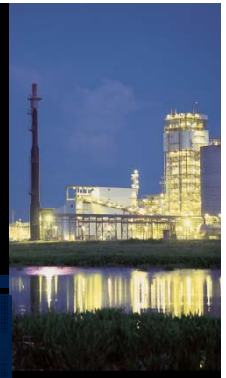
TECO
TAMPA ELECTRIC



IGCC Process Overview and Permitting Implications for NACAA

Tampa FL. May 6, 2008

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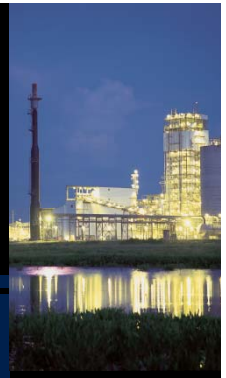
Tampa Electric Generation



- Big Bend Station 1842 Mw
  - 4 Coal-fired steam units (+ CT's)
- Bayside Power Station 1650 Mw
  - Repowered NGCC
  - One 3 on 1
  - One 4 on 1
- Polk Power Station 920 Mw
  - One IGCC
  - Four peaking CT's (2007)
- Phillips Power Station 36 Mw
  - Two slow-speed diesels
- Total capacity (approx.) 4450 Mw

2007 Summer Ratings

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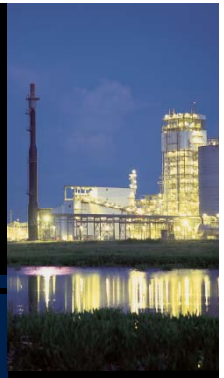
Polk Power Station



- Unit 1 IGCC, Base load on syngas, intermediate on oil
  - Combined cycle, GE 7F, 7221 192 MW
    GE D11, steam 128 MW
  - Dual fuel, Syngas/Distillate Oil
  - DOE Clean Coal Technology co-funding $120M
  - In service 1996
- Unit 2, 3, 4 & 5 Simple Cycle CT, Peaking
  - Simple cycle GE 7FA+E, 7241 150 MW each
  - 2 & 3 Dual fuel, Nat gas/Distillate Oil; 4 & 5 Nat Gas only
  - Unit 2 in service 2000, Unit 3 2002, Units 4 & 5 2007
- Total site over 4000 acres (previously mined for phosphate)
  - 750 acre cooling pond
  - 80 Tampa Electric employees

