Gasification for Power, Chemicals and Fuels

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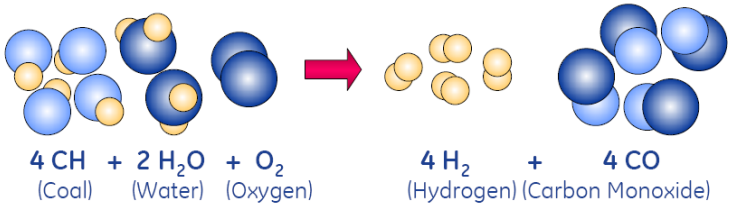
Feedstocks for Gasification

- Coal
- Pet coke
- Liquid refinery wastes
- Biomass
- Municipal solid wastes
- Blends

Intermediate Product of Gasification

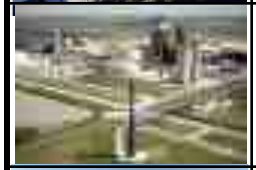
- Syngas
- Primarily composed of H_2 and CO
  - It's not methane (natural gas)
- 120-450 Btu/scf
  - depends on gasifier type
  - air-blown or oxygen-blown
- Syngas has multiple uses



End Products

- Combust syngas in gas turbines, IC engines or boilers for generating electricity
- IGCC configuration for power generation
- Modify (shift) syngas for use in producing:
  - Commodity chemicals (CO, H_2)
  - Synthetic natural gas (SNG)
  - Ammonia and fertilizers
  - Fischer-Tropsch transportation fuels (“coal-to-liquids”)
  - H_2 and CO can be combined to produce longer chain chemicals

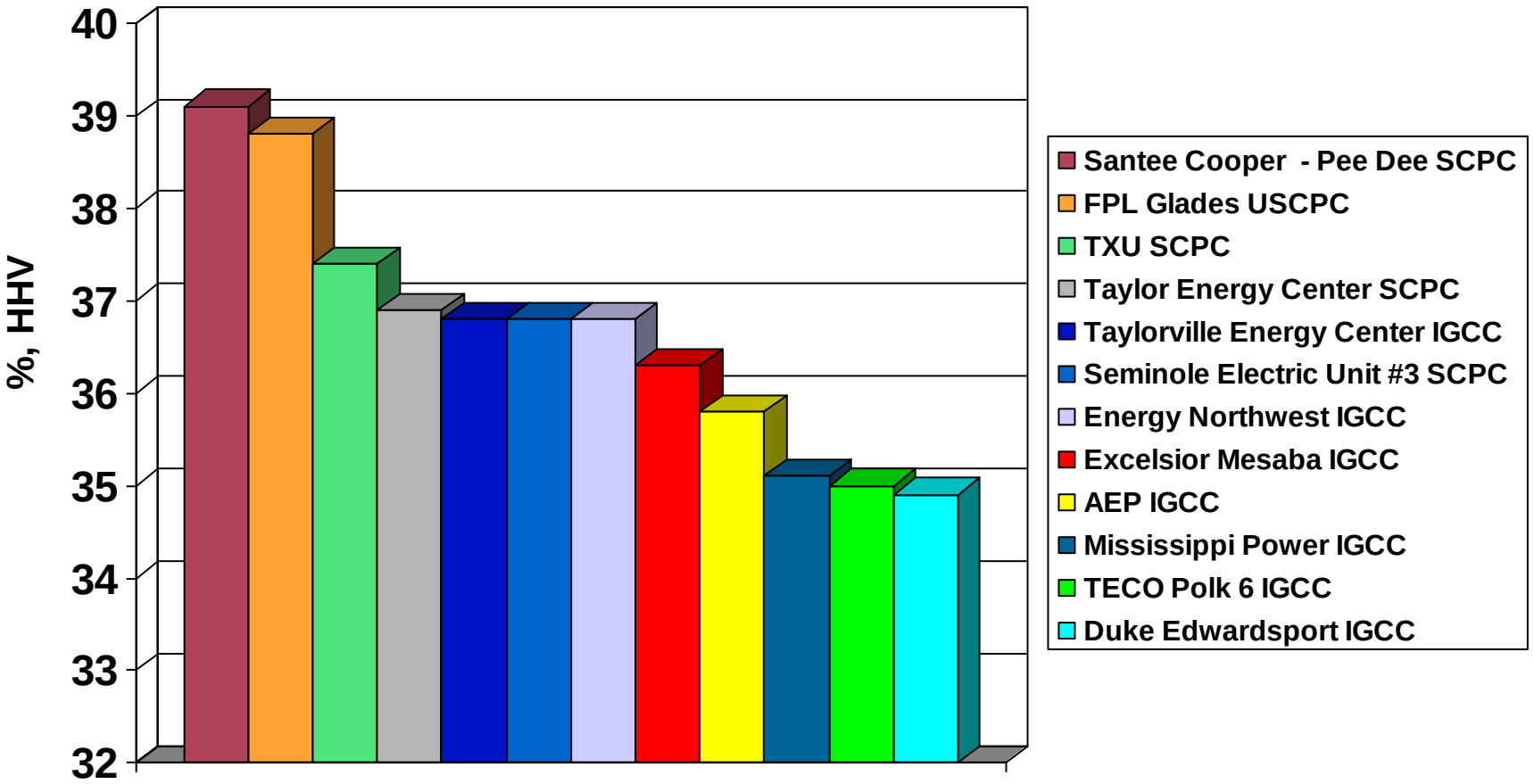
Where is Coal-based IGCC Being Demonstrated?

