Supply Side Energy Efficiency and Fuel Switch

Practical, Fast Track Approach To Implement Carbon Mitigation In Existing Power Generation Stations – The 400 MW Power Plant Example

Carbon Expo – May 11, 2006

Cologne, Germany

Presentation Outline

- Brief History and Introduction
- Fast Track Examples for Carbon Mitigation
- Full Capture Readiness for Key Pollutants
- Efficiency Impacts in Developing Economies
- Sustainable Growth in Power Generation
- Reduction and Market Potential for CDM/JI Supported Oxy-Fuel Power
- How can CDM/JI Help Overcome Remaining Obstacles

Economic Needs Industrial Solutions

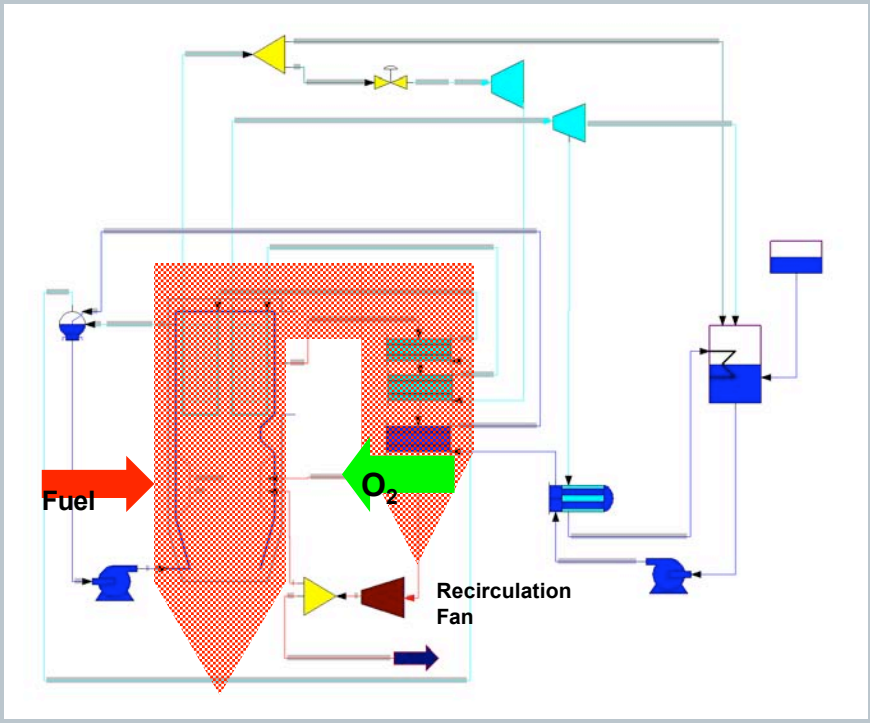
- In the 1990s reducing fuel consumption
- Privately funded research program
- Technology transfer one process many applications

Oxy-Fuel Combustion and Jupiter's Role

- Oxy-Fuel Combustion is the combustion of a fossil fuel with substantially pure oxygen
- Jupiter's Role
  - Process
  - High flame temperatures
  - Radiant heat transfer
  - Specifically designed oxygen equipment

Power Generation – Immediate Impacts

- Carbon Reductions from efficiency gains
- Efficiency gains through fuel reduction
- Improving the existing power plant
- Equipment
  - Oxygen generating equipment
  - Jupiter specified oxygen combustion system



Power Plant Basic Concepts

1) We use oxygen to increase efficiency
2) The efficiency increase leads to a reduction in fuel
3) The reduction in fuel is partially offset by the parasitic needs to generate the oxygen
4) The net result is a reduction in fuel
5) The reduction in fuel – reduces carbon

Natural Gas Power Plant

Power plant example	**Natural gas boiler 300 MW**	
Baseline Fuel Usage	26,805,600	MMBtus per year
Jupiter Oxy-Fuel	22,516,704	MMBtus per year after retrofit
Net Reduction	4,288,896	MMBtus per year saved at plant
percentage reduction	**16%**	
Electricity Required	27	MW per hour for cryogenic plant
Fuel to produce power	2,026,503	fuel based on same plant producing electricity for cryogenic plant
Net mmbtu reduction	2,262,393	adding back in fuel to produce additional MW
percentage reduction	**8%**	

Coal Fired Power Plant

Power plant example	**Coal Fired Boiler 400 MW**	
Baseline Fuel Usage	35,750,000	MMBtus per year
Jupiter Oxy-Fuel	31,460,000	MMBtus per year after retrofit
Net Reduction	4,290,000	MMBtus per year saved at plant
percentage reduction	**12%**	
Electricity Required	38	MW per hour for cryogenic plant
Fuel to produce power	2,988,700	fuel based on same plant producing electricity for cryogenic plant
Net mmbtu reduction	1,301,300	adding back in fuel to produce additional MW
percentage reduction	**4%**	

