INTERNATIONAL WORKSHOP
ADVANCES IN CLEANER PRODUCTION

São Paulo - Brazil - May 20-22 - 2009

"KEY ELEMENTS FOR A SUSTAINABLE WORLD: ENERGY, WATER AND CLIMATE CHANGE"

Solutions for Energy Savings & Environmental Compliance Leading to Cleaner & Lower Cost Production

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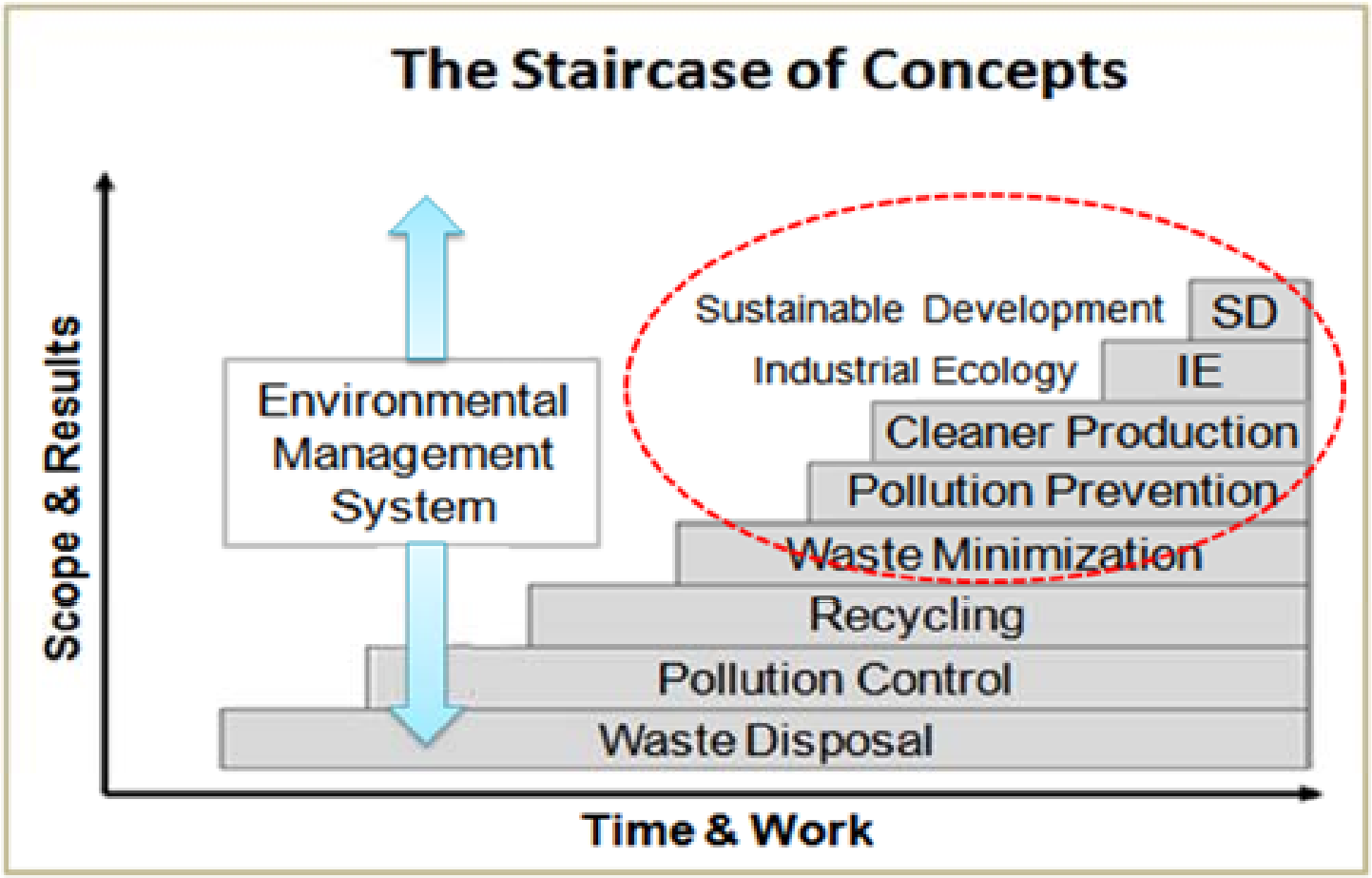
Presentation Outline

- Background (Rationale for this work)
- Current Industry Scenario & Key Issue
- Engineering solutions
- Industry in Focus & Applications
- Methodology with Examples (Case Studies)
- Typical Results & Benefit
- Concluding Remarks

Cleaner Production in terms of Sustainable Development Framework



POSITIVE Proof of Global Warning

Engineering Solutions for Tomorrow's Problems

Current Industry Scenario

Energy Initiatives

Conflicting Issues in Heavy Industry

- "Conventional Dirty Manufacturing" is linked with
  - Old Technology
  - Inefficient (*i.e.* higher) Energy usage
  - Poor Environment & Health conditions
- Developed countries have already accumulated wealth using conventional practice
- Global Competition & Quick ROI are discouraging Corporations to go environmentally friendly

Industry Challenges

Energy Conservation and Operational Efficiency

"Higher Productivity while consuming lesser energy"

Health and Safety – Noise Pollution

"Restraining existing power and process plants"

Environmental Compliance

"Plant modernization with constraint capital budget"