Aerial View of Polk Power Station

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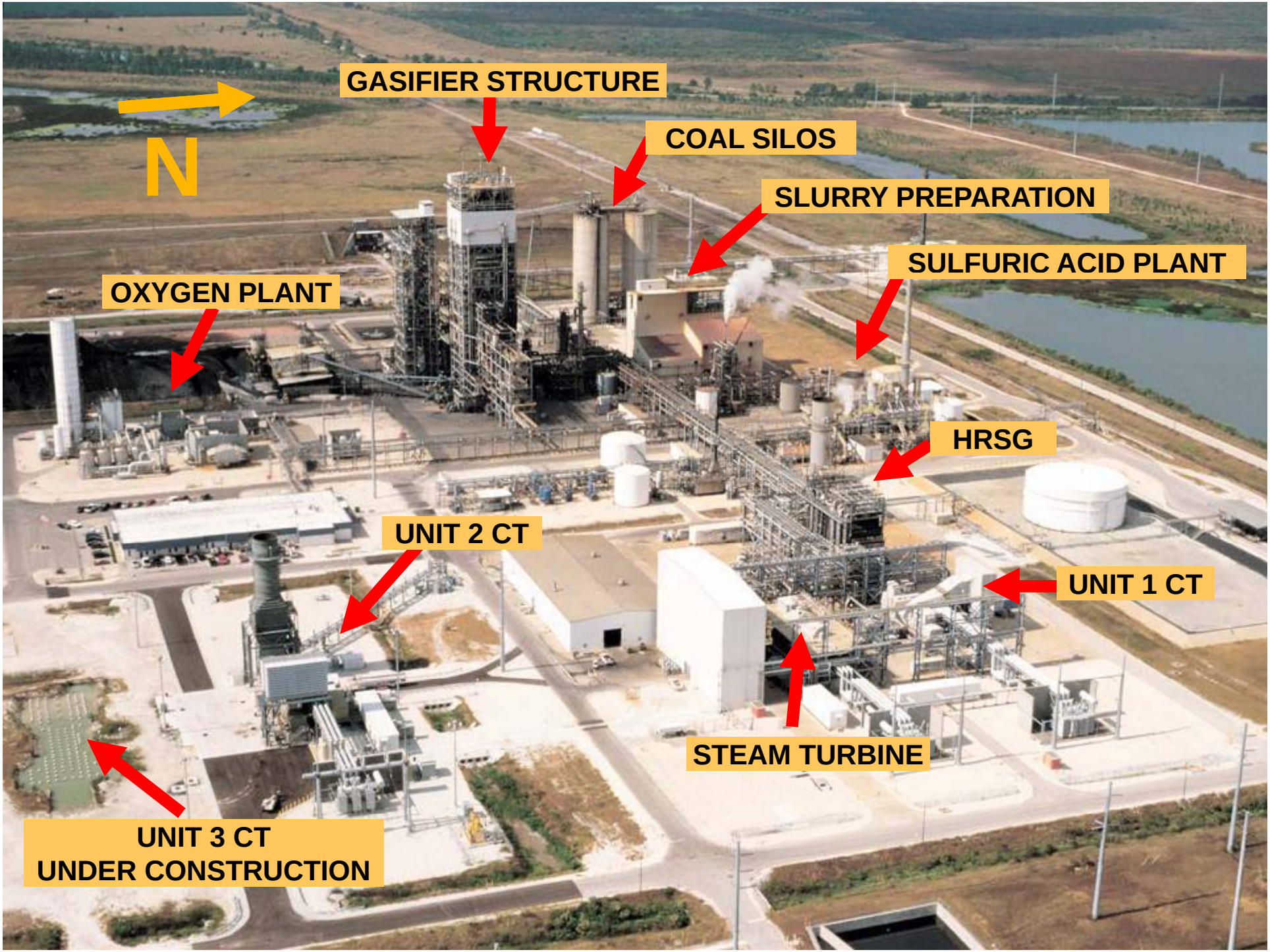
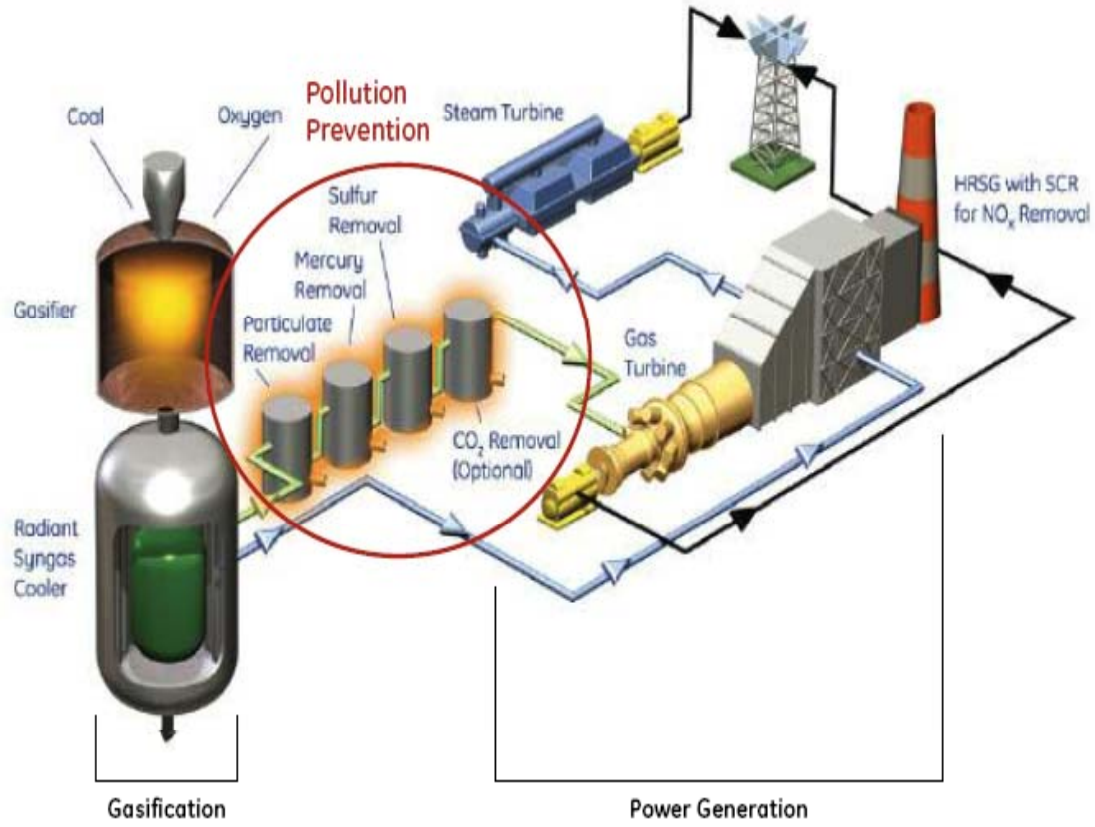
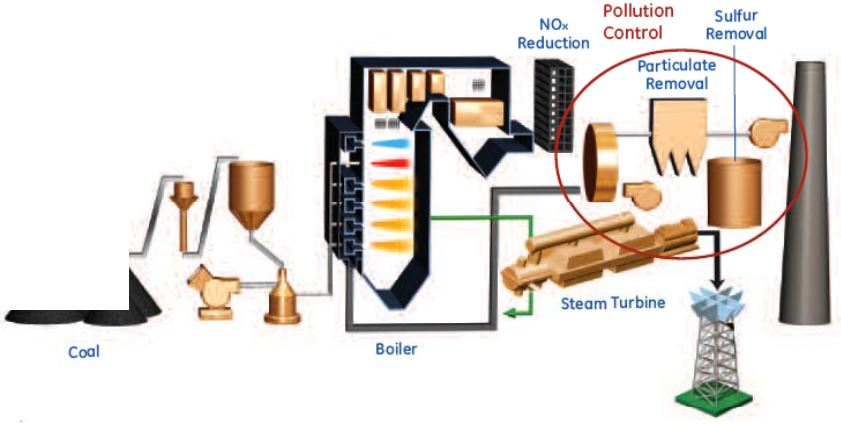

