The Innovative DRI-EAF Route for the Production of High-Purity Pig Iron

Kevin Kemper, Pure Fonte Ltée

Francesco Memoli, Tenova Inc.

Date: Monday, May 7, 2018
Time: 9:30 AM - 10:00 AM
Room: 204C
Session: Direct Reduced Iron - Carbon Content & Use
AIST #: 10511-500

STEEL'S PREMIER TECHNOLOGY EVENT

AISTech 2018

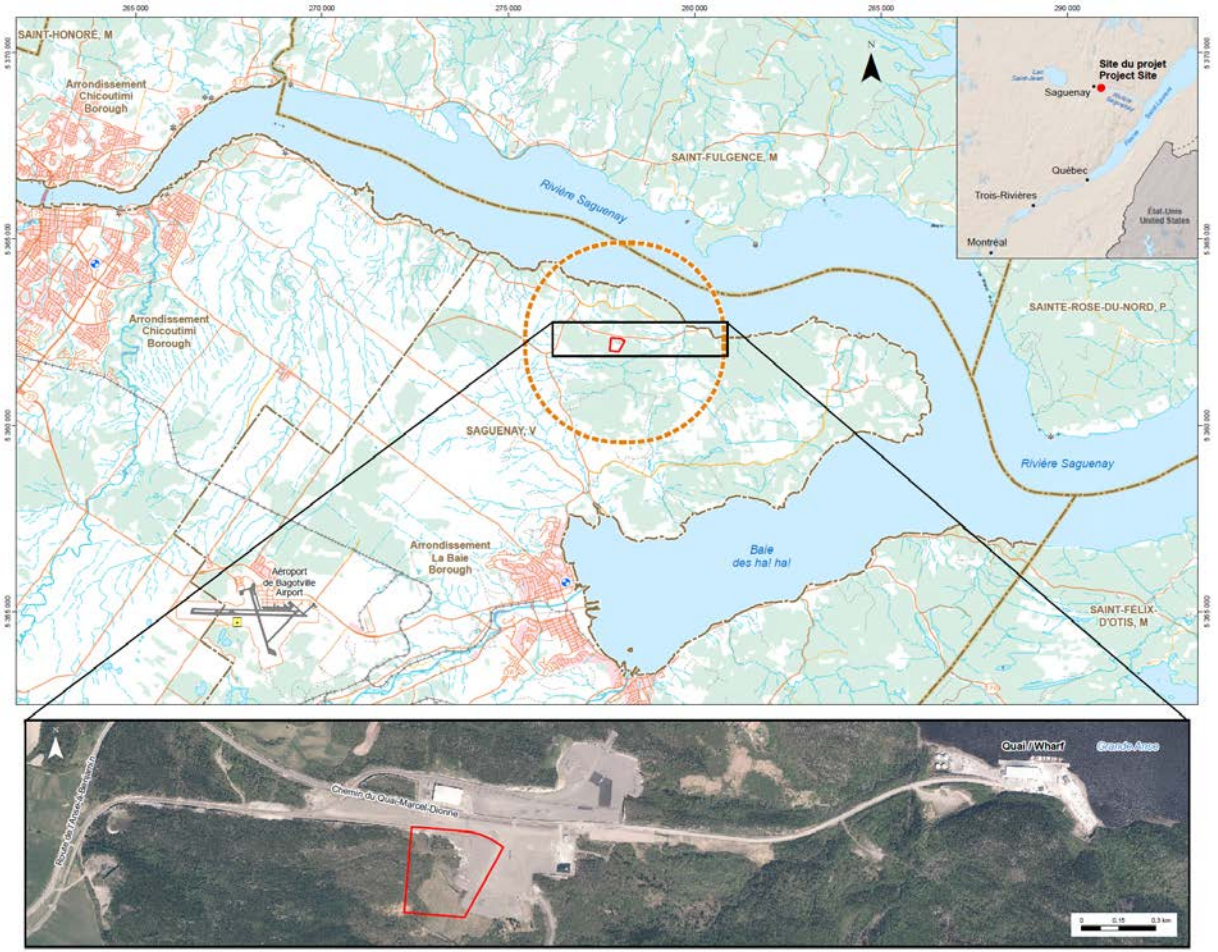
Introduction

- Pure Fonte Ltée. (PFL), successor of North Atlantic Iron Corporation (NAIC) is developing North America's first dedicated high-purity pig iron (HPPI) facility.