	Company	Facility	Location	Feedstock	Gasifier Technology	MW, net
	Nuon	Willem-Alexander Centrale	Buggenum, Netherlands	coal/biomass	Shell	253
	SG Solutions	Wabash River	W. Terre Haute, IN	coal/coke	Conoco Phillips	262
	Tampa Electric	Polk Power Station	Mulberry, FL	coal/coke	GE Energy	252
	ELCOGAS	Puertollano	Puertollano, Spain	coal/coke	Prenflo	260-280
	Multiple Japanese Utilities; MITI; CRIEPI	Clean Coal Power R&D Co.	Nakoso, Japan	coal	MHI	220

IGCC Reference Plant

- Reference plant gasifies eastern bituminous coal to produce syngas for two 232 MW gas turbines, with one 320 MW steam turbine
- Gross output: 784 MW
- Internal load: 154 MW (*20% of gross output*)
- Net output: 630 MW
- Feedstock requirements:
  - Bituminous coal: 6,000 tons/day
  - Pet coke: 4,000 tons/day
  - PRB coal: 8,200 tons/day

Efficiency of IGCC and SCPC Units



Note: some of these units have been cancelled

Data from public submittals

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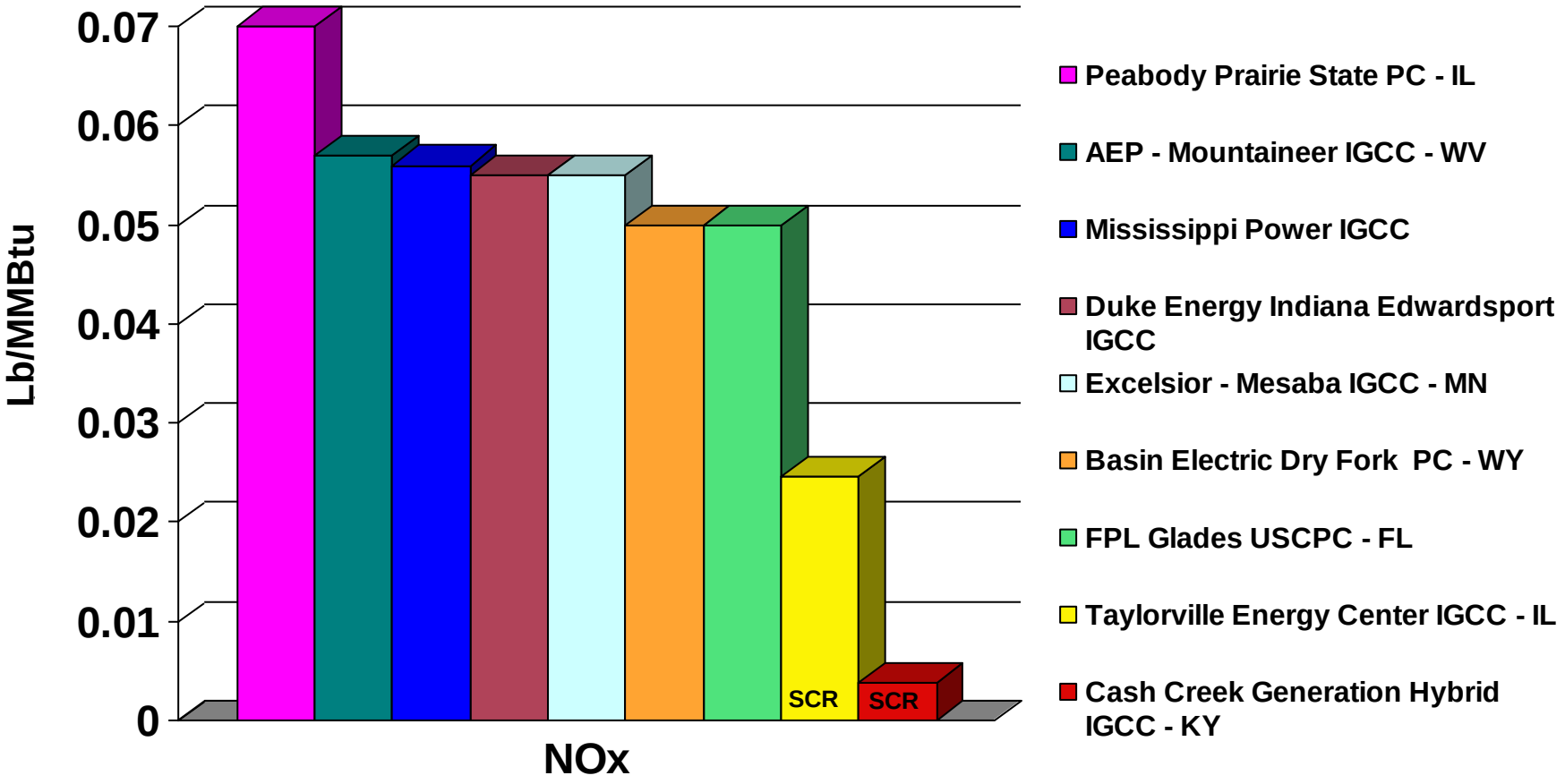
NOx Emission Rate Comparison
Coal Heat Input Basis