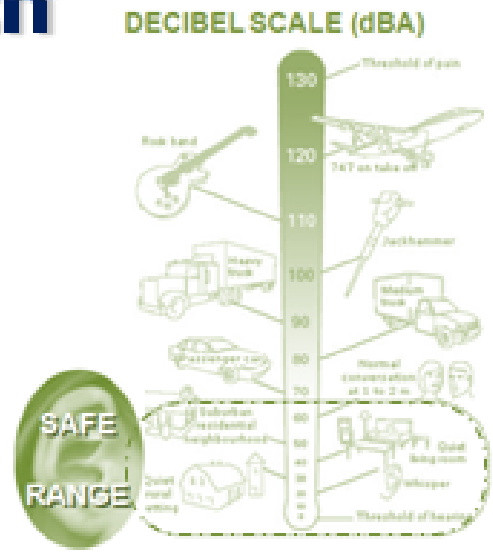
Smart Energy Management

Engineering Solution

- **Energy Savings:**
  - Identify areas with air as process media for immediate application
  - Lowering system resistance of the plant draft (air / flue gas) systems including flow through pollution prevention equipment
    - Primarily forced draft and induced draft fan systems
    - ESPs, Baghouses, Scrubbers
- **Improve Environment & Health:**
  - Noise and Vibration reduction (airflow induced)

Energy Savings Approach

- **Noise and Vibration** are indications of turbulent airflow and wasted energy.
- Uses "aero-acoustics" optimization techniques while integrating aerodynamics with fluid mechanics to manage air flow and minimize turbulence.
- Experience & knowledge in the area of air/gas flow behavior, fan operations & discharge profiles are used to retrofit & upgrade Legacy Programs, resulting in smoother flow.
- End result is reduced energy consumption, noise attenuation and minimize vibration in manufacturing environment, while maintaining similar productivity.

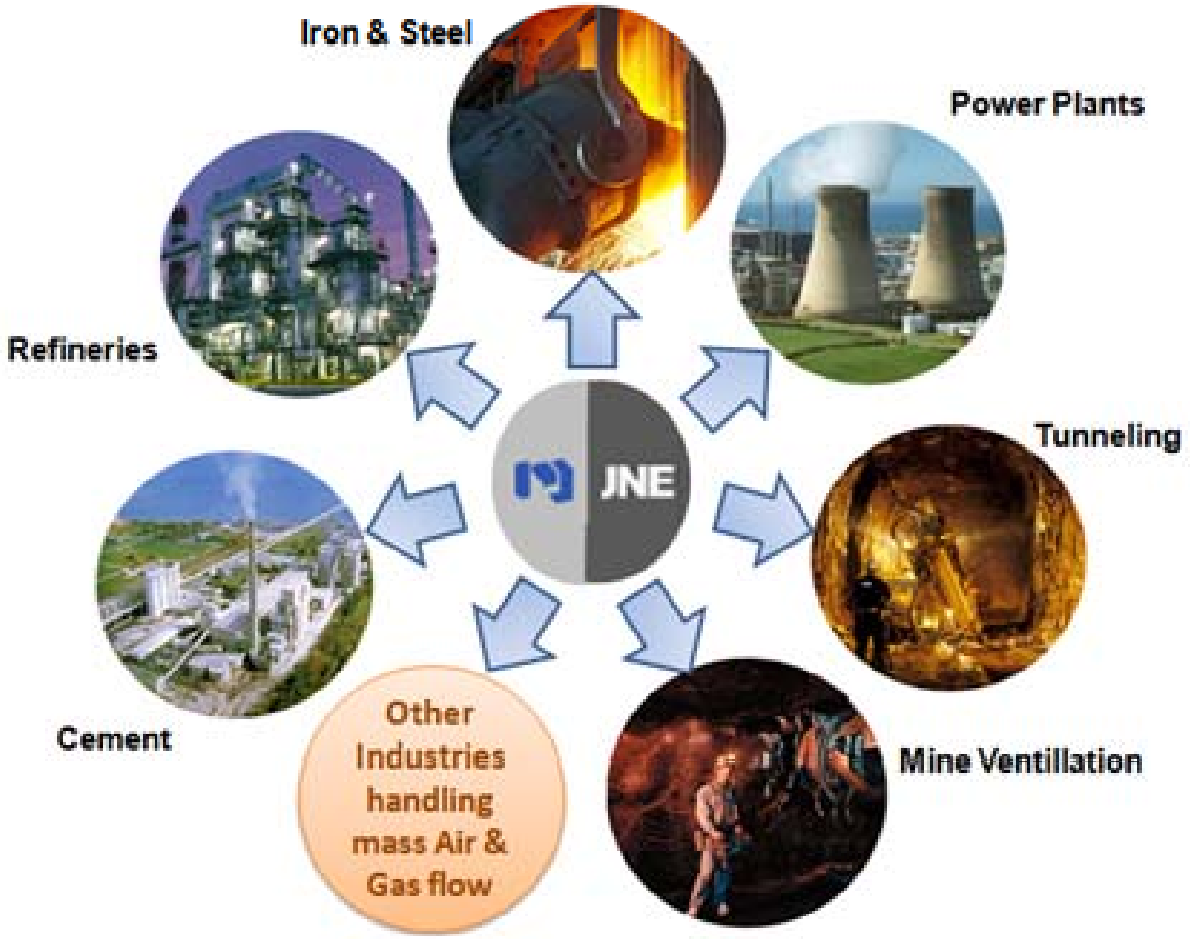


Helping in Global Energy Conservation

Energy Savings & Cleaner Production

- **Savings in kWh is obtained by**
  - Optimization and lowering system resistance of a fan or pump system (industrial operations), where process media is air or flue gases
  - **Focusing** on **energy savings and noise attenuation in fan systems,** handling air (fresh or exhaust) and flue gas
  - *Energy savings (e.g., consumption of less fuel) through process optimization is beyond the scope of this paper*