N
GASIFIER STRUCTURE
COAL SILOS
SLURRY PREPARATION
SULFURIC ACID PLANT
OXYGEN PLANT
HRSG
UNIT 2 CT
UNIT 1 CT
STEAM TURBINE
UNIT 3 CT
UNDER CONSTRUCTION

IGCC – Cleans the "Fuel Gas" not "Flue Gas"



- Gasifier at **400 PSIG**
- Syngas 1/100th volume of flue gas
- Removal equipment smaller and more effective

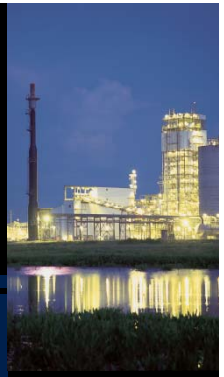
In *Integrated Gasification Combined Cycle (IGCC)* plants, gasification converts low cost fuels, like coal, pet coke and biomass into synthesis gas (syngas), and heat to fuel an efficient combined cycle system.



In *pulverized coal (PC)* plants, coal is fed into a boiler, which combusts the coal, followed by post combustion pollution controls.

Graphics courtesy of GE Energy

Polk 1 Performance Environmental



- Polk rated the “Cleanest Coal-Fired Power Plant in North America” by the Energy Probe Research Foundation

(Total emissions from 2002 TRI data)

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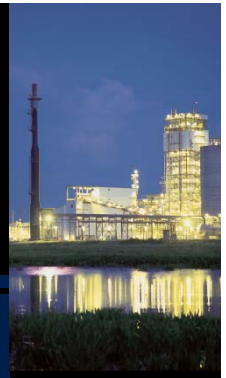
Low Emissions

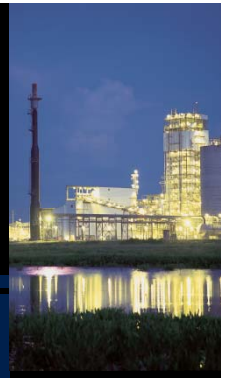


- Typical Emissions (Lb/MMBTU)