- This paper outlines the innovative HPPI production process, developed by Tenova adopted by PFL

- This process route is characterized by an extremely competitive operating cost and an unparalleled environmental performance, reducing in less than half the CO_2 emissions compared to the conventional pig iron production route

Plant Site: Saguenay, Quebec, Canada



STEEL'S PREMIER TECHNOLOGY EVENT

AISTech2018

Plant Site: Saguenay, Quebec, Canada

- Environmental impact would be of huge importance to local communities, governments, investors and any and all other stakeholders in the project.

- PFL determined it must be the “Global Leader on Minimizing Environmental Emissions” for the production of Merchant and High Purity Pig Iron.

Direct Reduction Processes Comparison

	Midrex	HYL III	ZR ENERGIRON	Fastmet/Inmetco	Finmet
Typical module capacity (kt/y)	600-2,000	200-2,000	200-2,500	450	500
Energy consumption					
NG (GJ/t)	10.5	11.0	9.9	12.6	12.5
Electr. (kWh/t)	110	30	75	< 10	175
Product	Cold/Hot DRI and HBI	Cold/Hot DRI and HBI	Cold/Hot DRI and HBI	Cold/Hot DRI and HBI	HBI
Metallization (%)	> 94	> 94	> 94	> 90	> 92
Carbon (%)	1.0-2.5	1.0-3.0	2.0-5.0	> 3.0	0.5-1.0
Environmental	Standard with no CO_2 off-taking	Potential CO_2 off-taking: 40% CO_2 can be commercialized	potential CO_2 off-taking: 60% CO_2 can be commercialized	Add. systems needed related to gases (NOx, sulfur, dust, coal handling, treatment, processing), to comply with regulation	Fulfillment with environmental regulations with no major modifications
	NOx ≤ 40 ppm with LNB	NOx ≤ 25 ppm with LNB	NOx ≤ 25 ppm with LNB		

Direct Reduction Processes Comparison

- Two processes were selected as industrially viable for the PFL case

- Coal-based process, comprising:
  - Iron ore fines and coal drying
  - Mixing ore, coal, bentonite, molasses
  - Cold Briquetting (CB)
  - Reduction in a Rotary Hearth Furnace (RHF)
  - Melting in an Electric Furnace (EF)
  - De-Sulfurizing in a de-sulf station (De-S)
  - Pig Casting (PC)

- Gas-based process, comprising
  - Iron ore pellet screening & coating
  - Natural gas Direct Reduction in a shaft module (DR)
  - Melting in an Electric Furnace (EF)
  - Pig Casting (PC)

Process Comparisons

	Coal-based process (RHF)	ZR ENERGIRON (DRI)
Raw Material	✓ Canadian Iron ore and coal	✓ Canadian Iron Ore Pellets
Drying	✗ by gas burners, CO_2 emissions	✓ not required
Mixing & Briquetting	✗ added maintenance & energy	✓ not required
Ore Reduction	✗ higher CO_2 emissions ✗ higher SO_2 emissions ✗ need of SO_2 scrubber ✗ higher NO_x emissions	✓ lower CO_2 emissions ✓ possible CO_2 capture ✓ low SO_2 emissions ✓ lower NO_x emissions
Melting	✗ higher amount of slag produced	✓ lower amount of slag produced
De-Sulfurization	✗ required to achieve MPI spec ✗ production of hi-S slag	✓ not required
Pig Casting	✓ same equipment	✓ same equipment