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Data from public submittals

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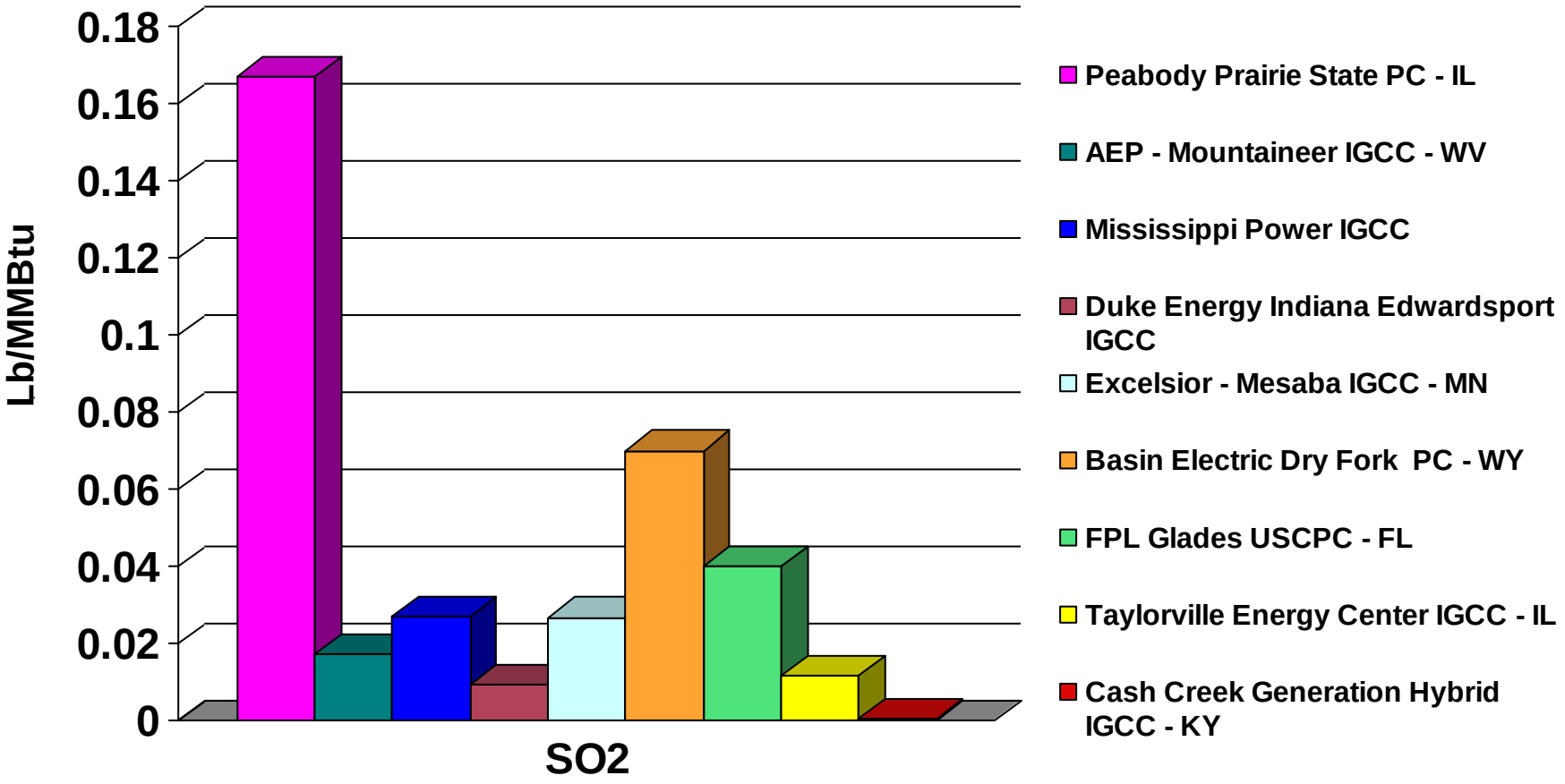
SO_2 Emission Rate Comparison
Coal Heat Input Basis