	Polk (Permit)	Polk (Steady State)	Expected New IGCC
SO_2	0.14	0.12	0.019
NO_x	0.055	0.04	0.038
Particulate	0.007	<0.004	0.007
Mercury	NA	NA	90%+ removal

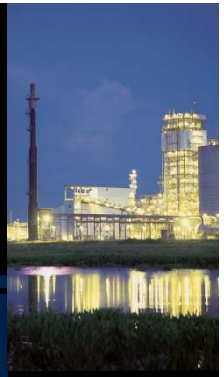
(New IGCC values are basis 8,800 hhv btu/kwh net)

Other Environmental Advantages



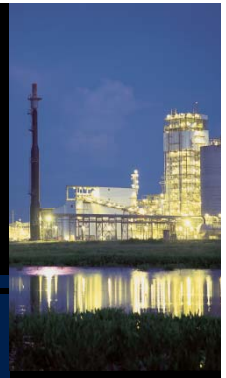
- Beneficial Reuse of Sulfur – H_2SO_4 at Polk
- Beneficial Reuse of Slag
- Low Water Use (2/3 that of PC unit)
- Minimal solid waste (no gypsum from FGD)
- Zero Process Water Discharge

Environmental Opportunities



- Mercury - Cost-Effective Removal on IGCC using small activated carbon bed
  - Testing done at Polk
  - Commercially at Eastman to 95+%
- Other Volatile Metals – Will also be removed by carbon bed

Environmental Opportunities



$\underline{CO_2 \text{ removal}}$

- Solvents for sulfur removal can also remove CO_2
- For high levels of removal would "shift" syngas

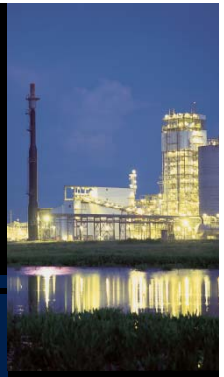
$$CO + H_20 \rightarrow CO_2 + H_2$$

- Shift plus CO_2 removal is common for chemicals

$\underline{CO_2 \text{ Storage (Sequestration)}}$

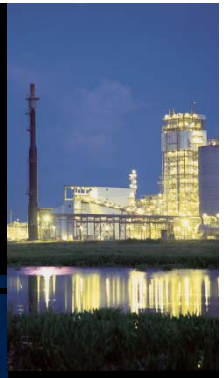
- Deep salt water zone injection – USF feasibility study

Fuel Flexibility



- Polk has operated on over 20 different fuels including:
  - Coals
  - Coal Blends
  - Coal/Pet Coke Blends
  - Coal/Coke/Biomass Blends
- Slagging gasifier requires somewhat higher fusion temps (Polk targets 2350 – 2700 F T_{250} temps)
- Low rank fuels can be used in slurry fed gasifiers, but hurt efficiency
- Power block can operate on syngas or distillate oil