Emissions Comparisons, CO_2, NOx, S

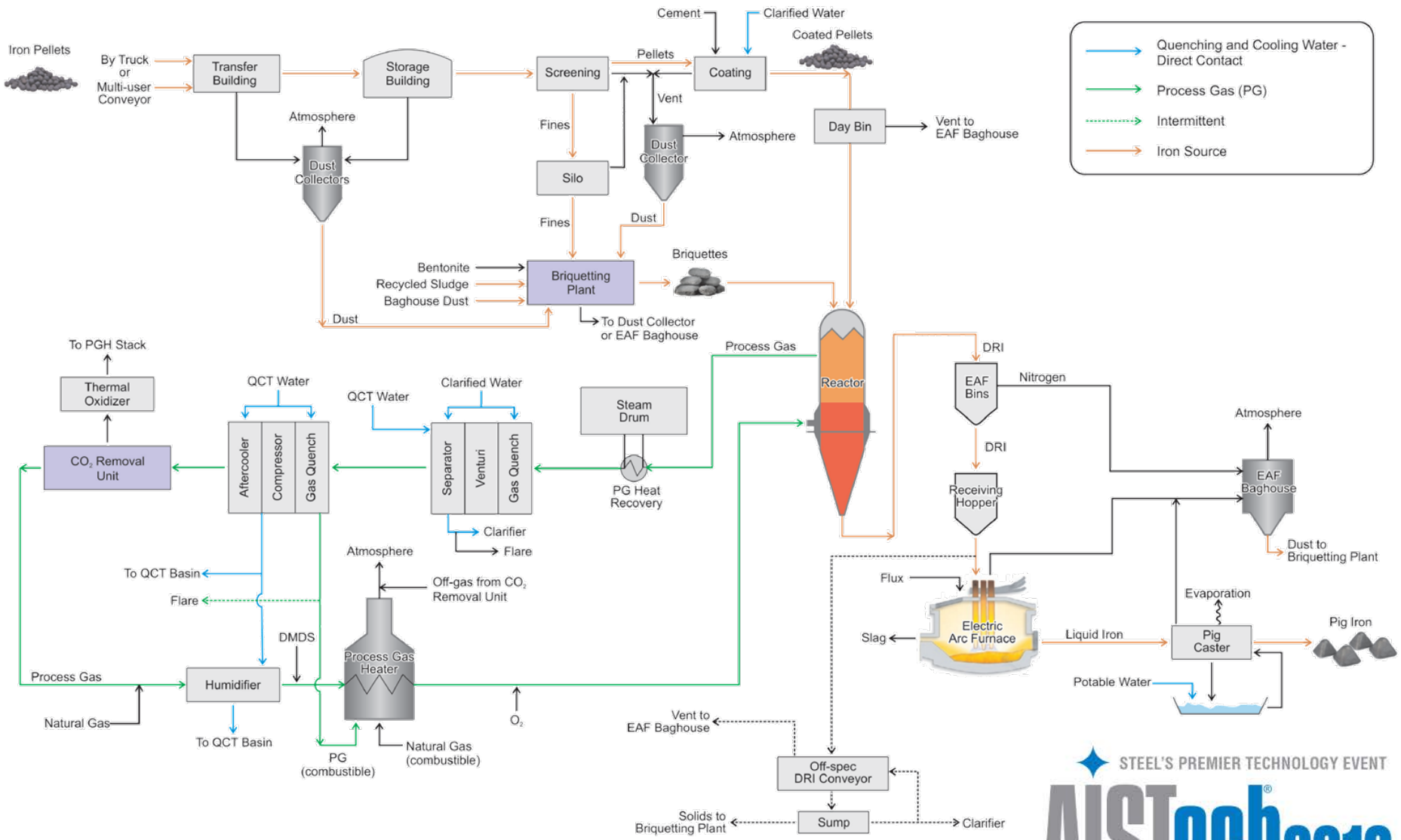
	Coal-based process (RHF)	Natural Gas-based process (DRI)
CO_2 (t/t mpi)	~1.5	below 1.0
NO_x (tpa)	~125	below 75
Sulfur at stack (tpa of S)	~300	below 40
Sulfur in scrubber dust (tpa of S)	2,600	None
Sulfur in EAF slag (tpa of S)	2,500	Below 10
Sulfur in de-sulf slag (tpa of S)	2,612	None
Sulfur in pig iron (tpa)	~42.5	~42.5

Based on the comparisons on:

- ✦ Energy requirements
- ✦ Environmental impact
- ✦ Plant size and infrastructure
- ✦ Reference plants in operation

PFL selected the ENERGIRON technology

Process configuration



STEEL'S PREMIER TECHNOLOGY EVENT

AISTech2018

Material Flow

- Material flow backward calculation based on 7900 hours of plant operation per annum:

Nodular Pig Iron:	425,000 tpy *53.8 tph*
Hot Metal:	430,877 tpy *54.5 tph*
High-Carbon DRI:	493,514 tpy *62.5 tph*
Iron Pellets:	672,147 tpy *85.0 tph*

Pellet fines will be collected, briquetted and recharged in the ZR module, increasing DRI yield.

