GE Energy - Gasification

Astana
September 2010

imagination at work

GE Power & Water… power generation platforms

Thermal

- **Gas turbines**
  - Heavy duty (40–500MW)
  - Aeroderivatives (18-100MW)
  - Combined cycle systems
- **Coal**
  - IGCC
  - Gasification Licensing
  - Steam turbines

Renewables

- **Wind**
  - Land based
  - Offshore
- **Solar**
  - Grid connected
  - Stand alone
- **Jenbacher**
  - Gas engines 0.3-3MW
  - Fueled with waste gas

Nuclear

- ABWR & ESBWR
- Adv nuclear fuel
- CANDU fuel & services
- Reactor & field services
- Performance services
- Nuclear isotopes

imagination at work

© 2010 General Electric Company.

Gasification: a diverse global team

Houston, TX – process & product design; IGCC experience & integration; R&D; services; operability

Bangalore, India – process design; R&D

Shanghai, China – materials characterization; R&D; services; component localization

Niskayuna, NY – R&D; validation

Irvine, CA – gasification modeling & experimental experts

Warsaw, Poland – reliability and maintenance analysis

Schenectady, NY/ Salem, VA – controls; simulation

Greenville, SC – design, adv materials, power block (IGCC)

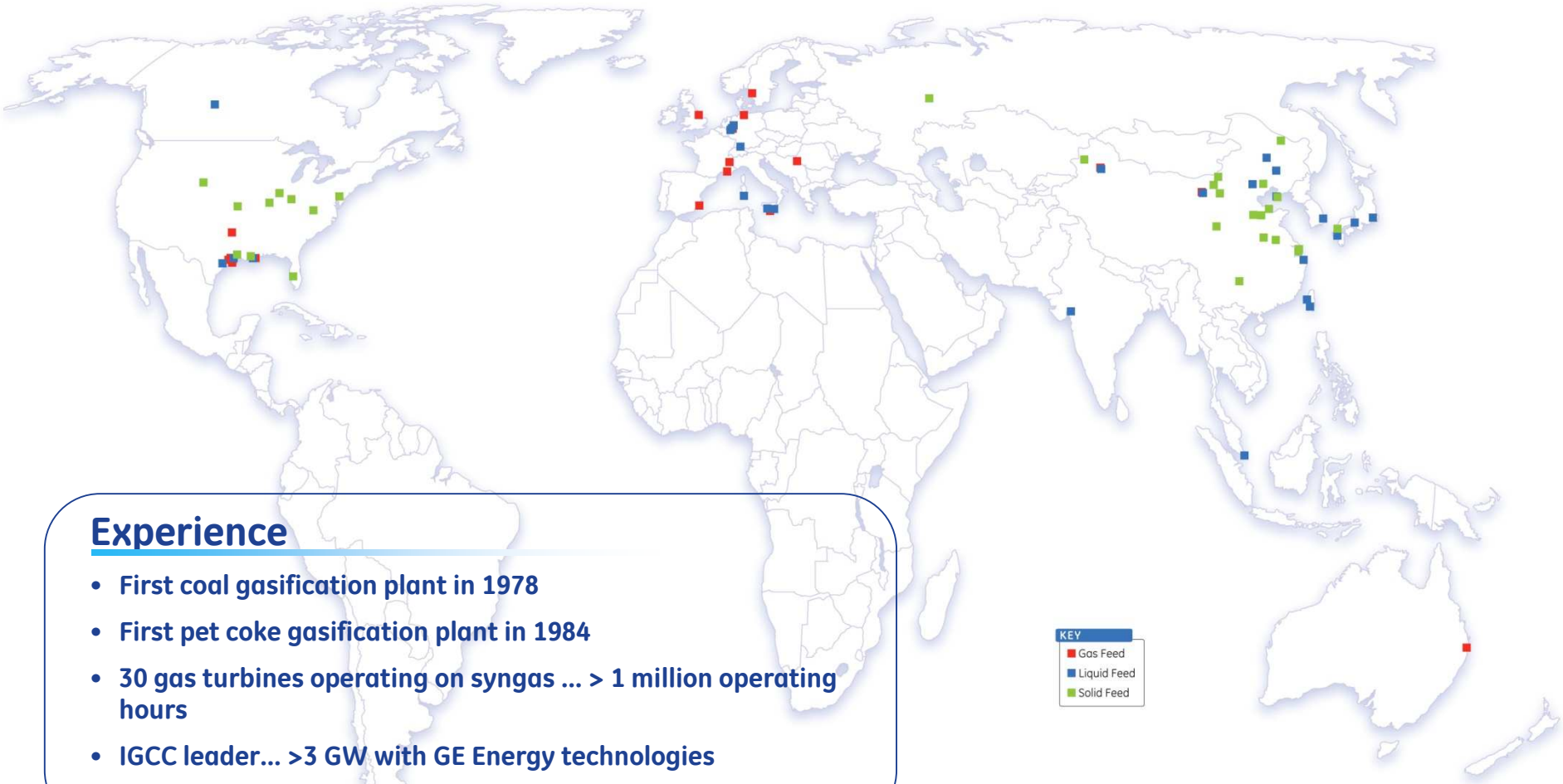
imagination at work

© 2010 General Electric Company.

