

Gasification: Ultra Clean & Competitive



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Office of Fossil Energy



Gasification: Coal to Power

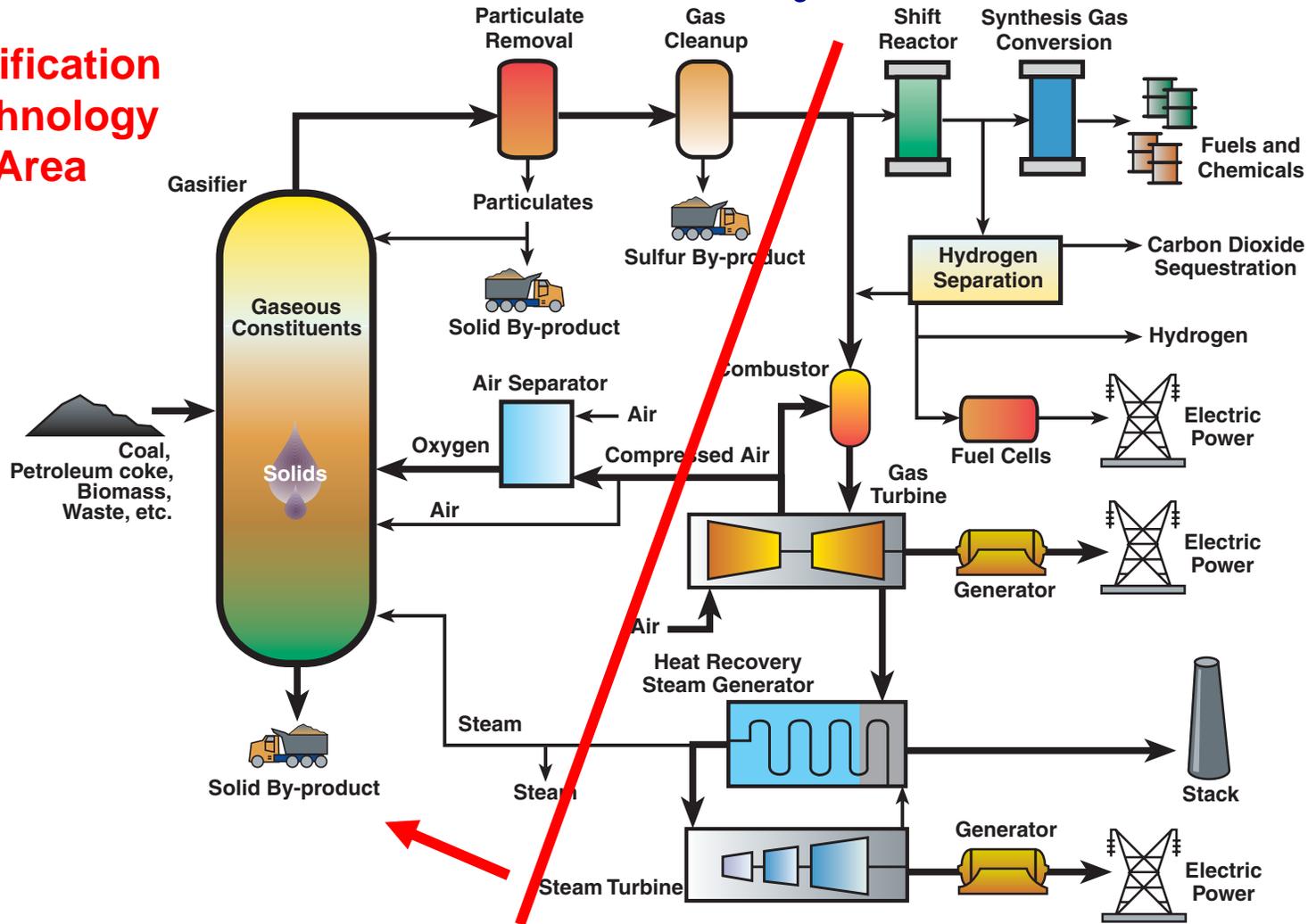
- **Ultra Clean Technology & Coal is an abundant national resource**
 - This is why gasification is great
 - But, we can do this now
- **Ultra Clean & ECONOMICALLY COMPETITIVE**

