BF Plus

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M. Lanyi
J. Terrible

BF Plus

An offered

- **Step-wise**
- **Near-term**
- **Economics-driven**

means to CO2 mitigation from BF ironmaking

DANIELI CORUS

AIR PRODUCTS

Vision

- **Lower the cost of hot metal**
- **Maximize energy production**
- **Provide platform for GHG mitigation**

  Step 1: Proper apportionment of CO2 across two products (HM+power)

  Step 2: "drop-in" CO2 removal

  Step 3: Precede CO2 removal with "shift reactor"

- **Achieved by:**
  - **Increasing coke displacement**
  - **Maximizing the value of higher calorific topgas**
  - **Employing efficient power production technology**
  - **Taking advantage of fuel gas compression required for Gas Turbine.**

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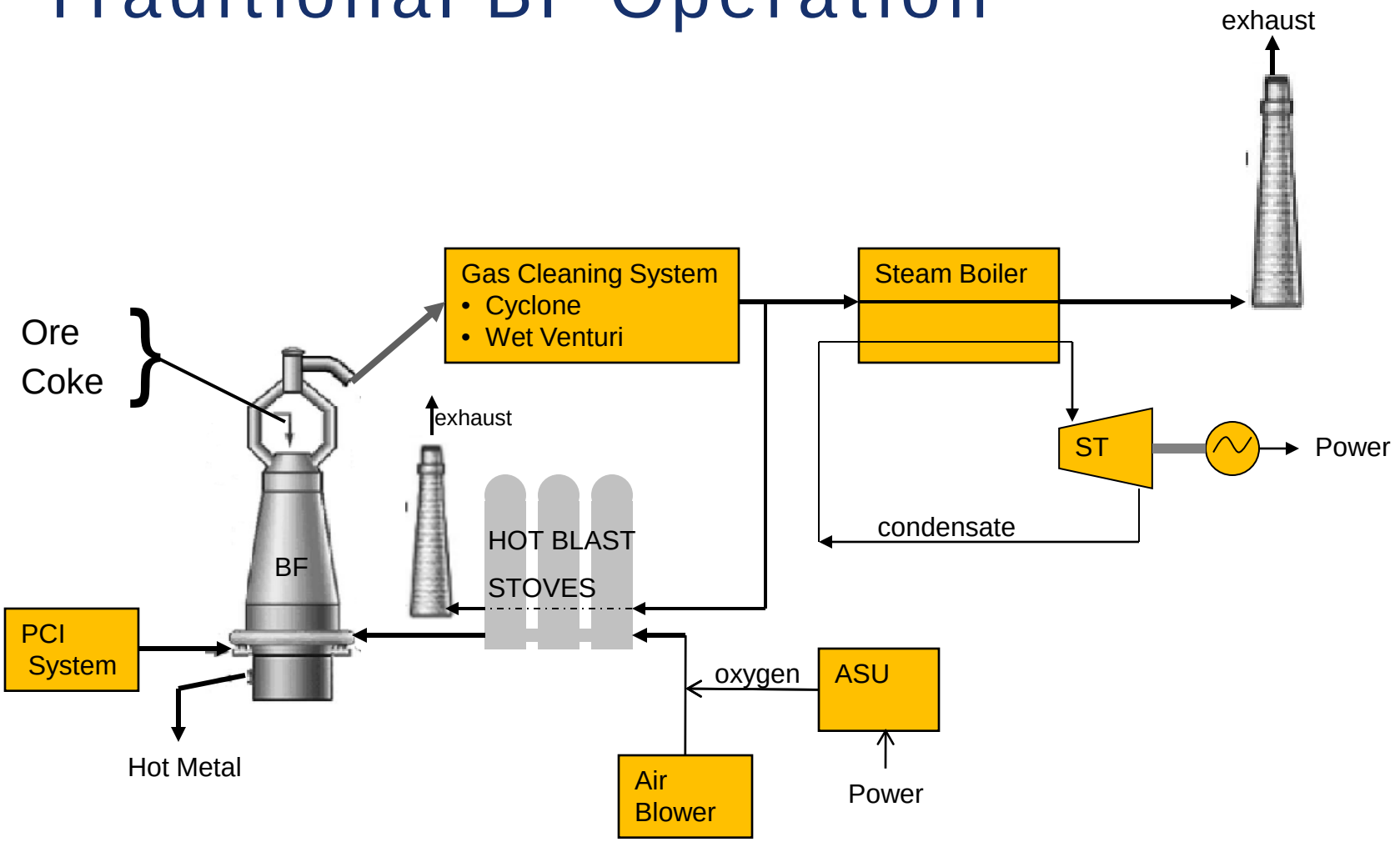
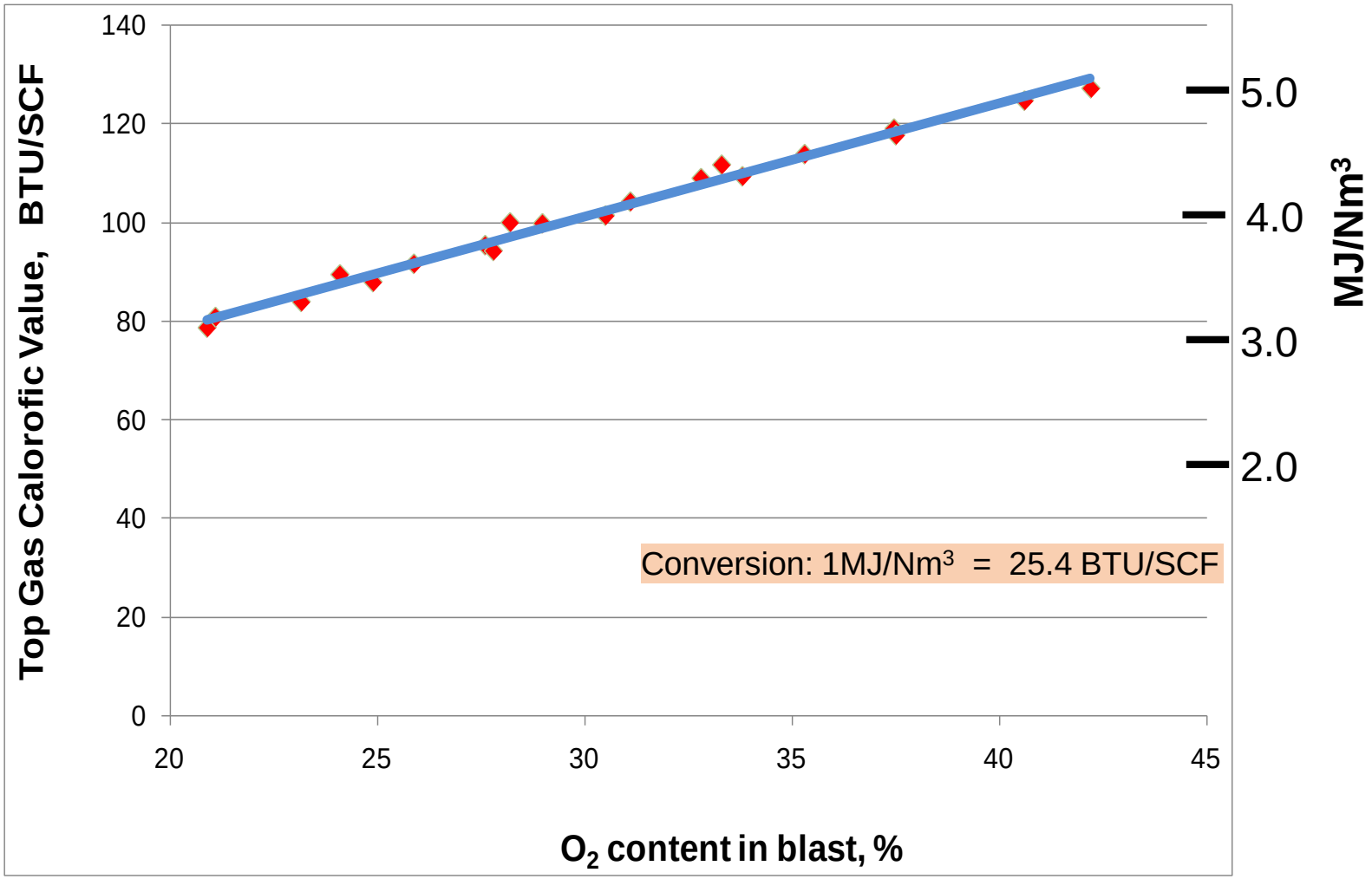
Traditional BF Operation