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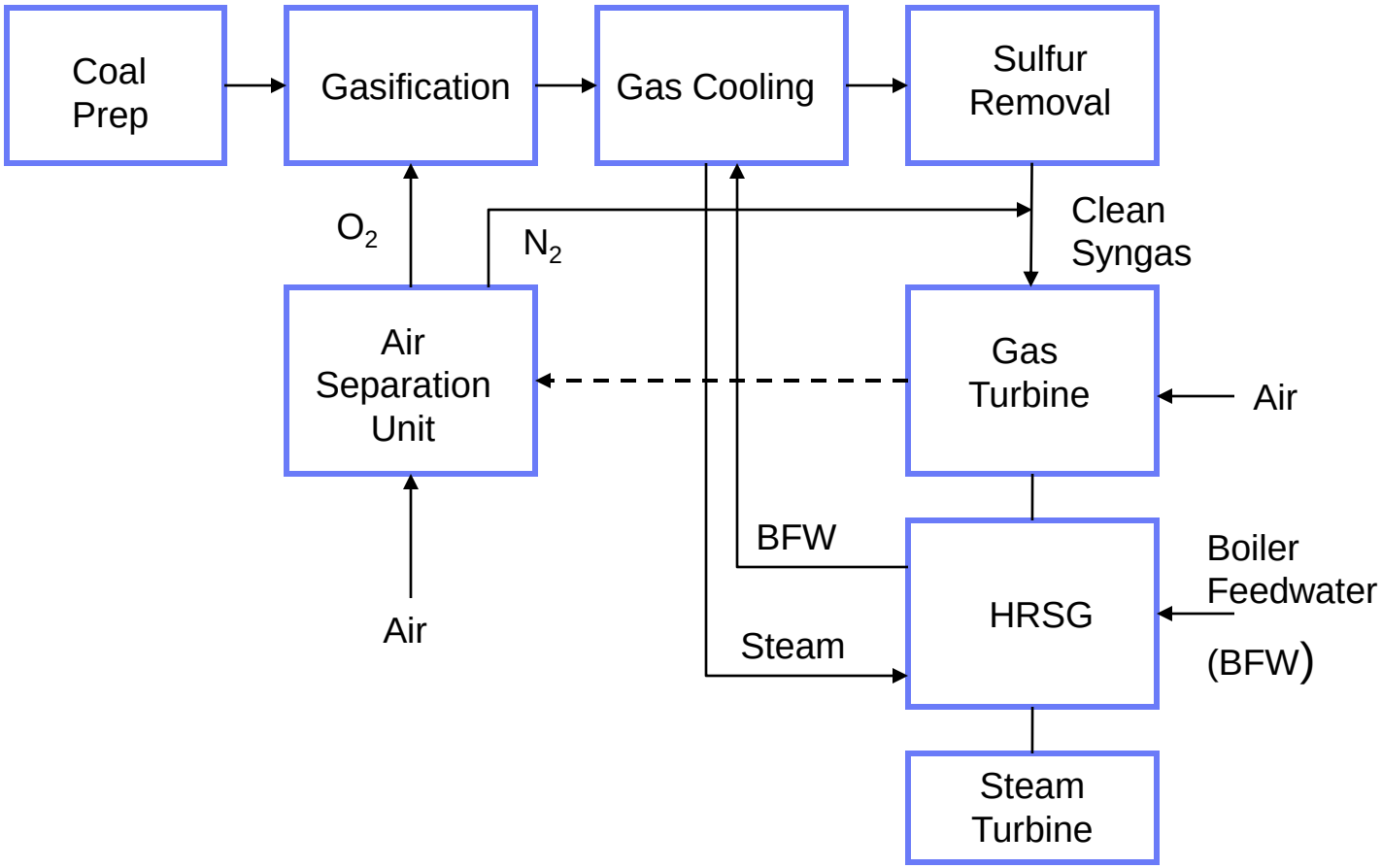
CO_2 Capture Technology for IGCC

- IGCC does not “inherently” capture CO_2
- Capturing CO_2 from an IGCC unit requires extensive addition of equipment
  - increase in capital and O&M expense
  - decrease in unit output and efficiency
- None of the coal-based IGCC units capture CO_2
- Technology proven in coal gasification plants will be applied to IGCC configuration