Experience

Gasification Leader

Over 65 facilities and 145 gasifiers operating worldwide



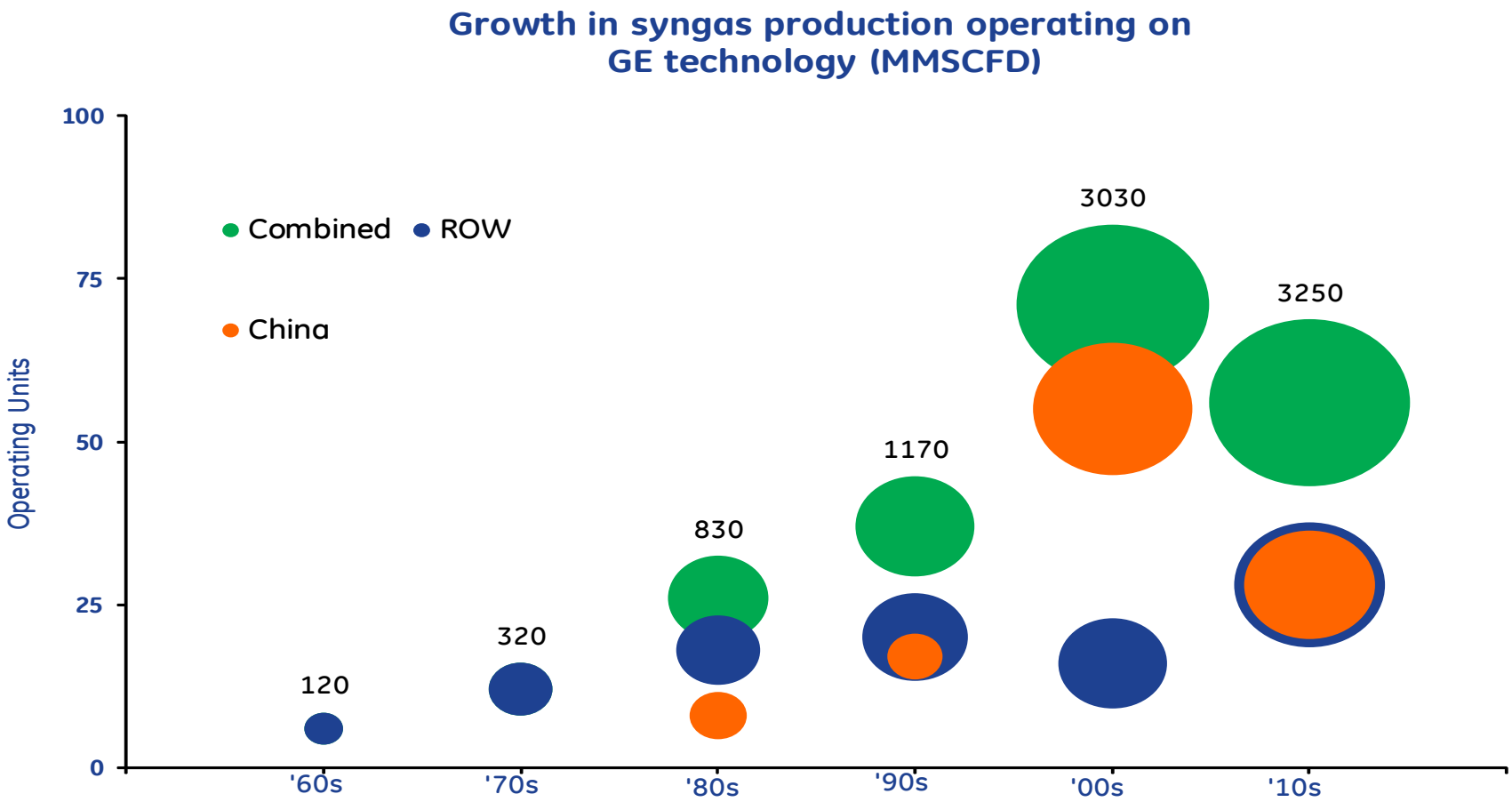
Experience

- First coal gasification plant in 1978
- First pet coke gasification plant in 1984
- 30 gas turbines operating on syngas … > 1 million operating hours
- IGCC leader… >3 GW with GE Energy technologies
- 40 projects globally that separate CO_2

imagination at work

© 2010 General Electric Company.

GE Syngas Production



imagination at work

© 2010 General Electric Company.

Segments

Gasification

Gasification Technology

Syngas

$(H_2 + CO)$

Feedstocks

- Coal
- Pet coke
- Asphalt
- Heavy Oil
- Vacuum Residue
- Natural Gas

- **Power (IGCC)**
  - Greenfield
  - Polygen
  - Refueling
  - Site repowering
- **Refineries**
  - Hydrogen
  - Steam
  - Power
- **Chemicals**
  - Methanol
    - Formaldehyde
    - MTBE
    - Acetic acid
    - Amine
    - DME
  - Ammonia
    - Urea
    - Ammonia nitrate/sulfate
  - Oxochemicals: Butanol, Ethylhexanol
- **Methanation** → Substitute natural gas
- **Coal to liquids** → Transportation fuels

imagination at work

© 2010 General Electric Company.