Renewable Fuels

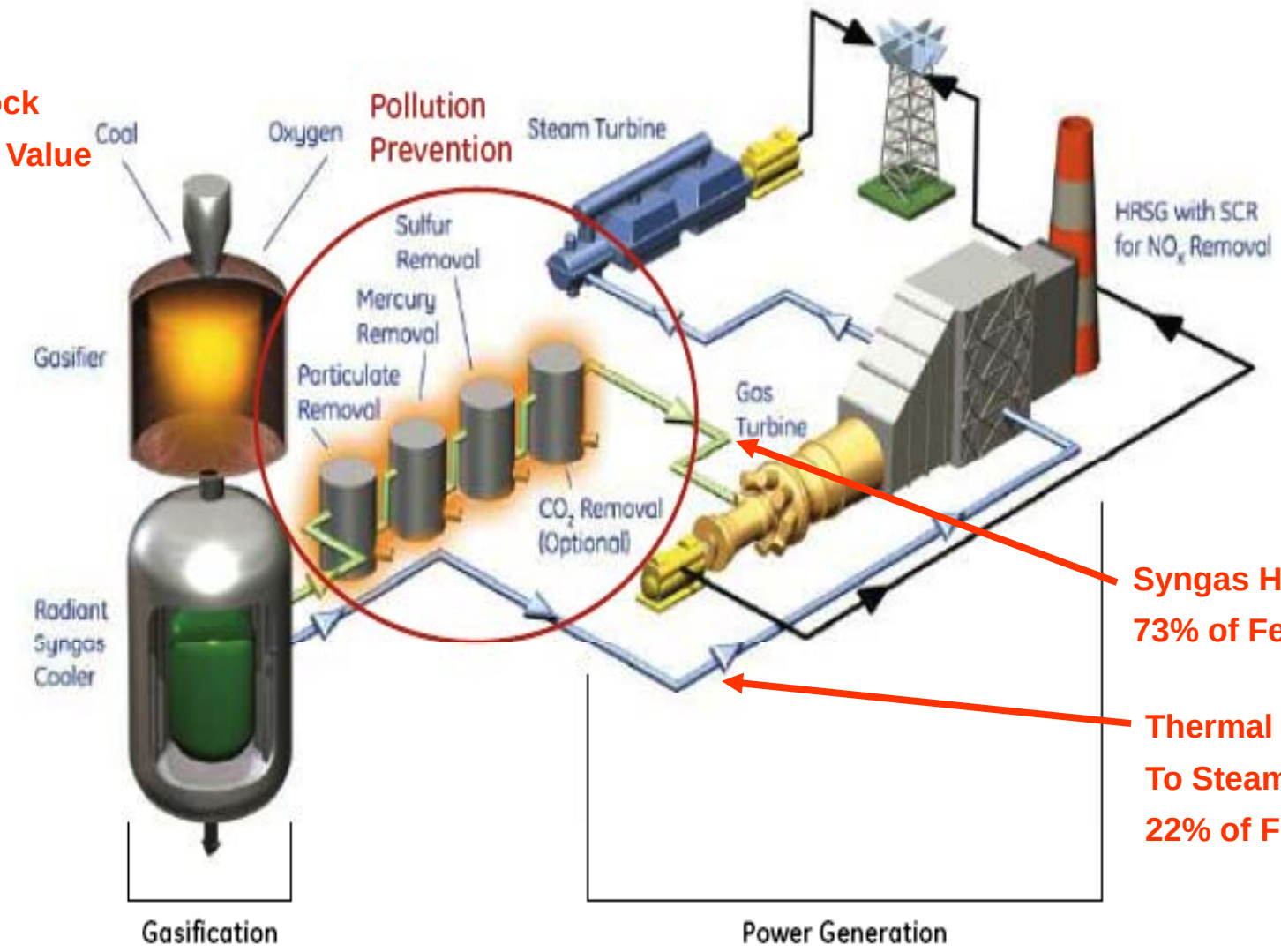


Biomass Co-Utilization Tests

- Eucalyptus Biomass Test - December, 2001
- Bahiagrass Biomass Test - April, 2004
  - (Bahiagrass Harvest and Storage Test started approximately one year prior)
- No impact on syngas quality or emissions
- Minor issues with material handling

Heat Input to CT is approx 70% of total

Feedstock Heating Value 100%

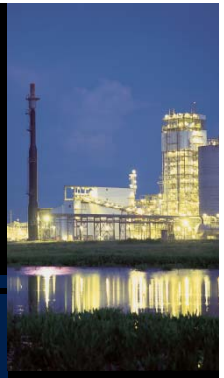


Syngas Heating Value 73% of Feedstock

Thermal Heat Recovery To Steam Turbine 22% of Feedstock

Graphics courtesy of GE Energy

Understanding Heat Input?



