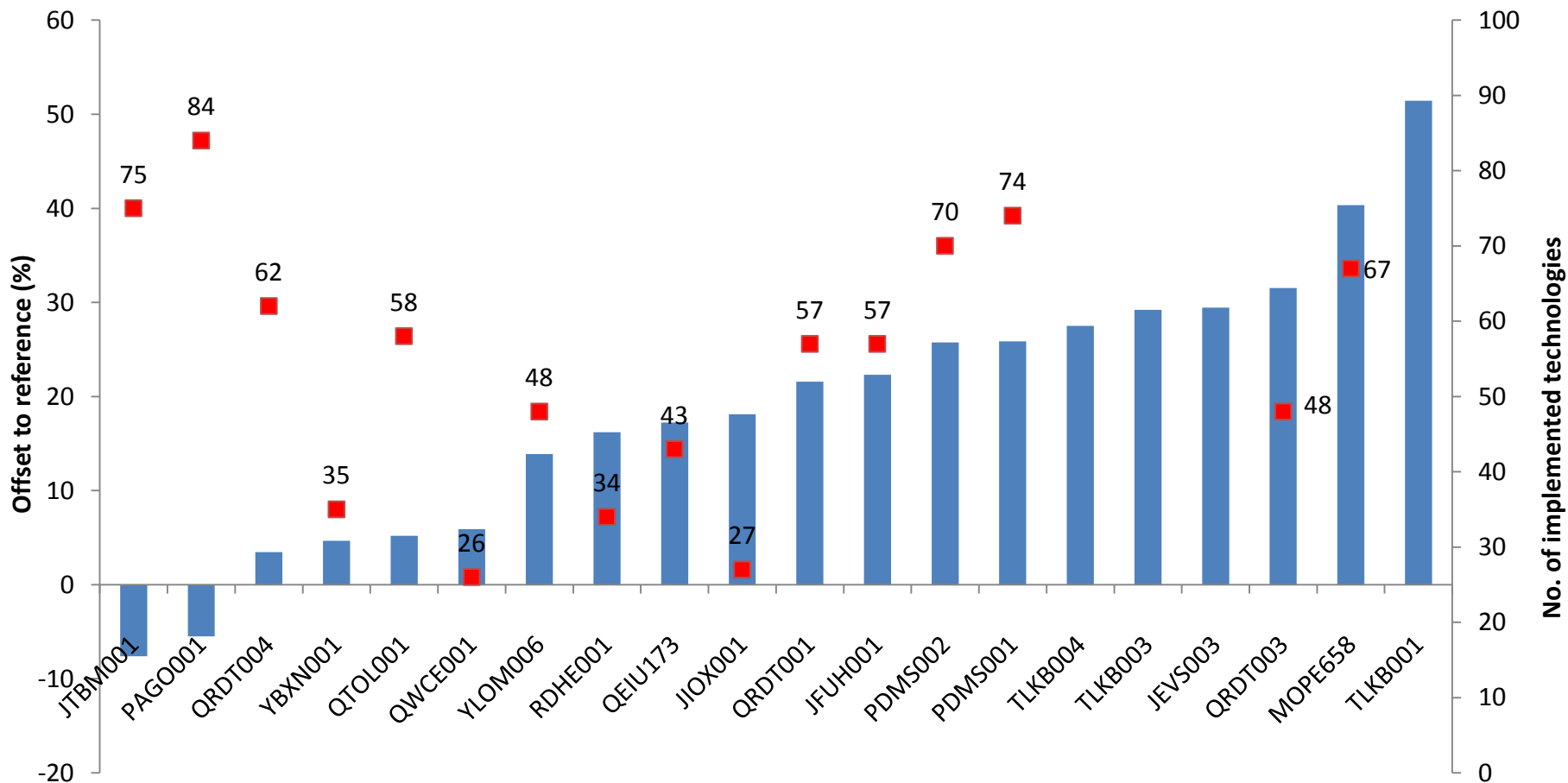
- **BF Gas recovery:** *The BF gas exported from the BF is typically used to fire hot stoves, coke batteries and any excess sent to power plant or HRM (5.4 – 6.5 GJ/t HM).*
- **Pulverized coal injection to BF:** *Energy saving depends on a total amount of pulverized coal injection to BF and it is in the range from 0.5 – 1.4 GJ/t HM.*
- **Top recovery turbine:** *The electricity production by TRT is in the range from 30 – 60 kWh / ton of hot metal (it depends on a type of gas cleaning system, BF operation mode, TRT turbine, etc.)*
- **Waste heat recovery of molten BF slag:** *Heat recovery from slag, i.e. dry slag granulation, is being developed. Slag contains about 2 GJ/t slag of sensible heat at 1500°C. This is high grade heat, with the possibility to produce high pressure steam.*