Fundamentals

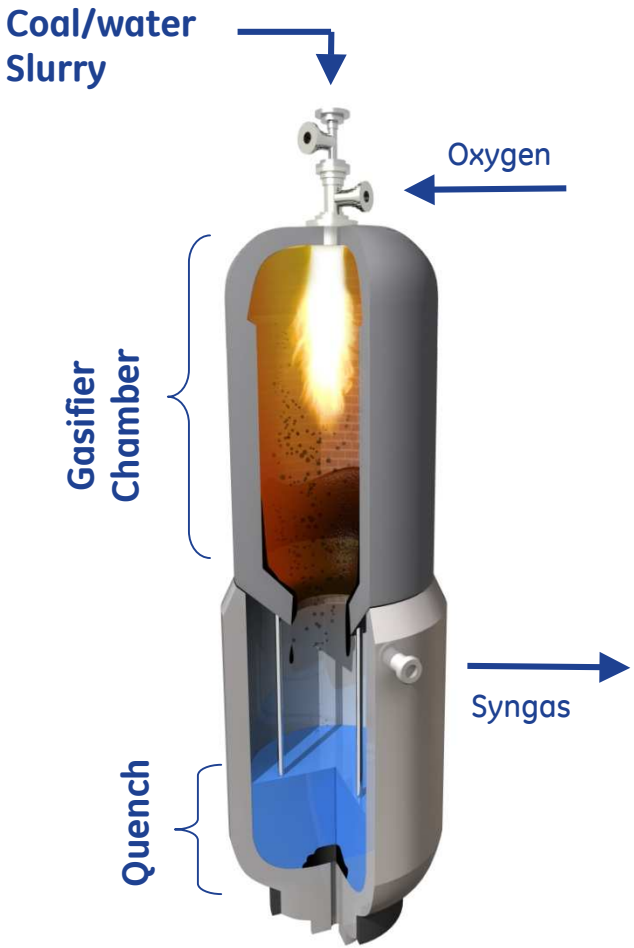
Gasification…more than BTUs

Combustion…	Coal composition	Gasification yields…	
CO_2	Carbon	CO	Used in manufacture of industrial chemicals Heating value
H_2O	Hydrogen	H_2	Used in manufacture of industrial chemicals Heating value
NO_X	Nitrogen	N_2	Inert gas for process
SO_X	Sulfur	H_2S	Useful in manufacture of chemicals and/or marketable by-product
Ash	Ash	Vitrified slag	Marketable by-product
100	Volatiles	1	Low volatiles saves on disposal

imagination at work

© 2010 General Electric Company.