Power Engineering Magazine, March 2007

Comparing Emissions: PC, CFB and IGCC

By: Robynn Andracsek, Burns & McDonnell

Figure 1 COMPARISON OF PC, CFB AND IGCC ACTUAL SO_2 EMISSIONS

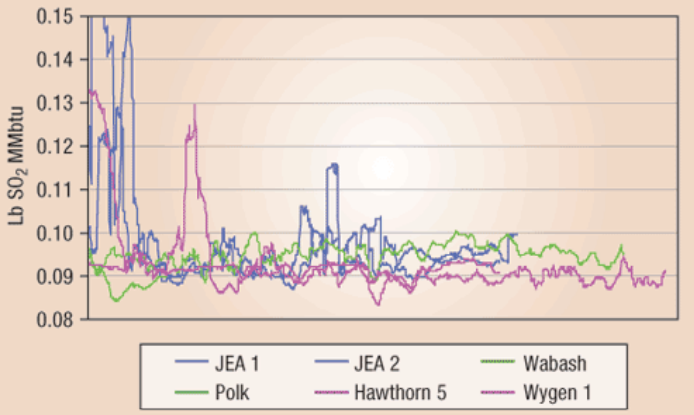


Figure 2 COMPARISON OF PC, CFB AND IGCC ACTUAL NO_X EMISSIONS

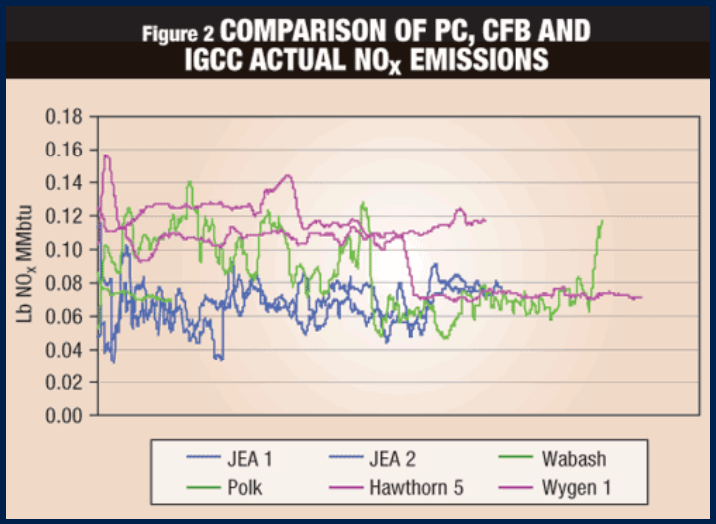
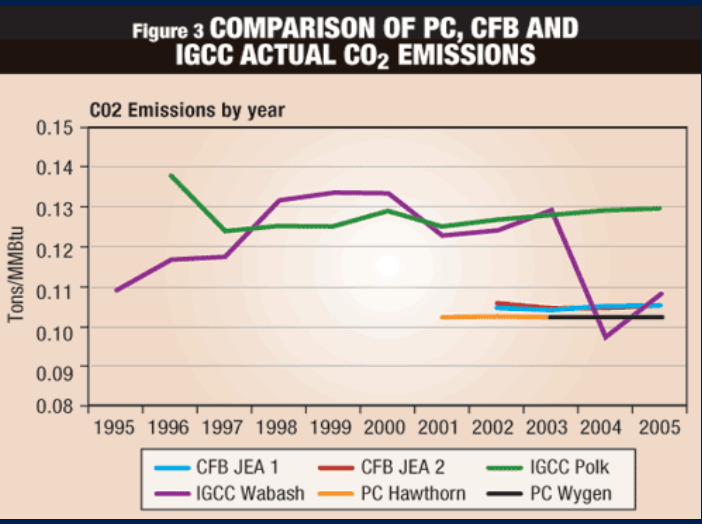


Figure 3 COMPARISON OF PC, CFB AND IGCC ACTUAL CO_2 EMISSIONS



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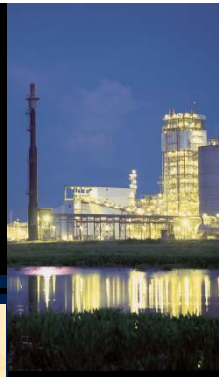