Energy Guzzling Industries Served



Energy Efficient Industry……A global challenge

Application Areas

Industrial Operations with air as process media and flue gas cleaning

- Power Plants (FD and ID fan systems including ESPs, Bag Houses, FGDs)
- Steel Plants (Primarily ID fan systems including ESPs and Bag Houses, captive power plants)
- Refineries (cooling tower fan systems, captive power plant)

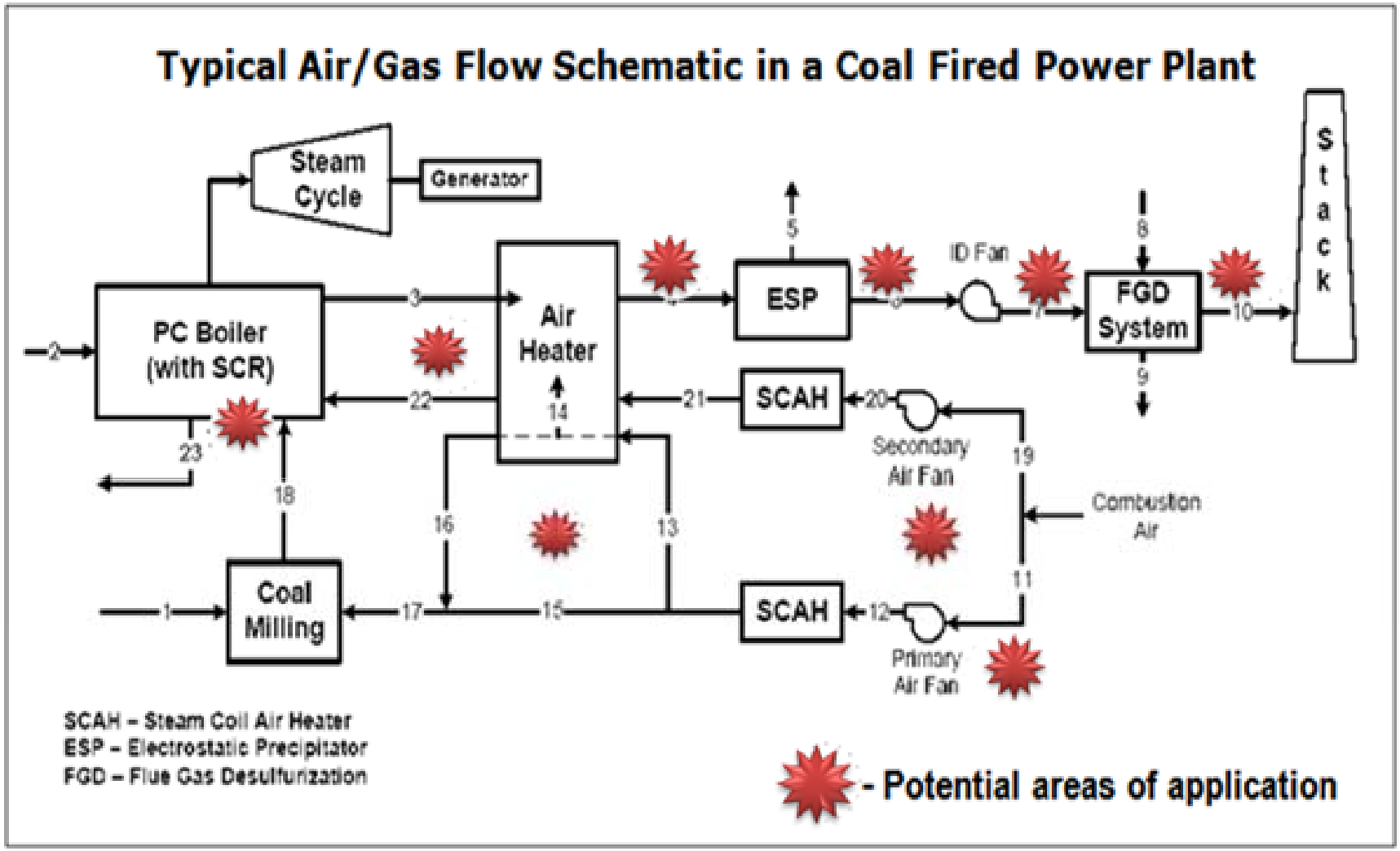
Application Areas (....continued)

Infrastructure related (Health and Safety) is of primary interest, e.g., airflow requirement is governed by