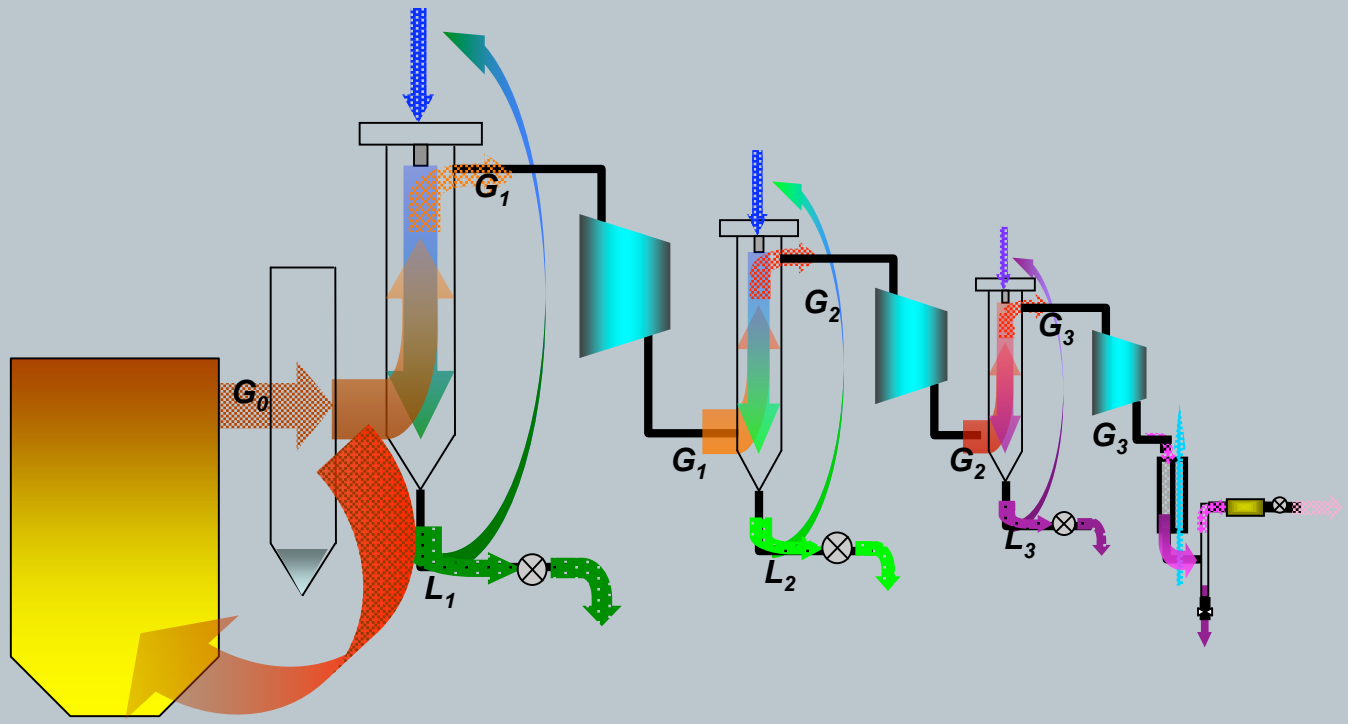
These Examples are the Easiest of Retrofits

- Does not reflect perhaps the true opportunity for plant efficiency gains in developing nations
- Project implementation is dependent on available equipment
- 400 MW coal fired
  - 100,000 tons CO_2 per year avoided
  - $3.5M (US) savings per year without credits after additional operating costs

Oxy-Fuel Enables Cost Reduced Capture

- Carbon source and oxygen yields carbon dioxide and water
- Without nitrogen we have undiluted flue gasses
- Undiluted flue gasses are easy to capture

Full Capture Concepts – for Capture Ready Technology



Clean Coal Power Plants

Environmental Results:

- 95%+ Capture of CO_2
- 99%+ Removal of Particulate in PM 2.5
- 99%+ SO_x Removal
- 90%+ Mercury Capture
- NO_x after Combustion of .05 lbs./ MMBtu