Top Gas CV and O_2 Relationship



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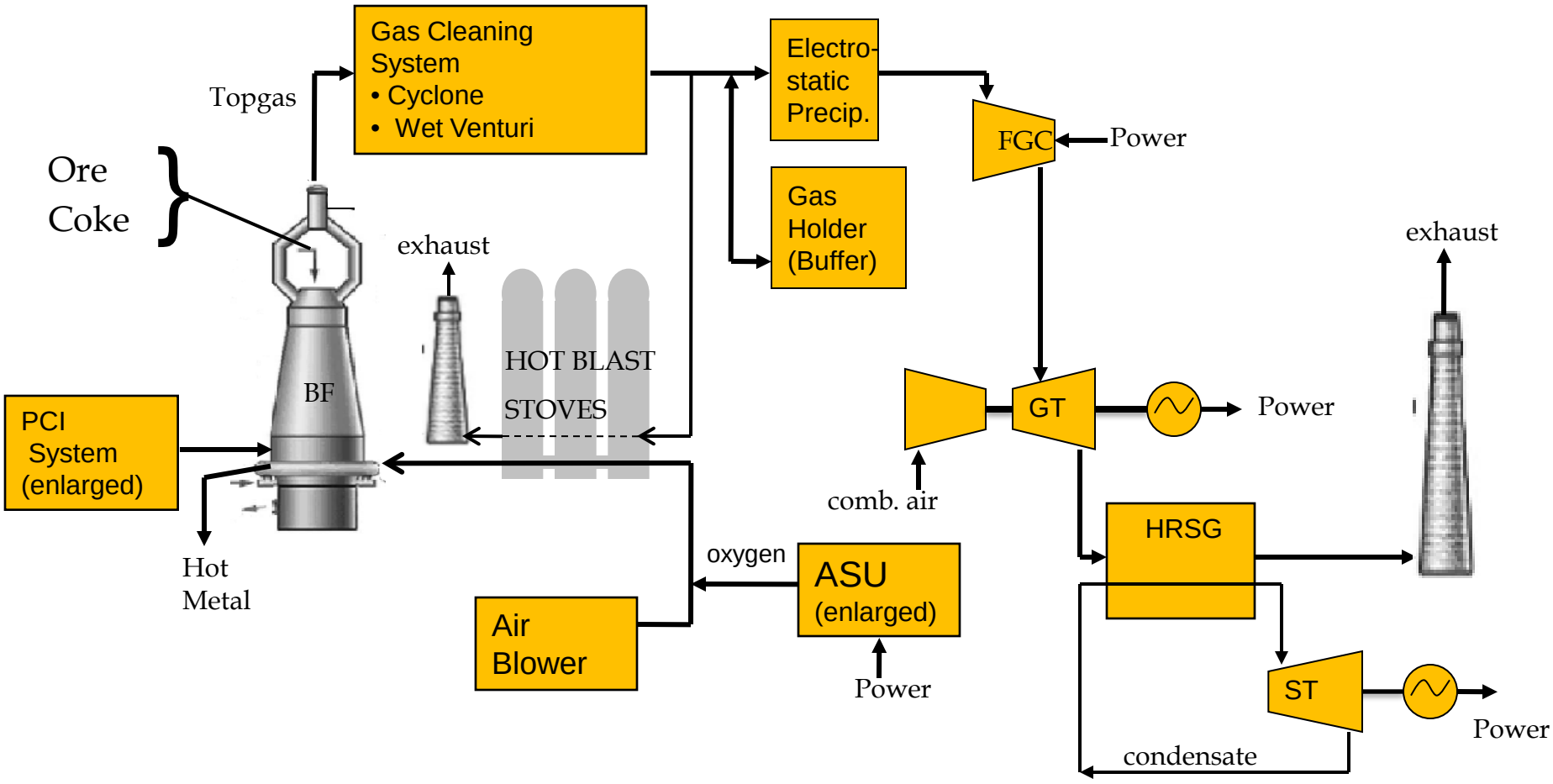
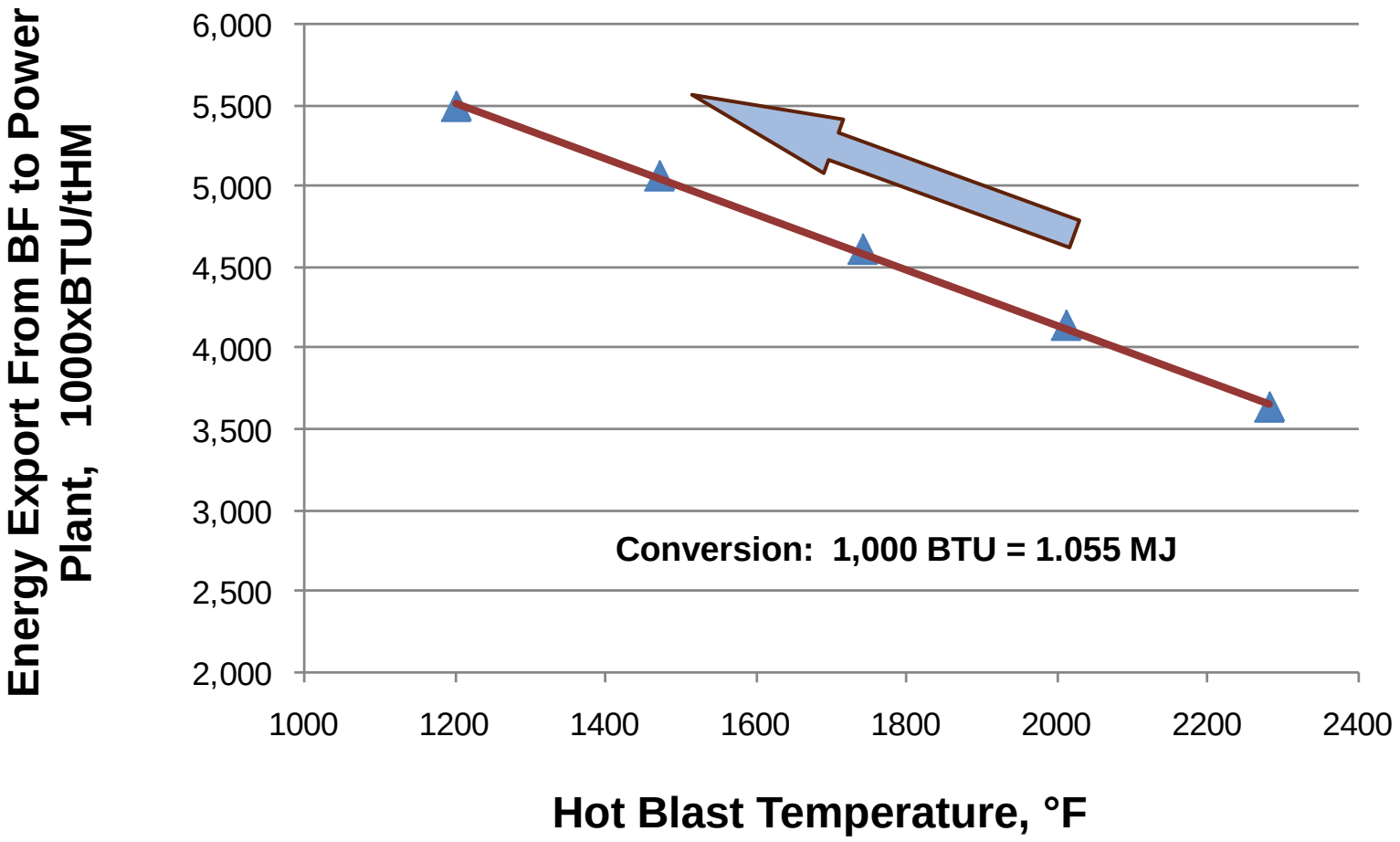