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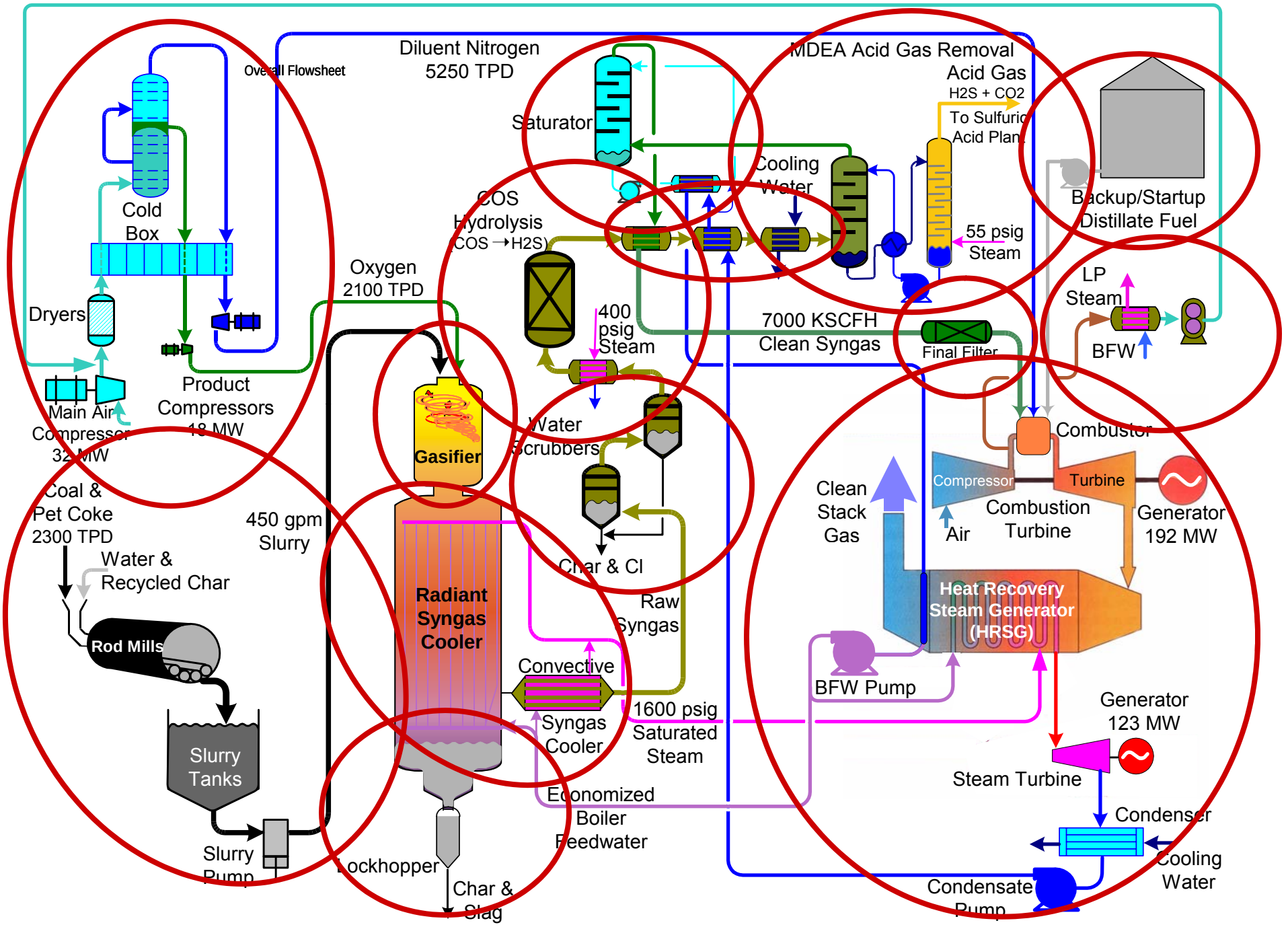
Overall Flowsheet
Diluent Nitrogen
5250 TPD
MDEA Acid Gas Removal
Acid Gas
H2S + CO2
To Sulfuric
Acid Plant
Saturator
Cooling
Water
Backup/Startup
Distillate Fuel
Cold
Box
COS
Hydrolysis
COS → H2S
55 psig
Steam
Oxygen
2100 TPD
LP
Steam
400
psig
Steam
7000 KSCFH
Clean Syngas
Final Filter
BFW
Dryers
Product
Compressors
18 MW
Main Air
Compressor
32 MW
Gasifier
Water
Scrubbers
Combustor
Coal &
Pet Coke
2300 TPD
450 gpm
Slurry
Char & Cl
Clean
Stack
Gas
Compressor
Turbine
Air
Combustion
Turbine
Generator
192 MW
Water &
Recycled Char
Radiant
Syngas
Cooler
Raw
Syngas
Heat Recovery
Steam Generator
(HRSG)
Rod Mills
Convective
Syngas
Cooler
BFW Pump
Generator
123 MW
1600 psig
Saturated
Steam
Slurry
Tanks
Steam Turbine
Economized
Boiler
Feedwater
Condenser
Slurry
Pump
Lockhopper
Char &
Slag
Cooling
Water
Condensate
Pump