Production of sellable CO_2 will be 125,000 tpy

Product quality: Pig Iron "PFL" grade

	Typical Foundry Pig Iron Chemical Specifications				
	C	Si	S	P	Mn
Basic	3.5 – 4.5	< 1.5	< 0.05	< 0.12	0.5 – 1.0
Hematite	3.5 – 4.5	1.5 – 3.5	< 0.05	< 0.12	0.5 – 1.0
Nodular	3.5 – 4.5	**0.05 – 2**	**< 0.02**	**< 0.04**	**< 0.05**

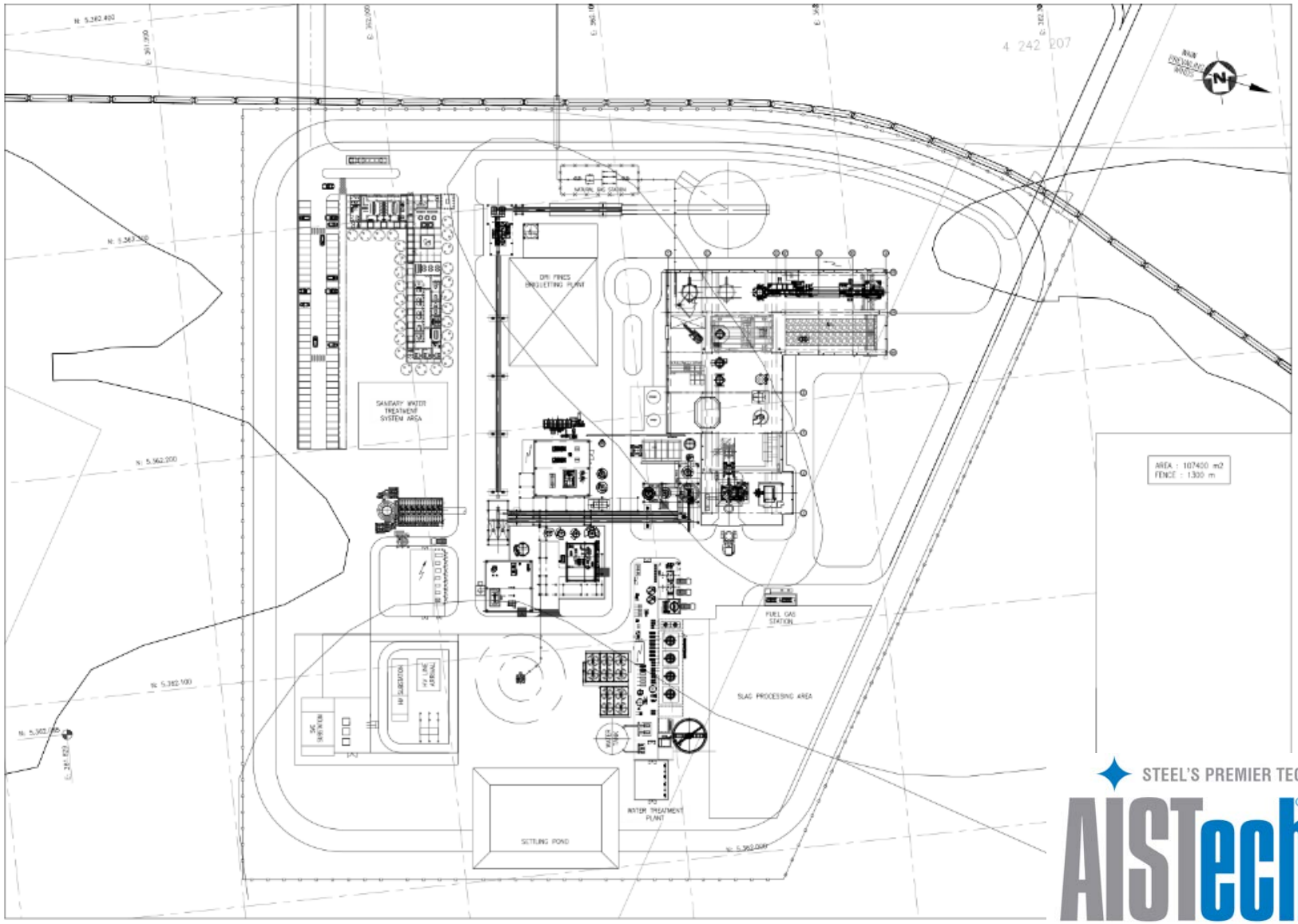
- Pellets are reduced and carburized in the ENERGIRON module (to 5% C at 94% metallization) to get a final pig iron with C > 3.5% and the other elements below the limits set above, starting from a typical Canadian BF IO pellet.