Gas Cleaning System
• Cyclone
• Wet Venturi
Topgas
Electro-static Precip.
FGC
Power
Ore
Coke
Gas Holder (Buffer)
exhaust
exhaust
HOT BLAST STOVES
BF
PCI System (enlarged)
GT
Power
comb. air
HRSG
Hot Metal
oxygen
ASU (enlarged)
Air Blower
Power
ST
Power
condensate

Maximizing Energy Export



Calculated for:

- Constant coke rate = 262 kg/tHM
- Constant top temperature = 100 °C

Balanced Cold Blast Operation*

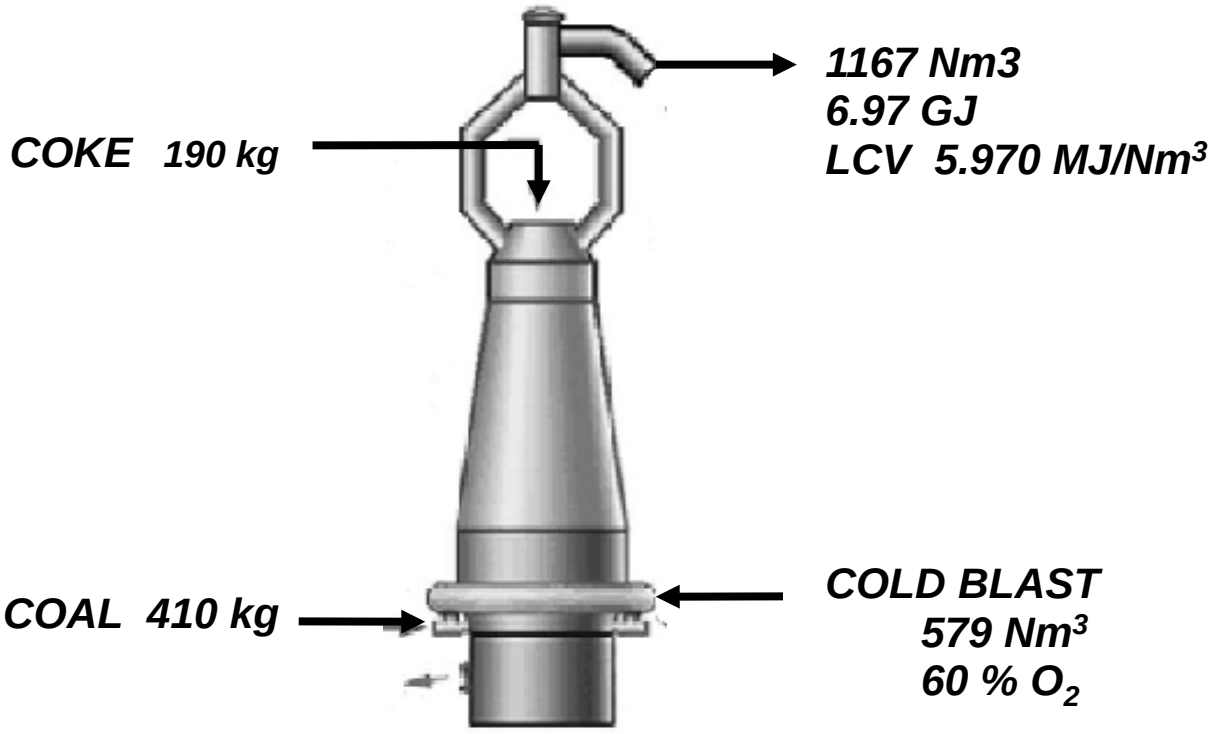


Fig. 5 Cold Blast Operation (60 % O_2) (for 1 ton HM)

* from: A. Poos and N. Pongis, "Potentials and Problems of High Coal Injection Rates", 1990 Ironmaking Conference Proceedings.

Comparisons

	Today	BF Plus (realizable today)	Future Potential
PCI, kg/THM	120-200	220-260	300+
Coke Rate, kg/THM	300-360	270-290	260
Blast Oxygen, %	21-29	~ 40	55 - 60
Blast Temperature, ºC	1050-1250	850-1050	ambient
Max. Hot Metal Production, %	100%	109%	110%
Top Gas Calorific Value, MJ/Nm^3	3.2 – 3.9	4.5 – 5.0	> 5.9
Net Export Power Production (base case 2.3 million tpy BF) • MW • MWh / THM	 25 - 50 MW ~0.2	 125 - 160 MW ~0.5	 200 - 250 MW ~0.8
CO_2 apportioned to Ironmaking, % (assigning 0.54 kg CO_2/kWh to power)	100%	91%	82%