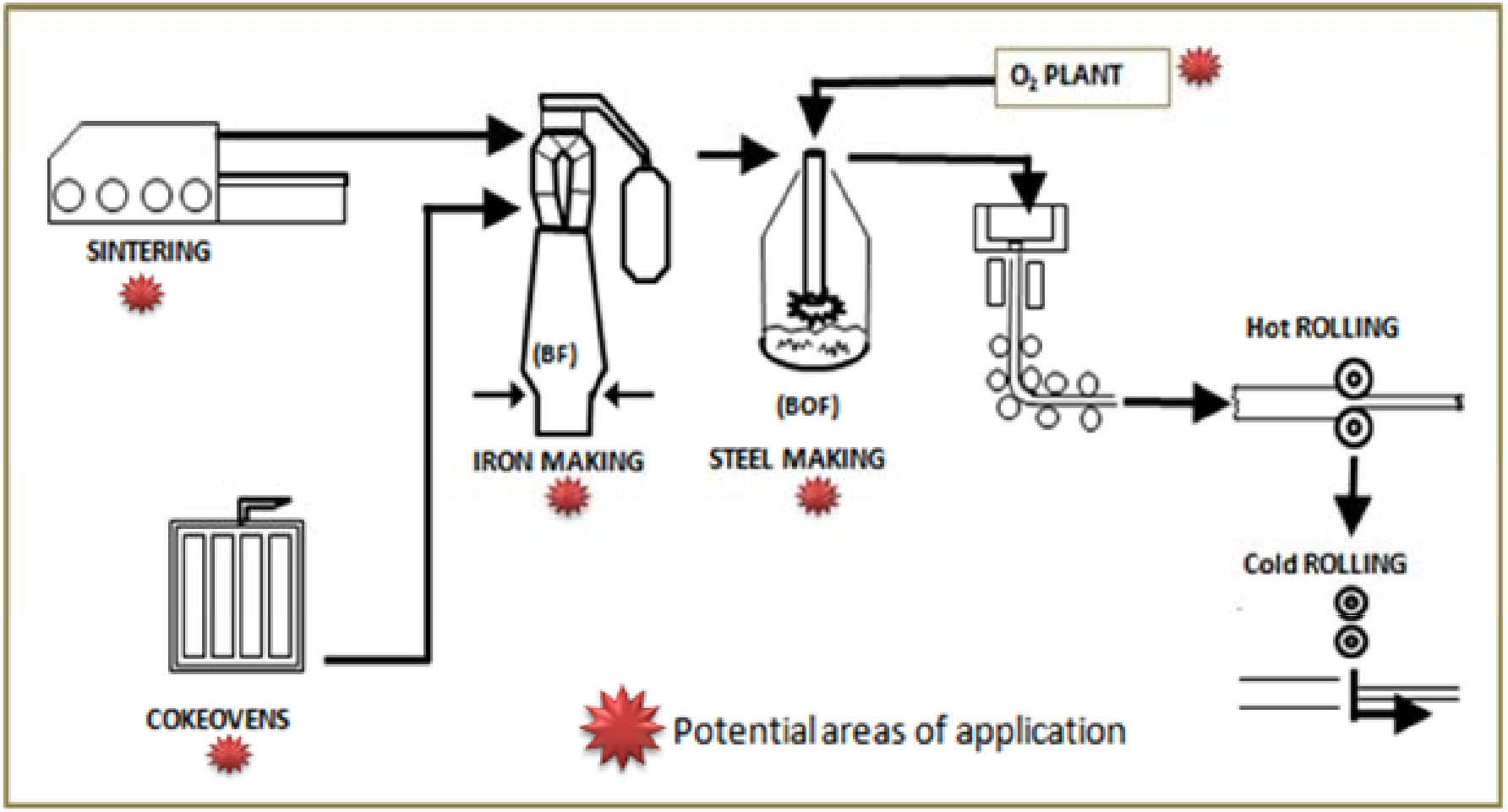
1. keeping methane level diluted enough to have no explosions in gassy mines, and
2. keeping diesel emission diluted for safe working in metal mines and tunnel construction (100 cfm per bhp)

- Mine ventilation (intake and exhaust fan systems on surface and auxiliary fans underground)
- Tunnel ventilation (during development and also permanent ventilation)

Power Plants

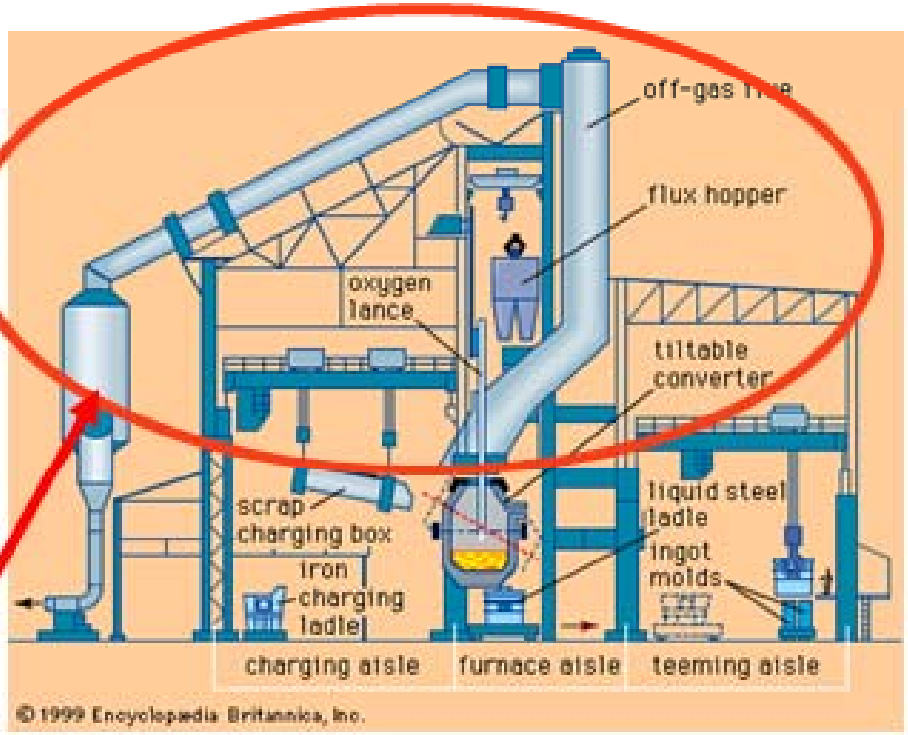


Steel Plants



Basic Oxygen Furnace

(A key area for energy conservation)