Top 4 energy saving technologies that can save most energy at the blast furnace plant:



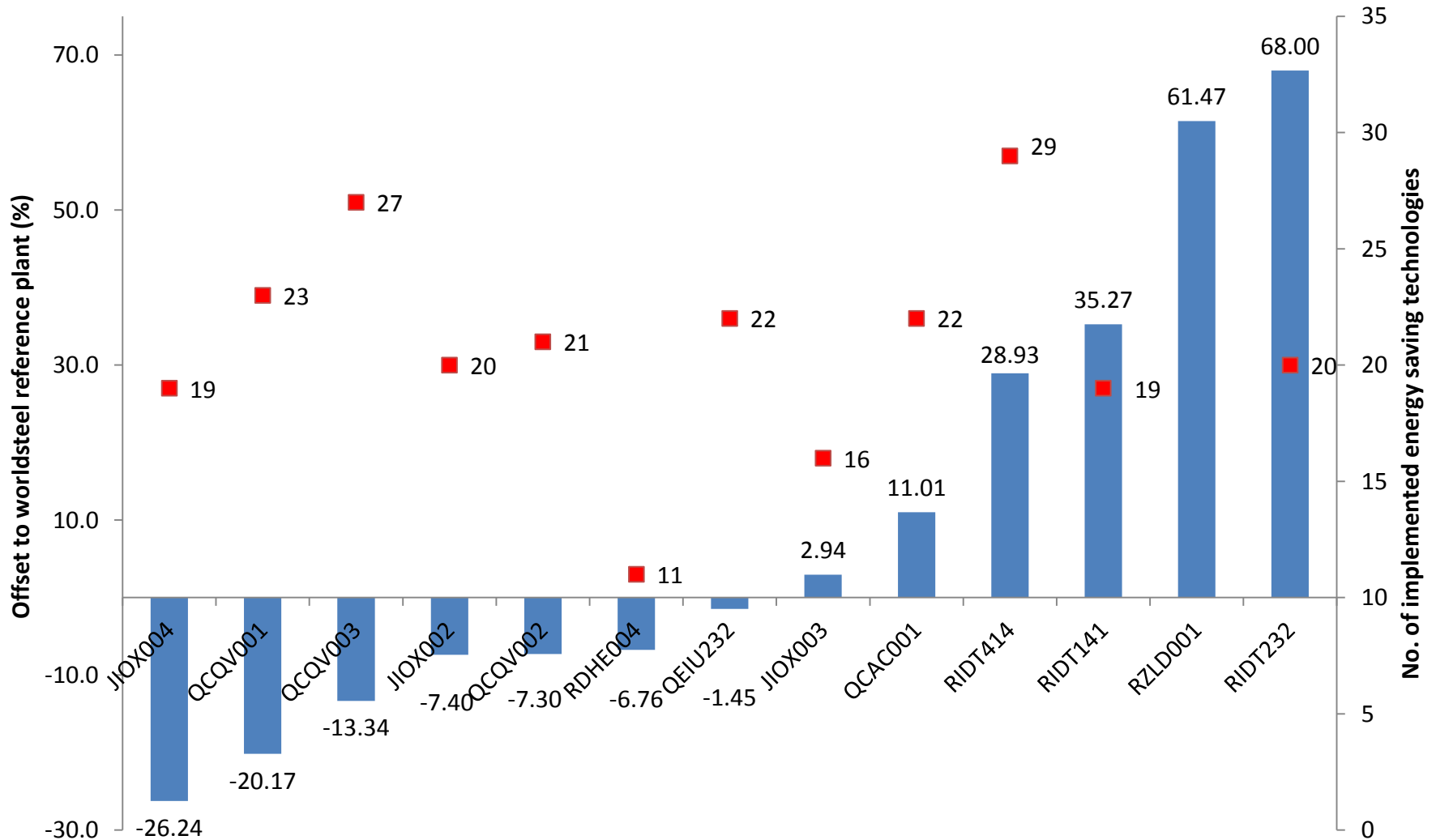
Site Energy Intensity vs. No. of Energy Eff. Technologies