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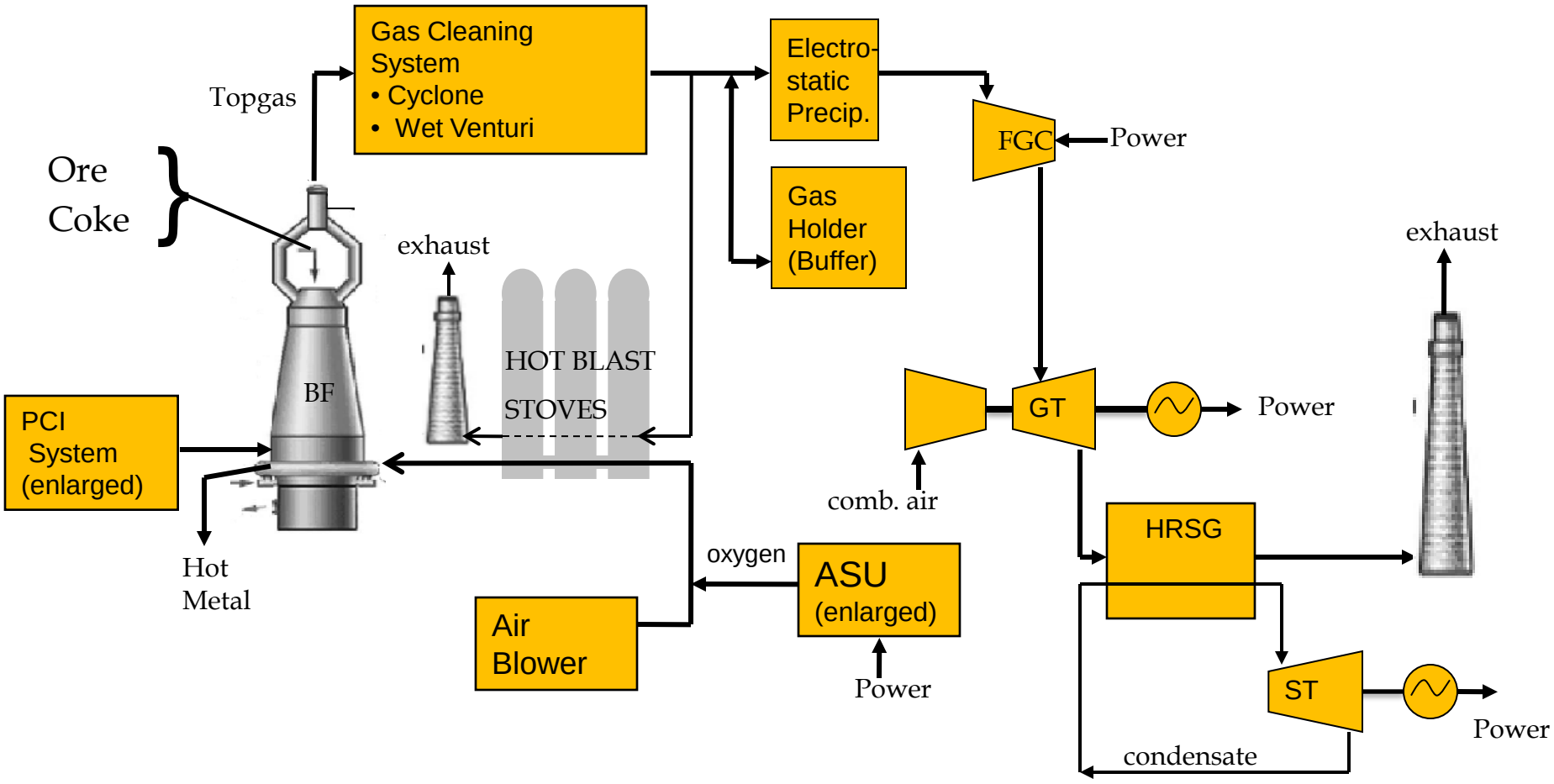
BF Plus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