*This is where
we have a
horse race*

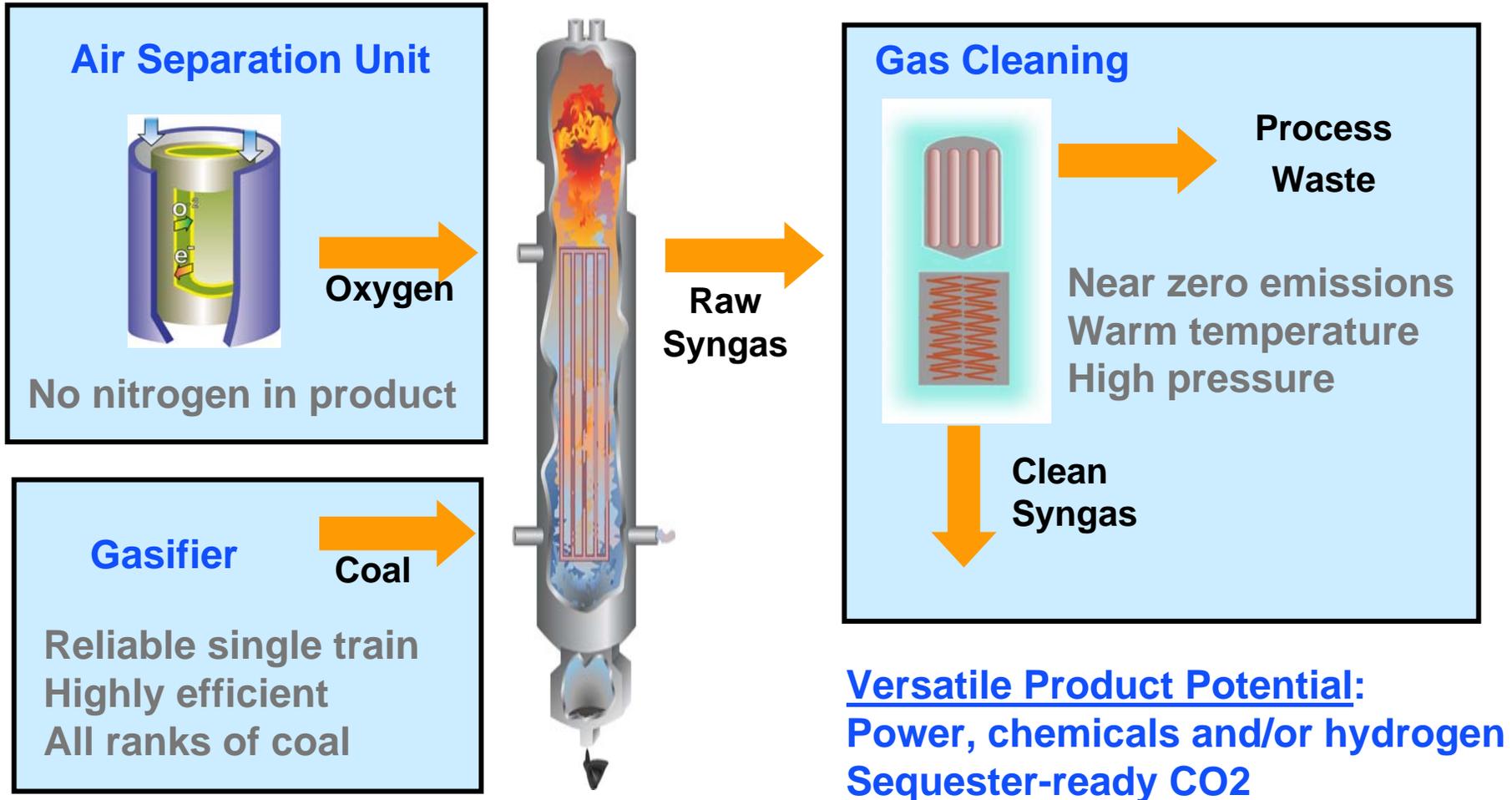


Gasification-Based Energy Production System

Gasification Technology Area



Main Gasification R&D Areas



Roadmap Performance Targets⁽¹⁾

(Represents best integrated new plant technology capability)

	Reference Plant	2010	2020
Plant Efficiency (HHV) ⁽²⁾	40%	45-50%	50-60%
Availability ⁽³⁾	>80%	>85%	≥90%
Plant Capital Cost ⁽²⁾ \$/kW	1000 – 1300	900 – 1000	800 – 900
Cost of Electricity ⁽⁴⁾ ¢/kWh	3.5	3.0-3.2	<3.0

- (1) Targets are w/o carbon capture and sequestration and reflect current cooling tower technology for water use
- (2) Range reflects performance projected for different plant technologies that will achieve environmental performance and energy cost targets
- (3) Percent of time capable of generating power (ref. North American Electric Reliability Council)
- (4) Bus-bar cost-of-electricity in today's dollars; Reference plant based on \$1000/kW capital cost, \$1.20/10⁶ Btu coal cost