BF-BOF process route

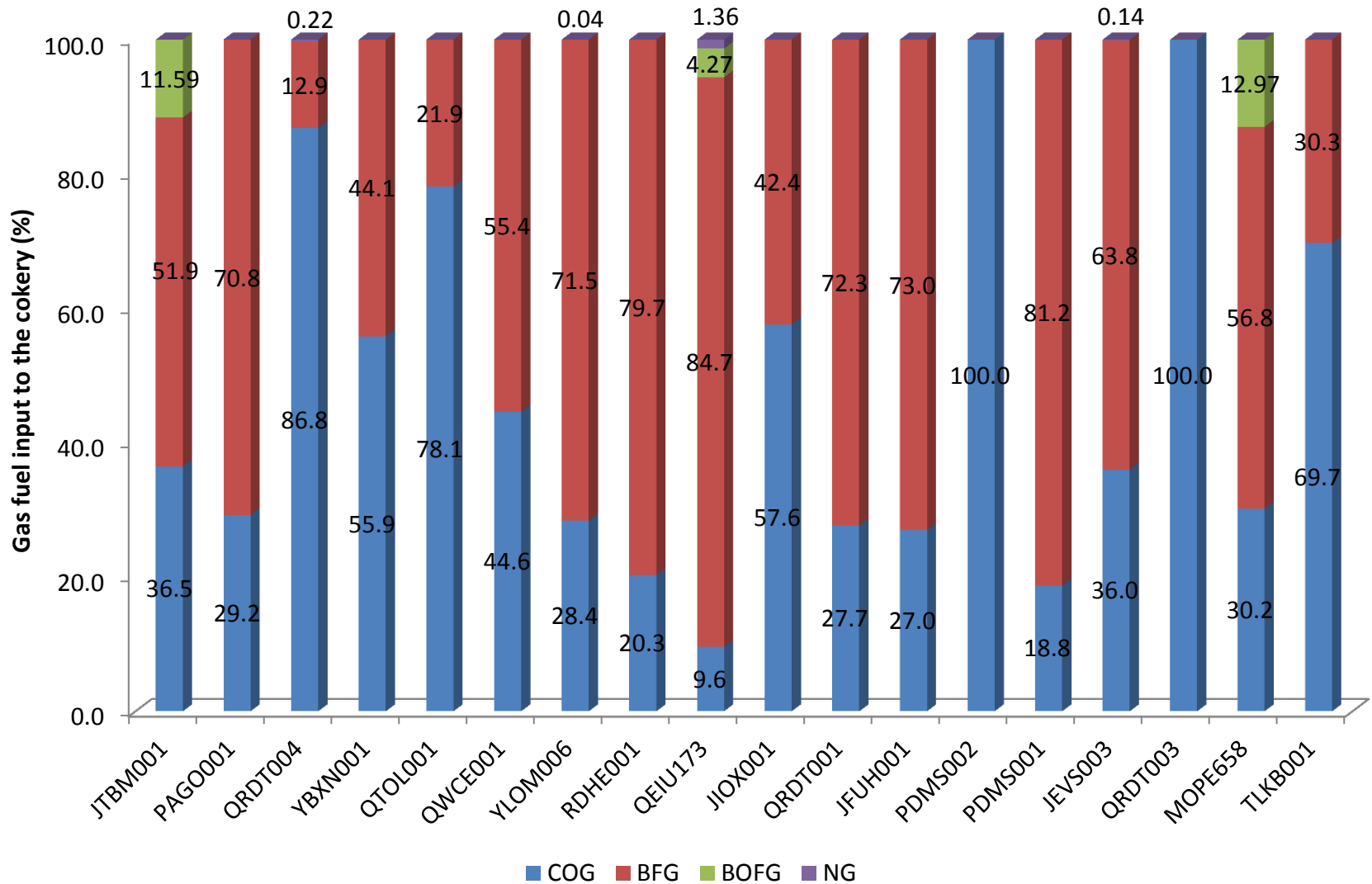


Site Energy Intensity vs. No. of Energy Eff. Technologies

EAF process route



Gaseous fuel input rate to the coke oven process

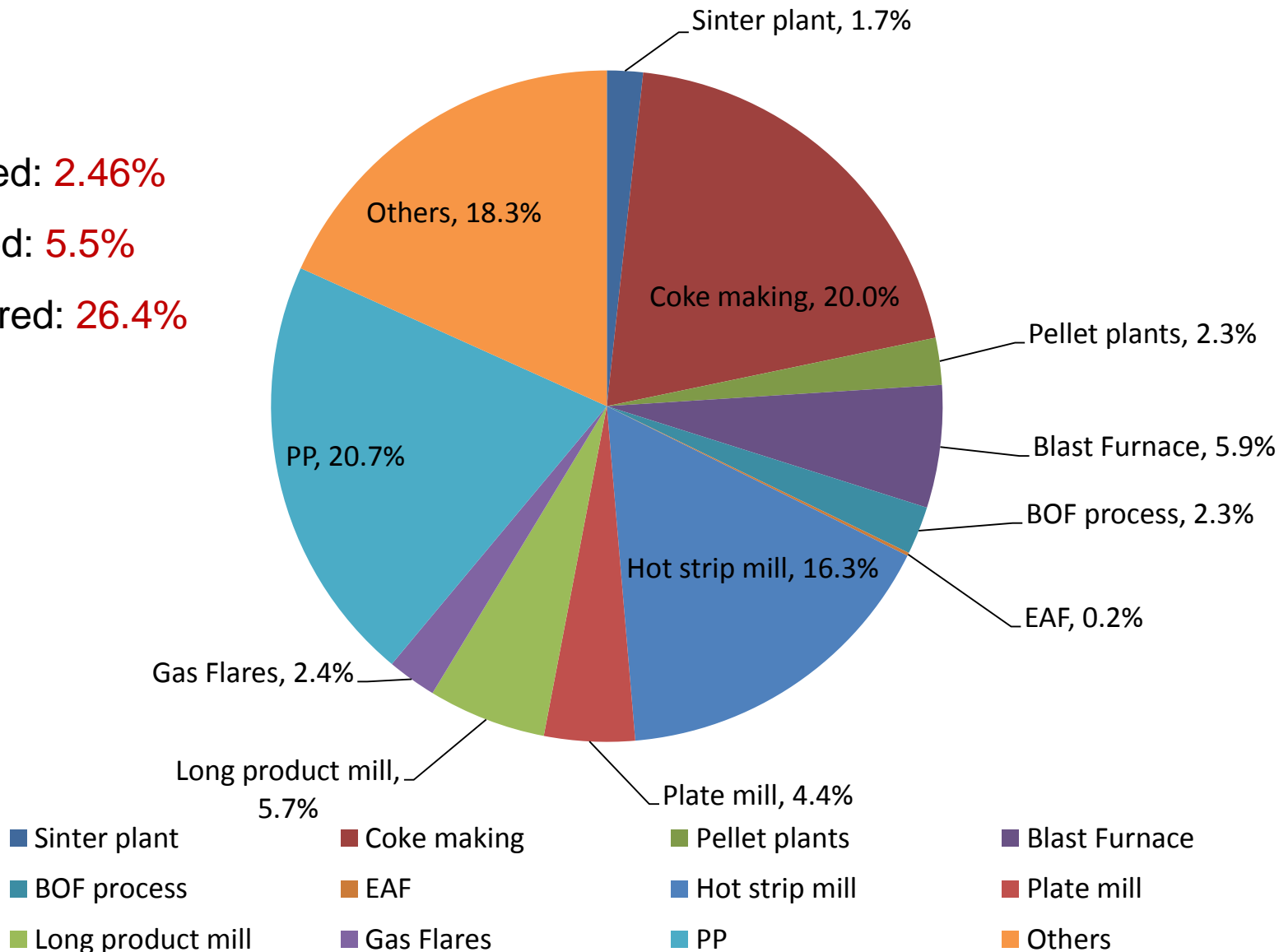


Destination of coke oven gas within metallurgy plants

COG flared: 2.46%

BFG flared: 5.5%

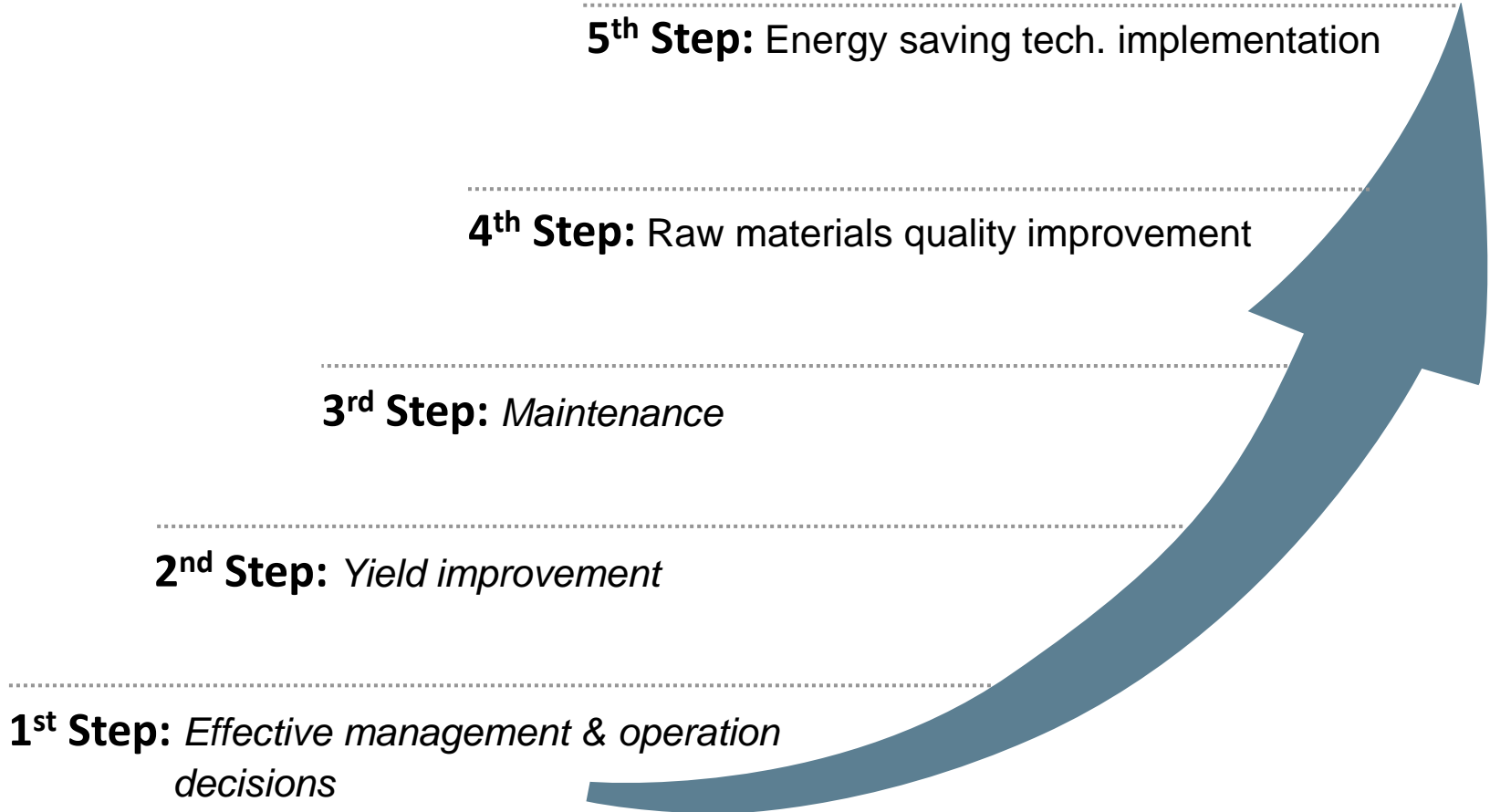
BOFG flared: 26.4%



Energy saving potential of metallurgy industry

- The energy savings identified from the surveyed plants shows that if the industry moves from an average value to a reference plant value, this is BF-BOF average value 18.934 GJ / t Crude Steel. BF-BOF Reference value is 17.674 GJ / t Crude Steel or a gap of **1.26 GJ / tonne of Crude Steel or 6.6% saving.**
- For the EAF route this is less as they are not as complex and use as energy mainly electricity. EAF average energy intensity is 7.33 GJ / tonne of CS. EAF reference value is 6.81 GJ / tonne of CS. Leaving a gap and potential saving **of 0.512 GJ / tonne of Crude Steel or 7.09% energy saving.**

Energy efficiency improvement – worldsteel suggestions



What value is able to be created from this work:

By saving 0.1 GJ / tonne of hot rolled coil is worth about 1.61 Euro per tonne @58 Euro/MWh

The worldsteel methodology and process developed can help you find out where and how to save energy by:

- *Making the right raw materials procurement decision*
- *Making different management & operation decisions*
- *By evaluating and justifying the implementation of technologies*

Energy Data Collection System (V2)

← → ↻ <https://energy.worldsteel.org/Account/Login?ReturnUrl=%2f>

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44 energy surveys already uploaded to the EDCS

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- Database developed in 4 languages
- Standard safety data store
- Multilevel data entry (administrator and user entry)
- 1 system used for 4 worldsteel projects (*Safety, Energy, CO₂ data collection and Maintenance & Reliability*)
- Allow to entry for more users at the same time

**Thank you for your
attention**

Questions??

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