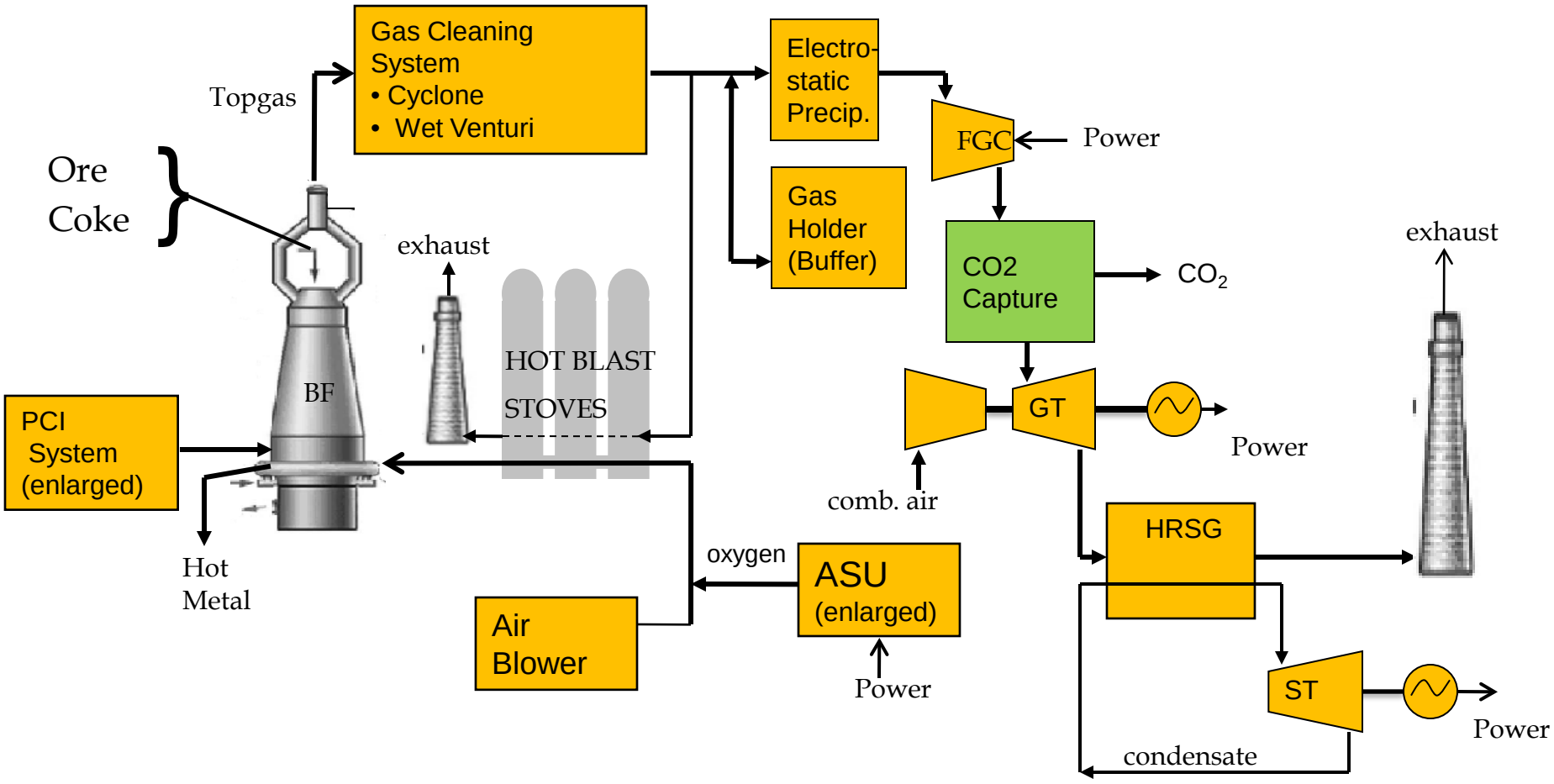
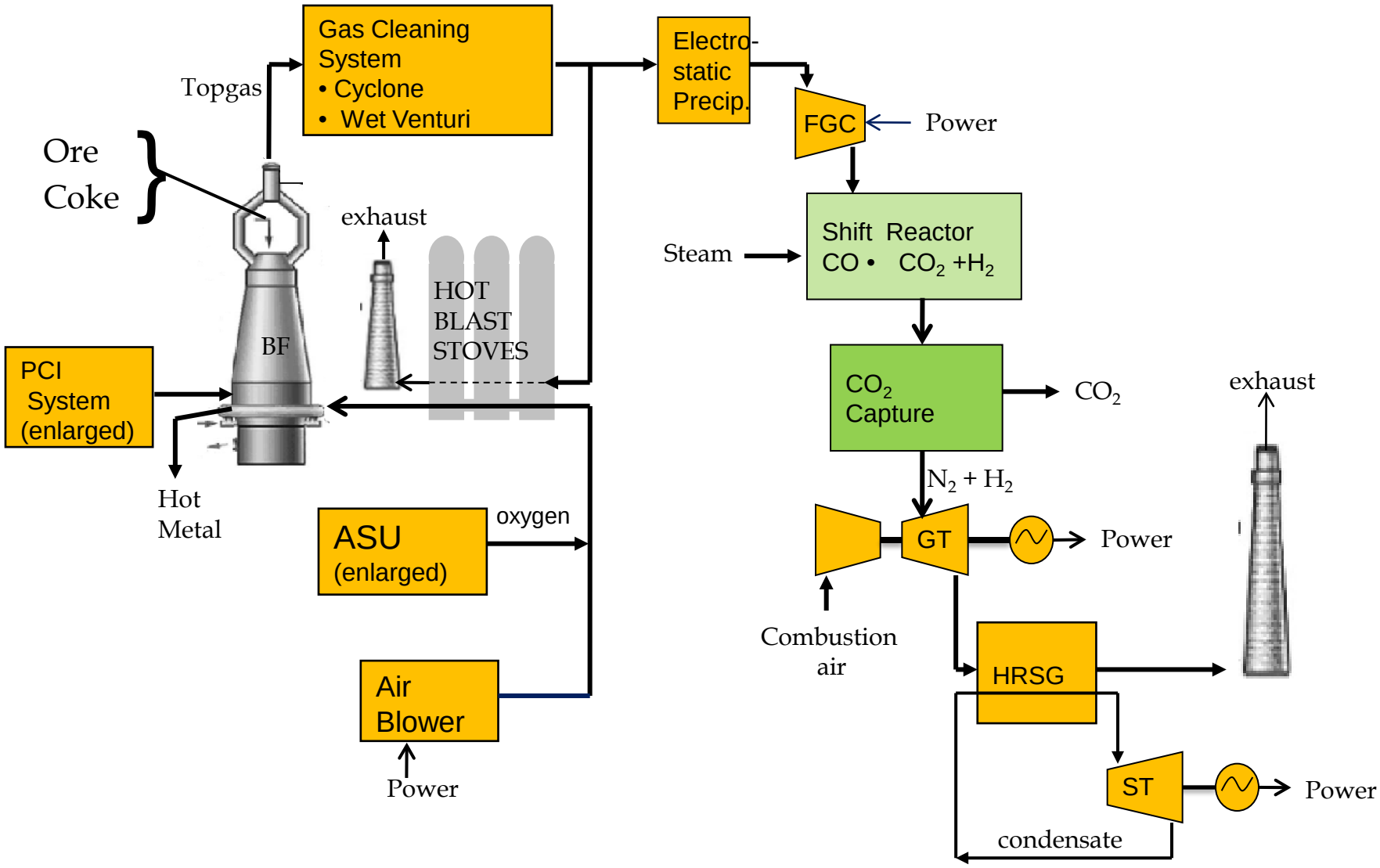
BF Plus with CO_2 Capture