Typical area of improvement in airflow conditions

Impact on CO_2 emission

- **Savings** in kWh ⇨ Reduction in CO_2 emission

STEEL INDUSTRY
Energy & Eqv. CO_2 Factors

Energy/Carbon Source	Energy Value	CO2 Factor
Boiler or Steam Coal	25 million BTU/ton	5,130 lb/ton
Coking or BF Injection Coal	27 million BTU/ton	5,540 lb/ton
Coke	26 million BTU/ton	6,580 lb/ton
EAF Charge or Injected Carbon	26 million BTU/ton	5,540 lb/ton
No. 6 Fuel Oil	150,000 BTU/gal	26 lb/gal
Distillate/Diesel Oil	140,000 BTU/gal	22 lb/gal
Gasoline	124,000 BTU/gal	19 lb/gal
Light Oil	140,000 BTU/gal	26 lb/gal
Tar	160,000 BTU/gal	35 lb/gal
Liquefied Petroleum Gas	90,000 BTU/gal	12 lb/gal
Natural Gas	1,000 BTU/cu ft	0.12 lb/cu ft
Blast Furnace Gas	90 BTU/cu ft	0.044 lb/cu ft
Coke Oven Gas	500 BTU/cu ft	0.048 lb/cu ft
Steam (coal basis)	1,000 BTU/lb	0.06 lb/lb
Electricity (U.S. grid basis)	3,413 BTU/kwh	1.4 lb/kwh
Limestone (12% C)	---	880 lb/ton
Raw Dolomite (12.8% C)	---	940 lb/ton
Carbon Electrodes (99% C)	---	7,260 lb/ton
Pig Iron (4% C)	---	290 lb/ton
DRI or HBI (2% C)	---	145 lb/ton
Iron Carbide (6.5% C)	---	480 lb/ton
Carbon Steel (0.04% C)	---	0.0015 lb/ton

3,413 BTU/kwh ≡ **1.4** lb/kwh

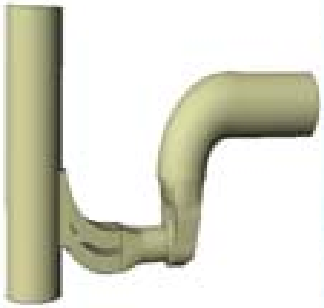
ELECTRICITY (U.S. grid basis) — **CO_2 emission**

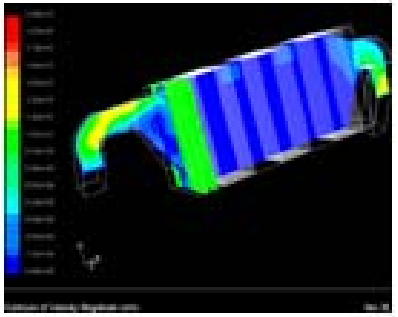
Energy Source	Energy Value	CO_2 Factor
Coal	104 million BTU/ton	22.79 lb/ton
BF Gas	90 BTU/cu.ft.	0.044 lb/cu.ft.

REF: American Iron and Steel Institute: *Principles for a Steel Industry ...*
www.climatevision.gov/sectors/steel/pdfs/ghg_protocol.pdf

Examples:

Airflow Improvement for Energy Savings and Noise & Vibration Reduction





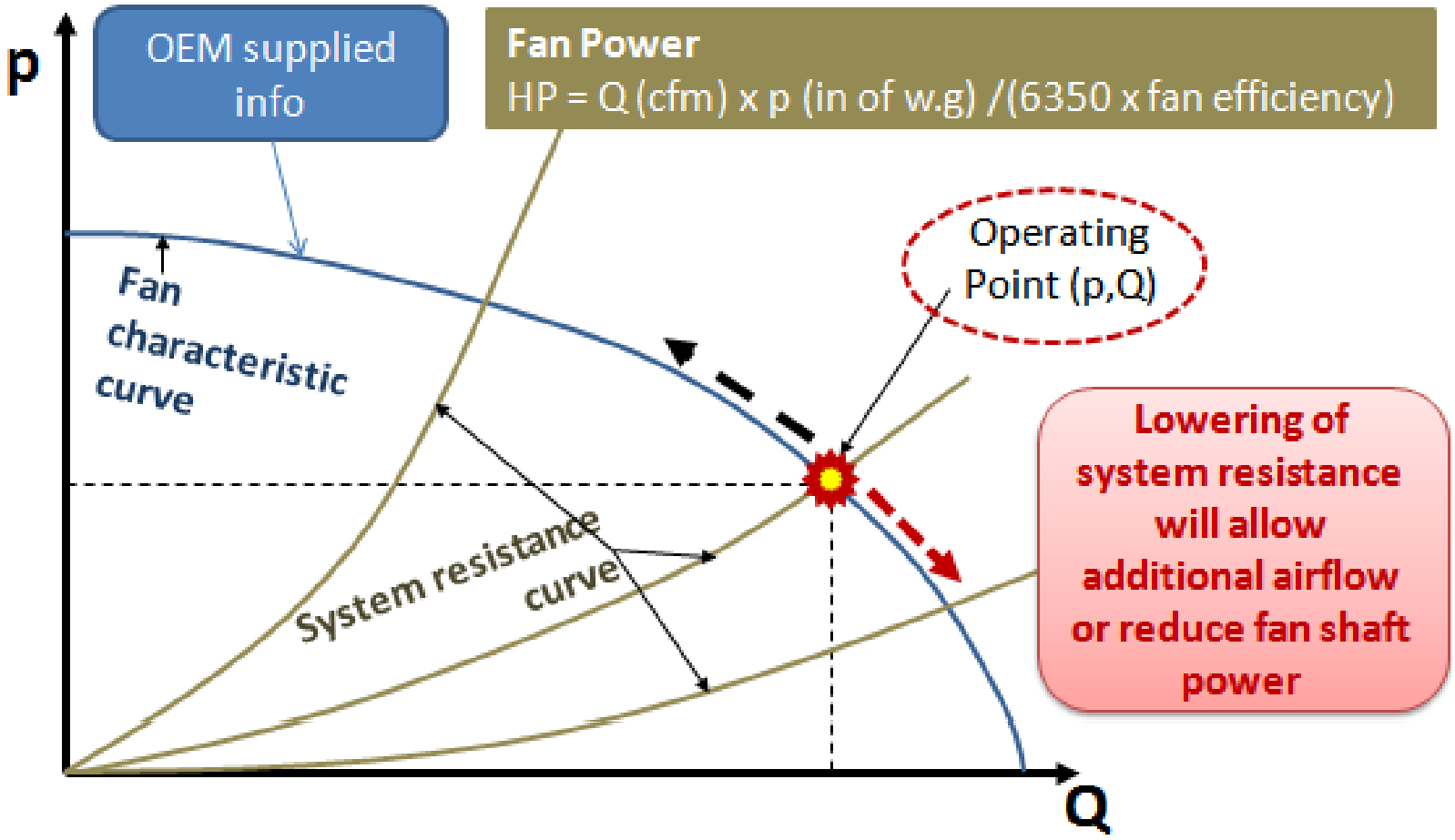
Duct Optimization and Fan Inlet & Outlet Condition Modification

