Environmental Footprints of IGCC and PC Plants - An Update

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Provided Performance and Cost Estimates for IGCC and PC plants

What We'll Cover Today . . .

- EPA IGCC Initiatives
- IGCC vs. PC Plants, Technical Study Scope
- Preliminary Study Results*
  - Thermal performance
  - Air pollution impacts
  - Water use and solid waste impacts
  - CO_2 capture and sequestration potential

* Study is expected to be finalized and issued by April 2006

Environmental Technology Initiatives

- Creation of a joint EPA and DOE team for promotion of IGCC technology
- Major EPA/DOE activities:
  - Develop a model to assess the economic viability of IGCC plants under different conditions
  - Conduct a technical study to establish the environmental footprint of the IGCC technology, relative to conventional PC plants

Technical Study Scope

- IGCC and PC plant comparisons provided, using bituminous/sub-bituminous coals and lignite
- Plant size: 500 MW
- Plant configurations:
  - Oxygen-blown IGCC, 1800 psig/1000F/1000F
  - Subcritical PC, 2400 psig/1000F/1000F
  - Supercritical PC, 3500 psig/1050F/1050F
  - Ultra-supercritical PC, 4500 psig/ 1,100F/1,100F (double reheat)

Technical Study Scope, (Cont'd)

- **IGCC plant environmental controls:**
  - NOx: Diluents (SCR evaluated)
  - SO_2: MDEA (Selexol evaluated)
  - Particulate: Filter
  - Mercury: Carbon-bed
- **PC plant environmental controls:**
  - NOx: Combustion controls and SCR
  - SO_2: Wet FGD for bituminous coal (BC) and lignite (LIG) and spray dryer for sub-bituminous coal (SBC)
  - Particulate: Baghouse
  - Wet precipitator: Acid mist control for BC and LIG
  - Mercury: Activated carbon injection for SBC

Thermal Performance Methodology / Issues

- Estimates based on Gate cycle and Nexant in-house thermal performance software
- Estimates use coal slurry feed gasifier for bituminous and sub-bituminous coals and dry coal feed gasifier design with lignite
- IGCC performance based on F-type gas turbine
- Estimates for IGCC with low-rank coals based on literature, with relatively low confidence level
- No US experience with ultra-supercritical PC plants – estimates based on literature, with relatively low confidence level

Thermal Performance Bituminous Coal

Plant Type	IGCC	PC Sub-Critical	PC Super-Critical	PC Ultra Super-Critical
Net Output, MW	500	500	500	500
Thermal Efficiency, % HHV	41.8	35.9	38.3	42.7
Heat Rate, Btu/kWh	8,167	9,500	8,900	8,000

Thermal Performance Sub-Bituminous Coal

Plant Type	IGCC	PC Sub-Critical	PC Super-Critical	PC Ultra Super-Critical
Net Output, MW	500	500	500	500
Thermal Efficiency, % HHV	40.0	34.8	37.9	41.9
Heat Rate, Btu/kWh	8,520	9,800	9,000	8,146

Thermal Performance Lignite

Plant Type	IGCC	PC Sub-Critical	PC Super-Critical	PC Ultra Super-Critical
Net Output, MW	500	500	500	500
Thermal Efficiency, % HHV	39.2	33.1	35.9	37.6
Heat Rate, Btu/kWh	8,707	10,300	9,500	9,065

Environmental Impacts Methodology / Issues

- Air emissions based on air permit documents, vendor information, and literature
- Recent air permit documents used from 12 PC plants and 5 IGCC plants
- Air permit data not available for low-rank coal IGCC plants– assumed pollutant reduction levels similar to those for bituminous coal
- Limited air permit data available for lignite PC plants – assumed pollution reduction levels similar to other coals

Air Emission Comparisons*

Pollutant	IGCC Bituminous	Subcritical PC Bituminous	Subcritical PC Subbituminous	Subcritical PC Lignite
NOx	0.049	0.06	0.06	0.06
SO_2	0.043 (99% removal)	0.086 (98% removal)	0.065 (87% removal)	0.04 (98% removal)
PM/PM_{10}	0.007	0.012	0.012	0.012
VOC	0.0017	0.0024	0.0027	0.0027
CO	0.03	0.10	0.10	0.10
Hg	$0.76x10^{-6}$	$0.76x10^{-6}$	$0.42x10^{-6}$	$0.73x10^{-6}$

*** All emissions in lb/MMBtu. IGCC NOx based on 15 ppmvd/15% O_2 and with no SCR. An SO_2 removal of 87% reflects a very low coal sulfur content (0.22%).**

Water Use and Solid Waste Comparisons

Parameter*	PC Plant	IGCC Plant	% less for IGCC
Solid waste, bituminous coal, tpd	1,090	430	60
Solid waste, subbituminous. coal, tpd	480	280	42
Solid waste, lignite, tpd	2,080	1,600	23
Plant makeup water, gpm	9,340	6,030	35
Wastewater discharge, gpm	2,910	1,960	33

* Assumes no sale for solid wastes, except for sulfur produced in IGCC. .

Water Use and Solid Waste Comparisons – Special Notes

- Solid waste differences between IGCC and PC plants will vary with sale of wastes
- Number of PC plants selling solid wastes:*
  - 26% plants with wet FGD sold gypsum
  - 5% plants with dry FGD sold SO_2/ash waste
  - 20% plants sold fly ash and 16% bottom ash
- Study assumes sale only of IGCC sulfur byproduct (no sale for other PC or IGCC wastes)
- Water use for IGCC and PC plants will vary with cooling tower design assumptions and reuse of certain wastewater streams.

* EIA website, EIA-767 Data Files for 2004, http://www.eia.doe.gov/cneaf/electricity/page/eia767.html

SCR Application on IGCC

- One operating asphalt-based IGCC SCR installation in Japan
- Issues with applying SCR to IGCC:
  - Concerns with sulfur compounds
  - Need for ultra-efficient SO_2 controls
  - Lack of experience
- Cost estimate: $6,040 – 11,870 per ton of SO_2
- Case-by-case review of permit applications

CO_2 Capture and Sequestration Potential

Parameter	IGCC Plant	PC Plant*
CO_2 capture, %	91	90
Unit output derating, %	14	29
Heat rate increase, %	16.5	40
Capital cost increase, %	47	73
COE increase, %	38	66

* Oxycombustion technology currently under development has the potential to substantially reduce CO_2 capture costs for PC plants.

Conclusions

- IGCC thermal performance significantly better than PC technologies applied in US
- Ultra-supercritical PC thermal performance may match or exceed current IGCC performance
- Better environmental performance for IGCC
- IGCC has potential advantage in capturing and sequestrating CO_2 at lower costs
- Limited information available for the study on low-rank coal applications for IGCC and on ultra-supercritical PC plants