Gasification System Configuration



Simple system configuration

- Slurry pumps used
- No coal drying systems
- High H2/CO ratio
- No additional steam for shift reaction
- Size advantage for downstream systems

imagination at work

© 2010 General Electric Company.

Summary

- 60 years of success in gasification operation and innovation
- Investments in design methods; tools; and validation facilities
- Investing in next generation industrial and power gasification technology

imagination at work

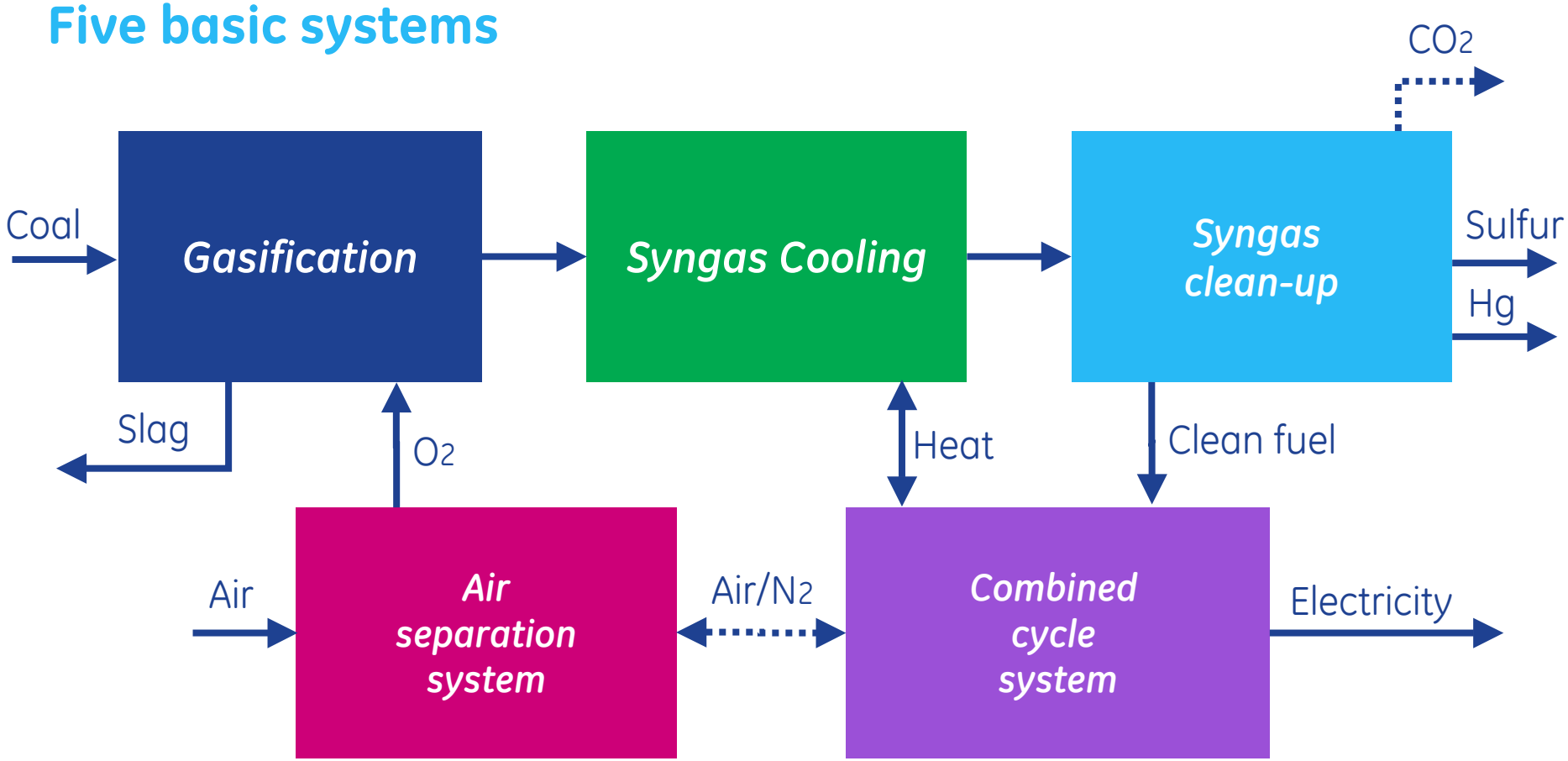
© 2010 General Electric Company.