Plant Draft System Components: Fans

- Primary Air mover for combustion and exhaust of flue gas through a series of pollution prevention equipment
- Types – Axial and Centrifugal
- Usage
  - **Force Draft (FD) – to push air or gases**
  - **Induced Draft (ID) – to extract the gaseous products**
  - **Primary Air (PA) – to mix air + solid particles**

Design and engineering for reducing air/gas flow resistances, allowing either more air/gas handing capacity (increased generation) or reducing energy loss through the system

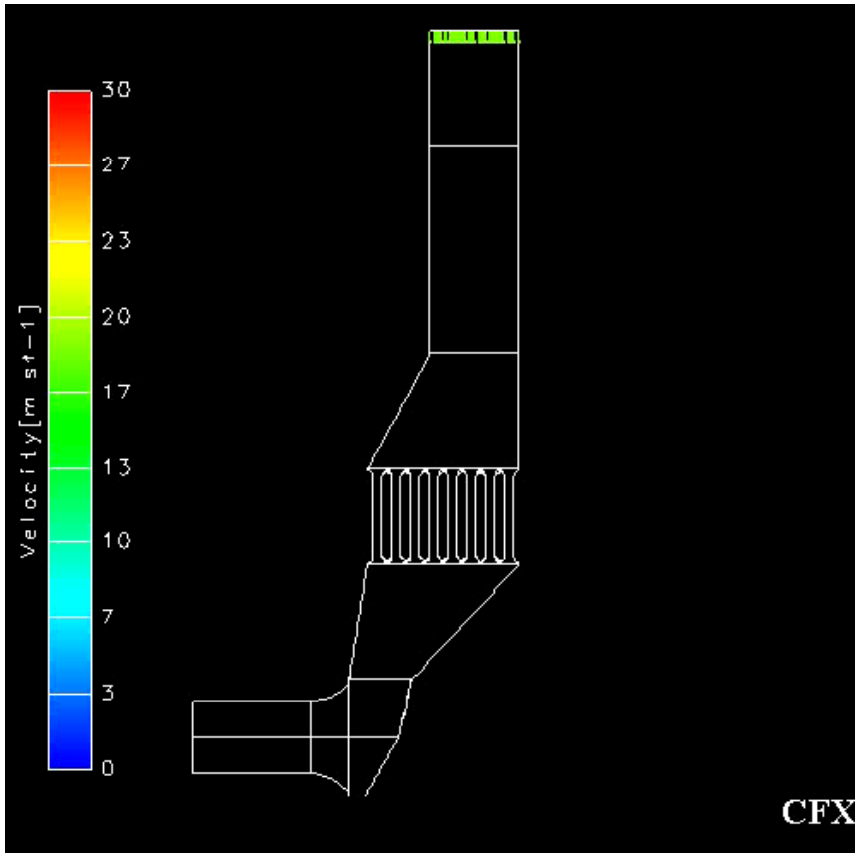
Fan Performance



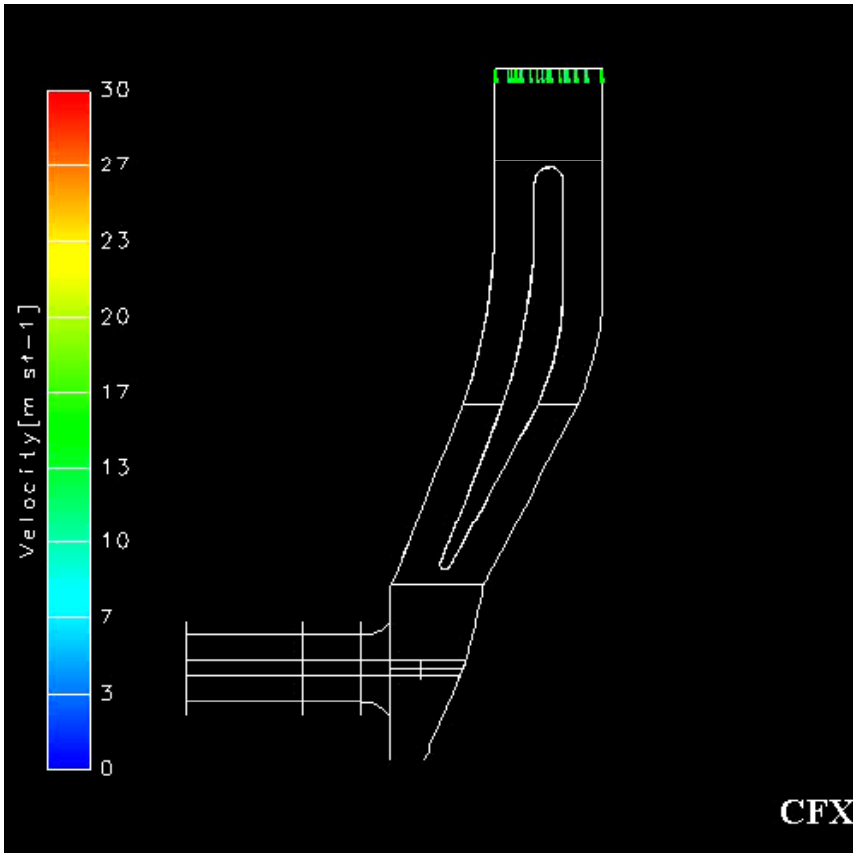
Fan performance enhancement improves performance of all key PP equipment (e.g., SCR, FGD, and ESP) including boiler and stack efficiencies

Example: Axial Fan

Fan (inlet) – Duct – Silencer Interaction



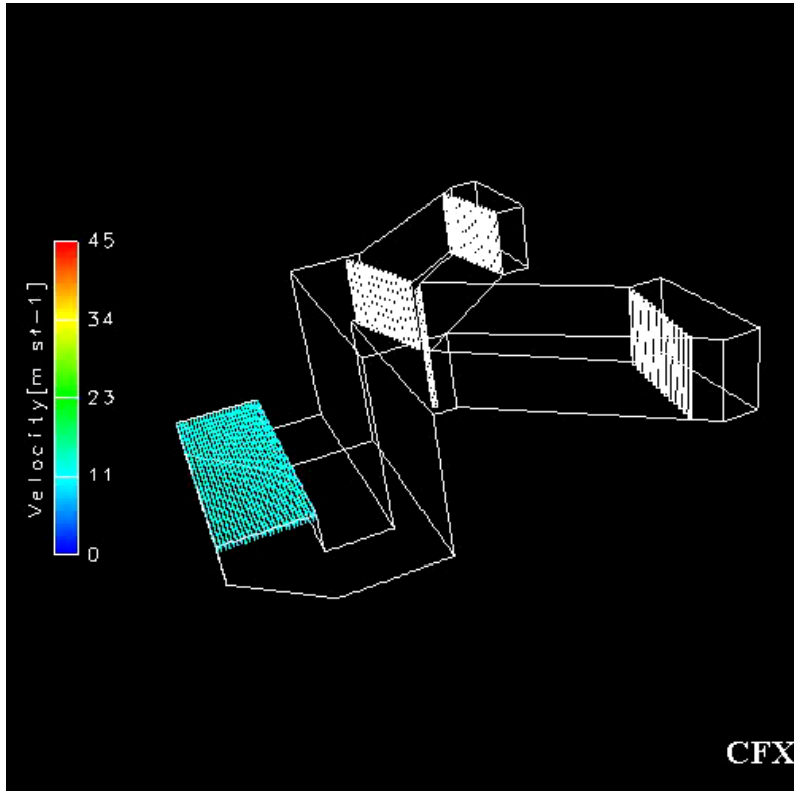
Before



After

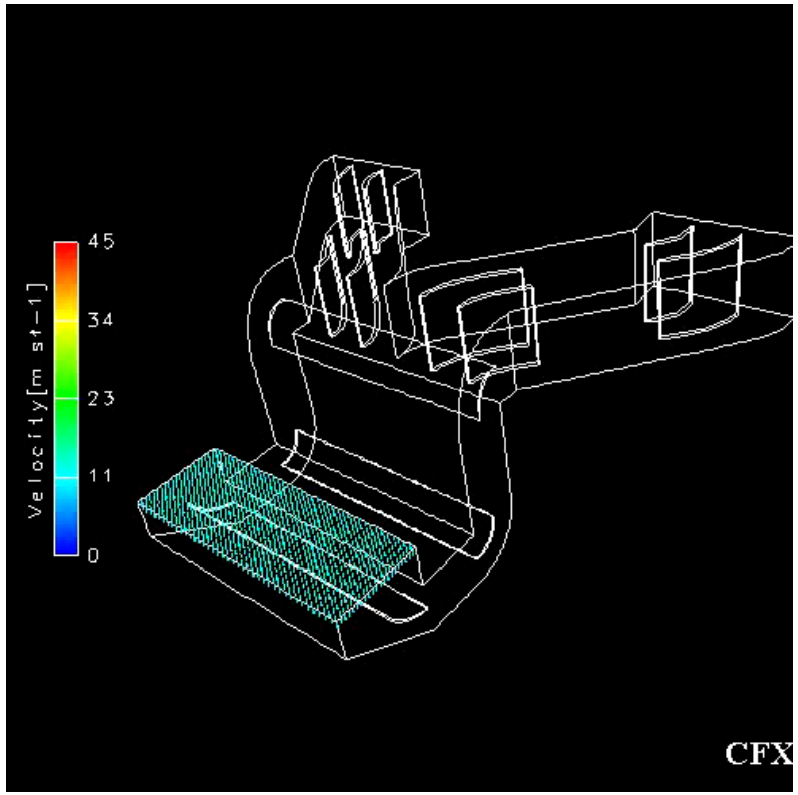
Example: ID Fan and duct optimization

(Fan outlet to ESP Inlet)