Oxygen Production

- **Air Products Ion Transport Membranes being developed for air separation**
 - More efficient than cryogenic separation
 - Only egg in the basket
 - *Still interested in novel approaches with economic potential at least equivalent to ITM*
 - Conservation of energy
 - Minimal complexity
 - Impressive integration possibilities
 - High reliability



Air Products ITM Status

- **Developed a stable, high-flux material**
- **Record oxygen flux**
 - 132% of commercial target
 - >99% purity
- **Sub-scale module operated >5,500 hours**
- **Completed conceptual 500 - 3000 TPD plant design**
- **Built commercial-scale all ceramic ITM Oxygen module**



Gasifier Operation

- **Sometimes difficult for new kids on the block**
 - Intellectual property rights
 - Knowledge closely held
 - Confidentiality agreements
 - Must obtain cooperation of technology “owner”
 - To obtain needed data
 - Field test site
 - Future use of technology



Gasifier Operation #2

- **Slagging Gasifier**
 - Commercial (GE & E-Gas); CCPI (E-Gas)
 - Bituminous coal
 - *Most interested in research to create single train reliability: injectors, refractory, monitors, etc.*
- **Southern Transport Gasifier**
 - Pilot scale operational; CCPI awarded
 - Low ranked coal; typically air-blown
- **Rocketdyne's plug flow entrained gasifier**
 - Design in early stages; Pilot plant 2007
 - All ranks of coal; oxygen blown



IGCC Technology Field Sites

- **Wabash River (E-Gas)**
 - 1996 Powerplant of the Year Award*
 - Partner in DOE cooperative agreements where they are not the prime
- **Tampa Electric (GE)**
 - 1997 Powerplant of the Year Award*
- **Eastman Chemicals (GE)**
 - Commercial chemical plant
 - Coal fueled
 - Partner in DOE cooperative agreements where they are not the prime
- **PSDF (Southern Company)**
 - Pilot scale
 - Partner in DOE cooperative agreements where they are not the prime

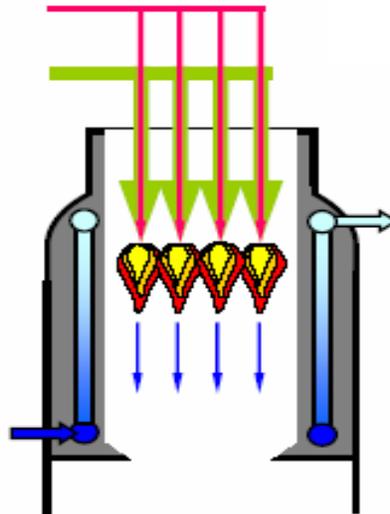


**Power Magazine*

Rocketdyne Gasifier Vision

Technology Improvements

- Plug Flow
- Rapid Mix, Multi-port Feed Injector
- Actively Cooled Wall
- Dry Coal Feed



Gasification

Benefits

- ↓ Capital Cost
- ↓ COE
- ↓ COH₂
- ↑ Efficiency
- ↑ Durability
- ↑ Availability
- ↑ Carbon Conversion

Gas Cleaning

- **Near Zero Emissions: H₂S, NH₃, HCl, Hg, As, Se, Cd**
 - Fewer pots and pans; better integration
 - Warm to maximize efficiency of process
 - High pressure to minimize capital costs
 - Various projects working towards these goals
 - *Still interested in novel approaches with more economic promise than those being developed*
- **What are “near zero” emissions, anyway?**

Precise goals are a moving target

Multiple end uses for the syngas

End use technologies changing/improving

Measurement technologies improving

Unpredictable future EPA regulations



Roadmap Performance Targets

(Represents best integrated plant technology capability)

	Reference Plant*	2010	2020
Air Emissions	98% SO ₂ removal	99%	>99%
	0.15 lb/10 ⁶ Btu NOx	0.05 lb/10 ⁶ Btu	<0.01 lb/10 ⁶ Btu
	0.01 lb/10 ⁶ Btu Particulate Matter	0.005 lb/10 ⁶ Btu	0.002 lb/10 ⁶ Btu
	Mercury (Hg)	90% removal	95% removal
By-Product Utilization	30%	50%	near 100%

*Reference plant has performance typical of today's technology;
Improved performance achievable with cost/efficiency tradeoffs.