IGCC Reference Plant Block Flow Diagram
No CO_2 Removal



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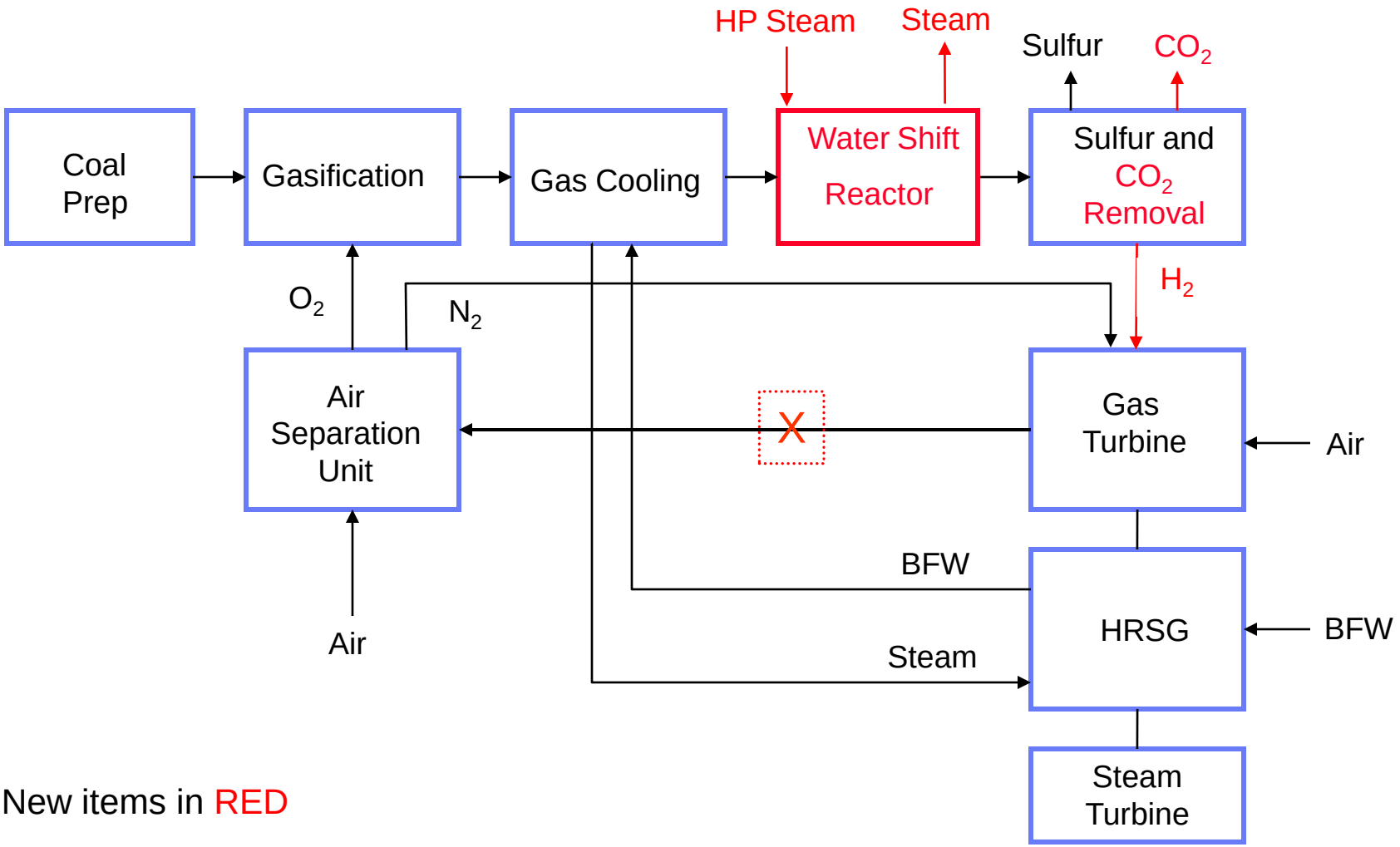
CO_2 Capture - Water Shift Reaction

- Concentration of CO_2 in syngas is only 2-14%
- By adding steam to the syngas, over a catalyst bed, the CO in the syngas is converted to CO_2, raising the concentration in the syngas to >50%

$$CO + H_2O \rightarrow H_2 + CO_2 \text{ (+ heat)}$$

- The CO_2 can then be efficiently removed from the syngas prior to combustion or use
- A commercially proven process used in refineries and chemical plants

IGCC Reference Plant Block Flow Diagram w/Water Shift Reactor and CO_2 Capture



New items in RED

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Impacts of CO_2 Capture on IGCC Reference Plant

	Net Output	Efficiency	Capital Cost	$/net kW	Cost of electricity
Change	-96 MW	-8.5 points	+$200 M	$958/net kW	$36/MWh
% Change	-15%	-22%	+11%	+32%	+40%

Sources: DOE, EPRI

Avg. of three IGCC technologies – eastern bituminous coal

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