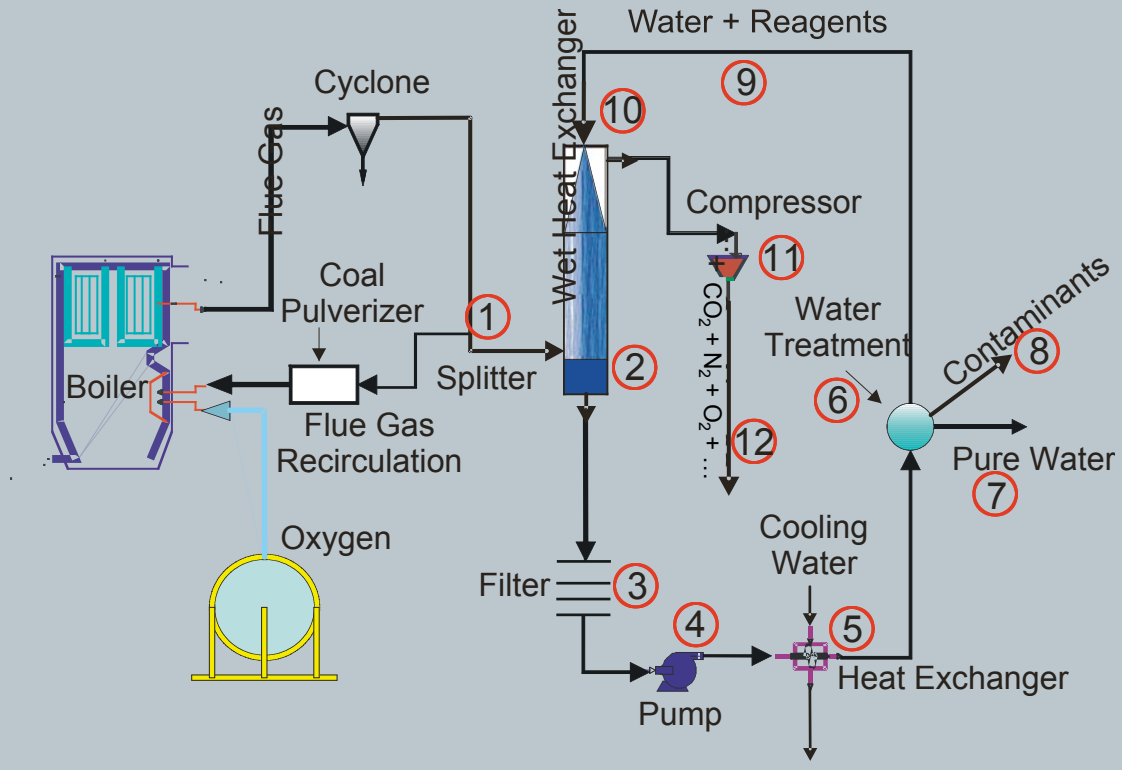
Efficiency Impacts in Developing Economies

- Key driver of economic growth is electricity
- Dual opportunity in developing nations
  - The retrofit
  - New power plant
- Fossil fuel power plant: we must look at the entire plant efficiencies from combustion to capture stream

Efficiency Impacts in Developing Economies

- Two examples of plant efficiencies:
  1) From 18% to 19% saves 998 BTU/kWh
  2) From 55% to 56% saves 11 BTU/kWh
- Oxy-Fuel efficient capture strategies in power generation

Jupiter Oxy-Fuel Enabled Full Capture Power Generation – Sustainable Growth



Key Technology Considerations

- If we intend to capture CO_2 – do not dilute the flue gas
- Select low cost – high impact solutions as most efficient systems
- Oxy-Fuel combustion is a process developed to increase efficiency
  - Components
  - Operational parameters
- Relies on existing components which are widely available

Reduction Potential from Oxy-Fuel Technology

- 400 MW coal fired power plant running at standard developed country operating efficiencies (PC Subcritical)
  - Save 100,000 Tons per year of CO_2 from boiler and combustion efficiency increases, with the use Jupiter's technology alone, enabling capture
  - Capture 2,500,000 tons per year of CO_2 (est.) in fully integrated plant at a capital cost of approximately $162,000,000 (US$')

Market Potential for Oxy-Fuel Technology

- Market potential (new and existing plants)
  - Natural gas
  - Oil
  - Coal fired

How can CDM/JI mechanism help ?

- Set priorities towards the most efficient solutions
- Critical capital resources have to be mobilized for start-up technology [first of its kind]
- Minimize development costs and achieve early market entry
- It is important for technologies such as Jupiter's Oxy-Fuel Combustion to be demonstrated

Importance of Jupiter's technology and CDM/JI- project development

- The IPCC 'Special Report on CCS' points to the potential of retrofitting power systems with oxy-fuel combustion technology:
  - Such as steam based PC and Natural Gas fired plants, which represent 40 % of the existing global infrastructure and which are **a major source of global emissions!**
  - Result based incentives, based on CO_2 as a commodity
  - Opening the markets in developing countries for higher efficiency and CO_2 mitigation in low cost - highest impact potential

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