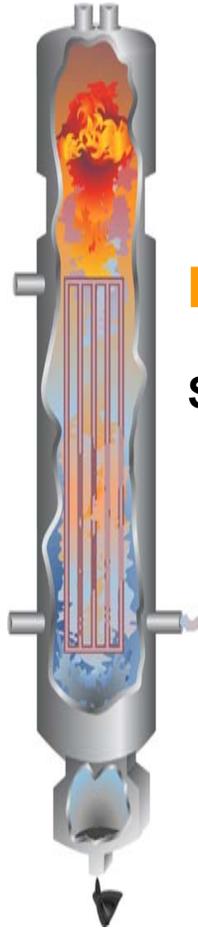
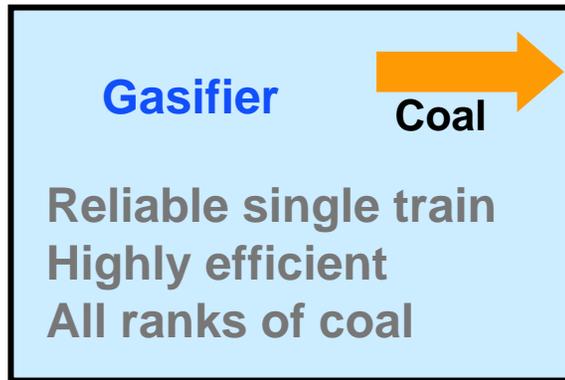


Technology Team Cleanup Goals

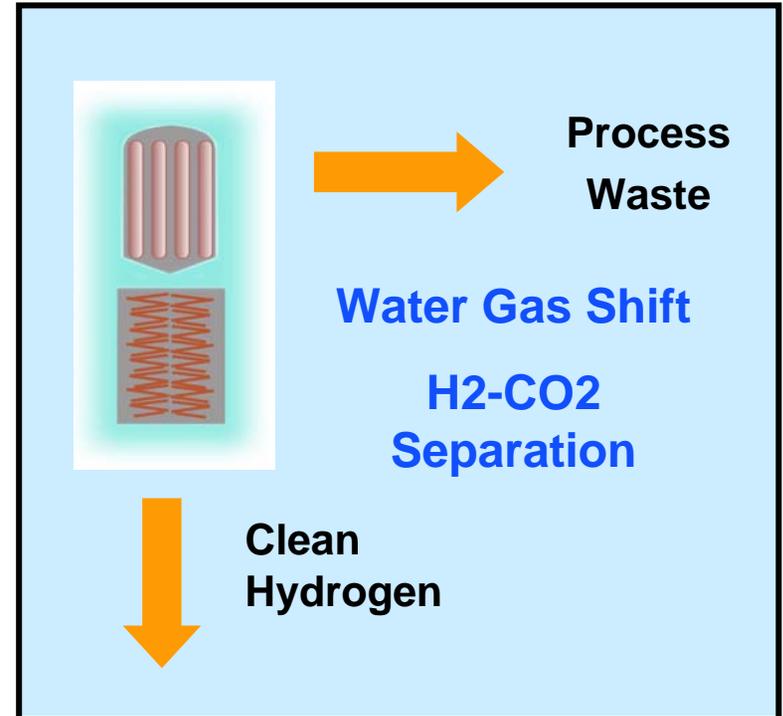
Contaminant	Maximum After Cleanup	Primary Concern
H ₂ S	50 ppbw	Fuel cell function/Chemical Production
NH ₃	0.1 vol%	Fuel cell function
HCl	1 ppm	Fuel cell function
Hg	5 ppbw	Chemical production/ environment
As	5 ppb	Fuel cell function/ environment
Se	0.2 ppm	Fuel cell function/ environment
Cd	30 ppb	Fuel cell function/ environment



Gasification Alternate Vision

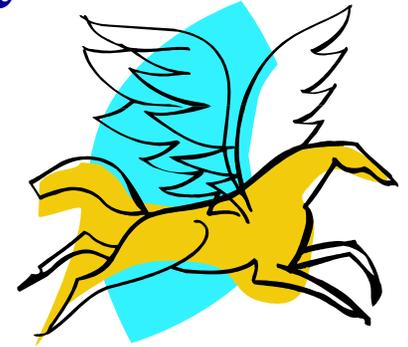


VIRTUE: One process waste stream; size minimized



CONCERN: Need contaminant – proof catalysts and separation process

R&D Big Picture Concept



- Know how your technology fits in the big picture, and makes it better (*Which big picture?*)
- Know your competition
 - Conventional
 - *Being developed* (our website is a good place to start)
- Predict technology's value in terms of cash and efficiency
 - Capital and/or Operation & Maintenance costs
 - Okay to assume all will go well at first
 - System studies in work plan a nice touch
 - Use project data
 - Show continuing advantage of you work
- Technology explanation *should include the technologies it interfaces with*
 - Conventional/being developed
 - Demonstrate cooperation