BEFORE

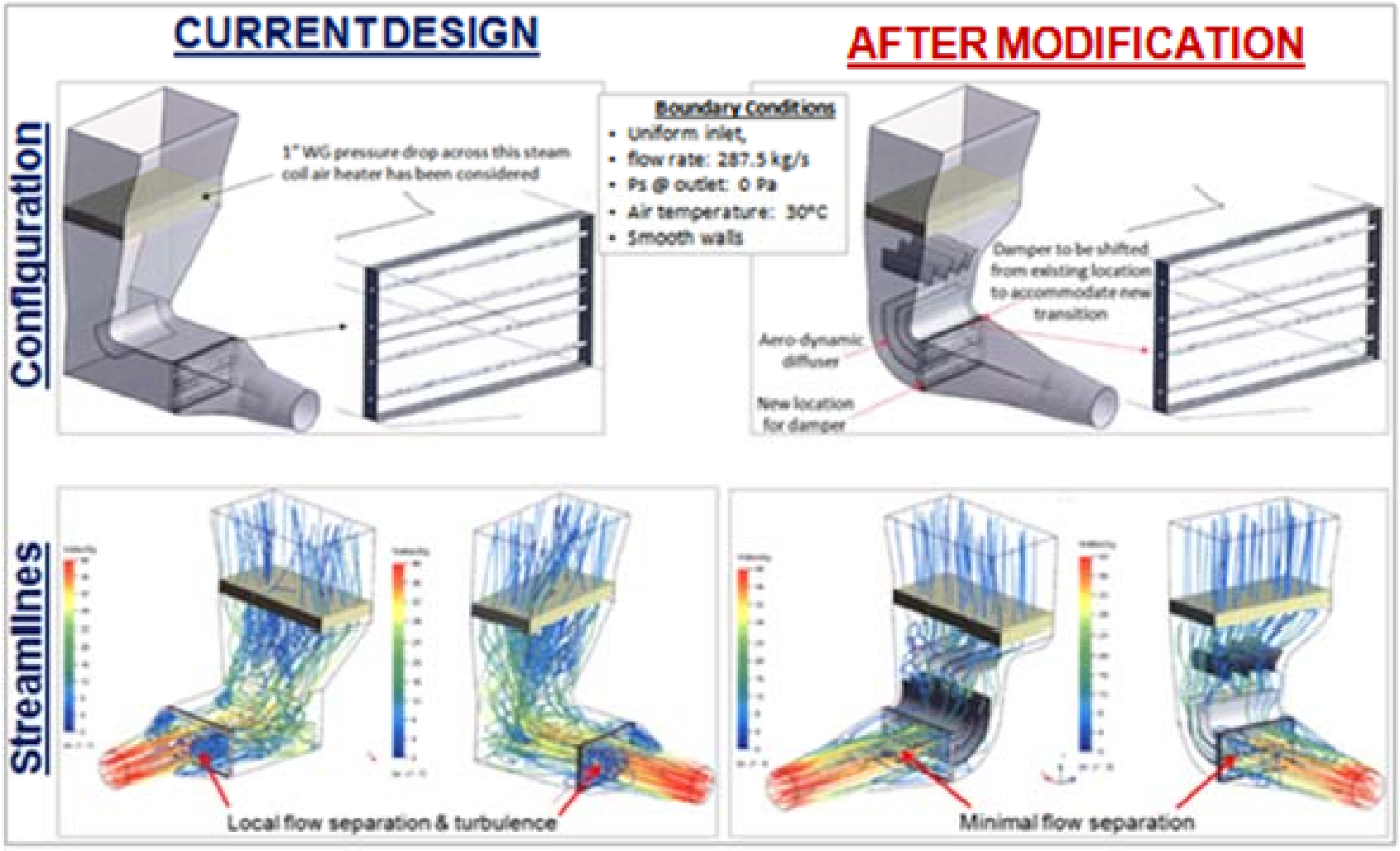
Base Case model showing non-uniform airflow and flow separation



AFTER

Recommended Solution showing airflow with less turbulence and more uniform velocity distribution

Examples: Duct optimization



Typical Estimated Benefits of Applying CFD Simulated Engineering Optimization

- Performance Improvement of the Pollution & emission control Equipment……10+%
  - Clean Environment with Carbon Credit
- Noise control Reduction……30+ dBA
- Fan systems Energy efficiency……25%
- Increase power & process units combustibility……..3+%
- Operational & maintenance Improvements:
  - Higher productivity
  - Lower wear & tear
- Carbon Credit

Results based on Technology Implementation

Concluding Remarks

- Energy efficient manufacturing has been achieved in existing heavy industry, leading to “cleaner production”.
- Use of aerodynamics with fluid mechanics to optimization and manage air flow, while minimizing turbulence has been demonstrated as successfully engineering solutions.
- CFD simulation is used as diagnostic tool for smart design and energy conservation.
- Besides the ongoing efforts with alternate energy, smart management of conventional energy could further contribute to eco-friendly world.