Product quality: Pig Iron "PFL" grade

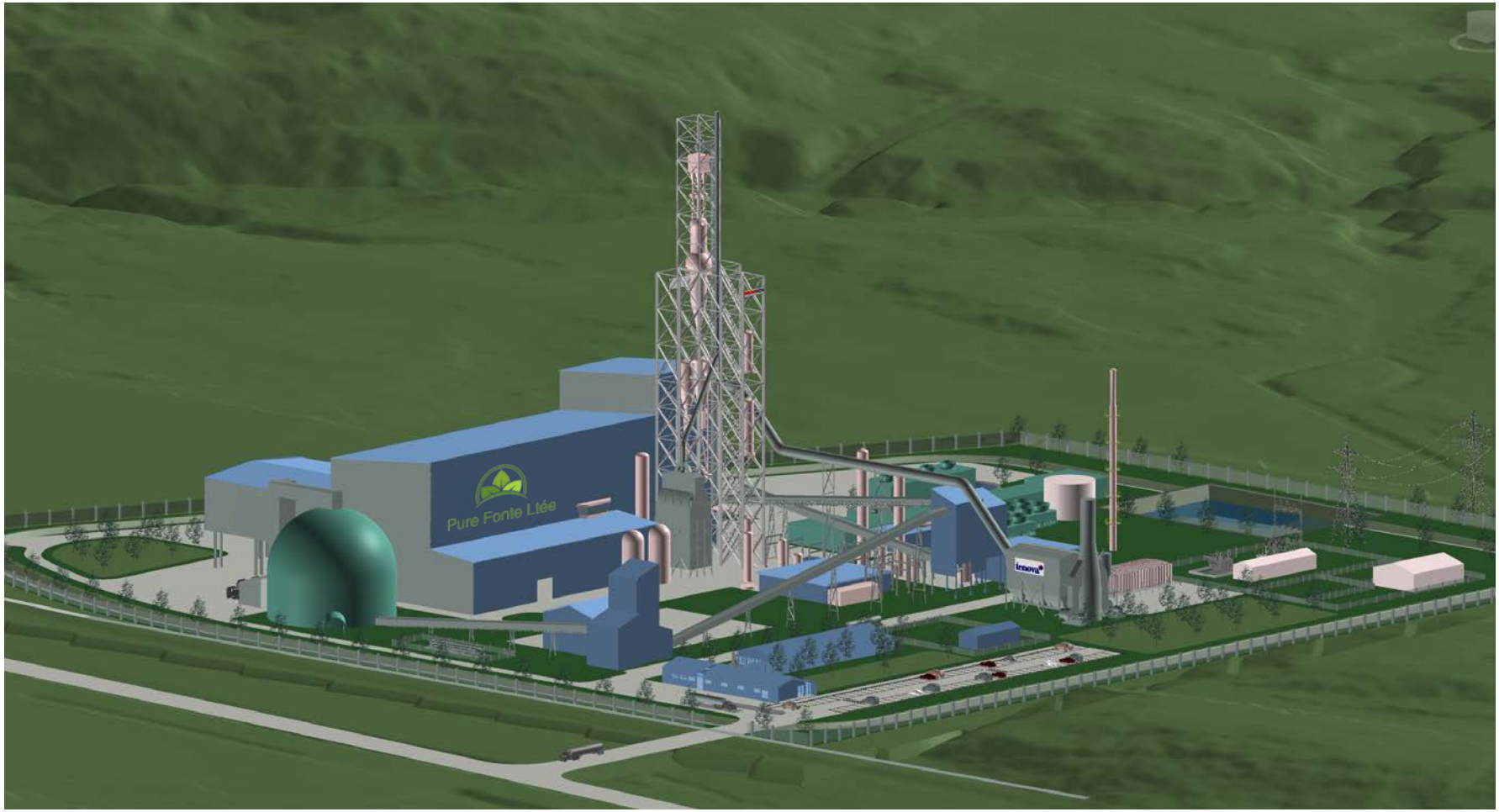
	Pig Iron for special foundry applications				
	C	Si	S	P	Mn
Triple Five	3.5 – 4.5	< 0.5	< 0.020	< 0.050	< 0.050
T35	3.5 – 4.5	< 0.5	< 0.002	< 0.035	< 0.035
Russian	3.5 – 4.5	< 1.0	< 0.020	< 0.055	< 0.090

- For certain particular foundry applications, pig iron specs are even more strict
- The "Triple Five" and even more strict specifications can be met using DR and some BF pellets in the gas-based PFL process

Plant Layout



Plant Layout



Plant Layout

Pure Fonte Ltée

Thanks for your attention

STEEL'S PREMIER TECHNOLOGY EVENT

AISTech 2018