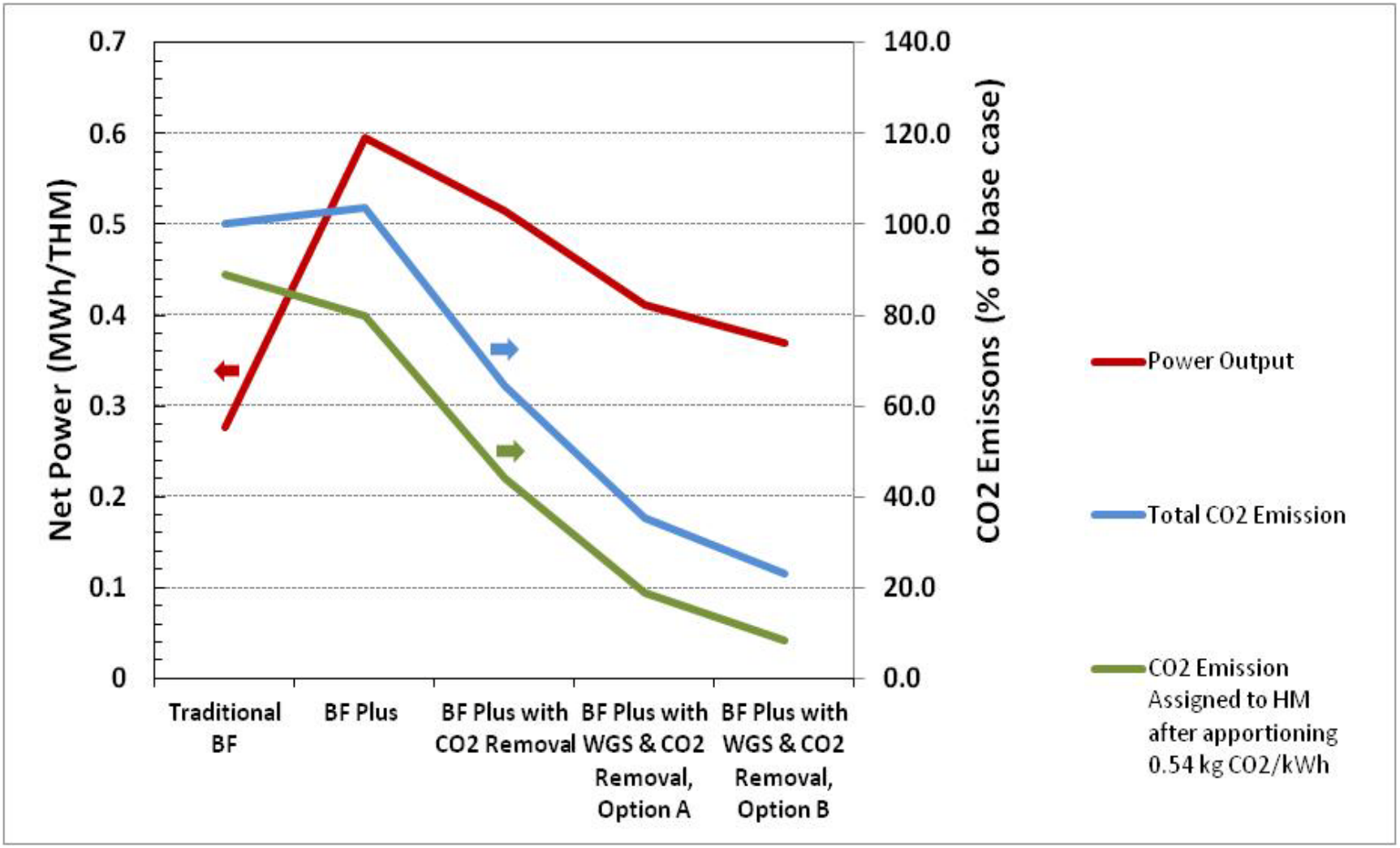
BF Plus with Shift Reactor and CO_2 Capture



BF Plus GHG mitigation options

	Indicative example(s):		
O2 in Blast (%)	~40		
Coke rate (Kg/THM)	270-290		
PCI (Kg/THM)	220-260		
Option	Comb Cycle Power	With CO_2 Capture	With CO shift +CO_2 Capture
Net Power export (kWh/THM)	546	509	433
CO_2 emissions allocated to HM	(Kg/THM)		
Direct CO_2 emissions	1,367	939	581
Global CO_2 emissions (assuming 0.54 Kg CO_2/kWh)	1,202	794	477

Power Generation and CO2 Reductions for various operating scenarios



Summary / Conclusions

- **Can combine known technologies**
  - **To achieve a range of CO_2 mitigation**
  - **While simultaneously improving the economics of BF ironmaking**
- **"Retrofitable" in a step-wise fashion**
  - **Minimizes risk and capital outlays**
  - **Quality of CO_2 produced suitable for immediate sequestration (without further upgrade or refinement)**
- **Known, proven technologies can be combined and implemented to mitigate CO2 emissions from BF ironmaking today.**

Thank you