IGCC

imagination at work

Integrated gasification combined cycle

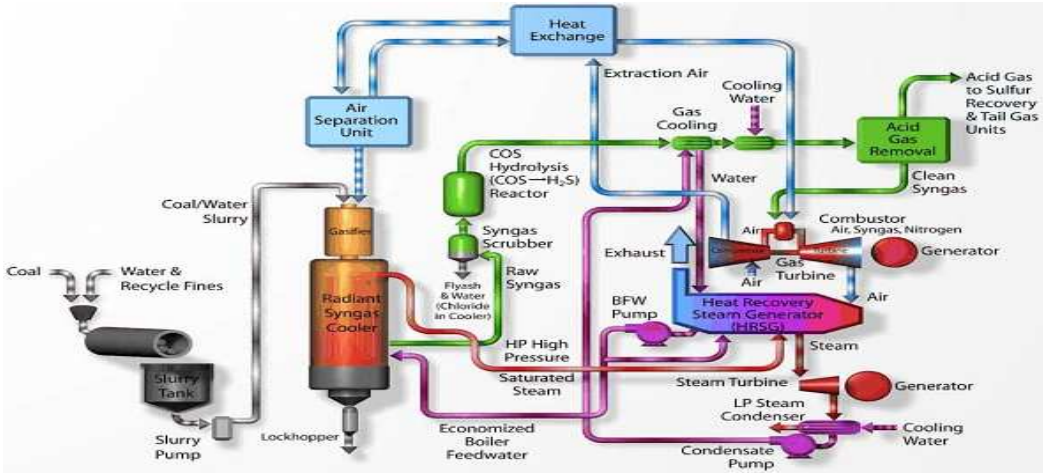
Five basic systems



imagination at work

© 2010 General Electric Company.

Radiant Syngas Cooler for IGCC



Syngas under high pressure flows from the gasifier into the Radiant Heat Syngas Cooler or RSC

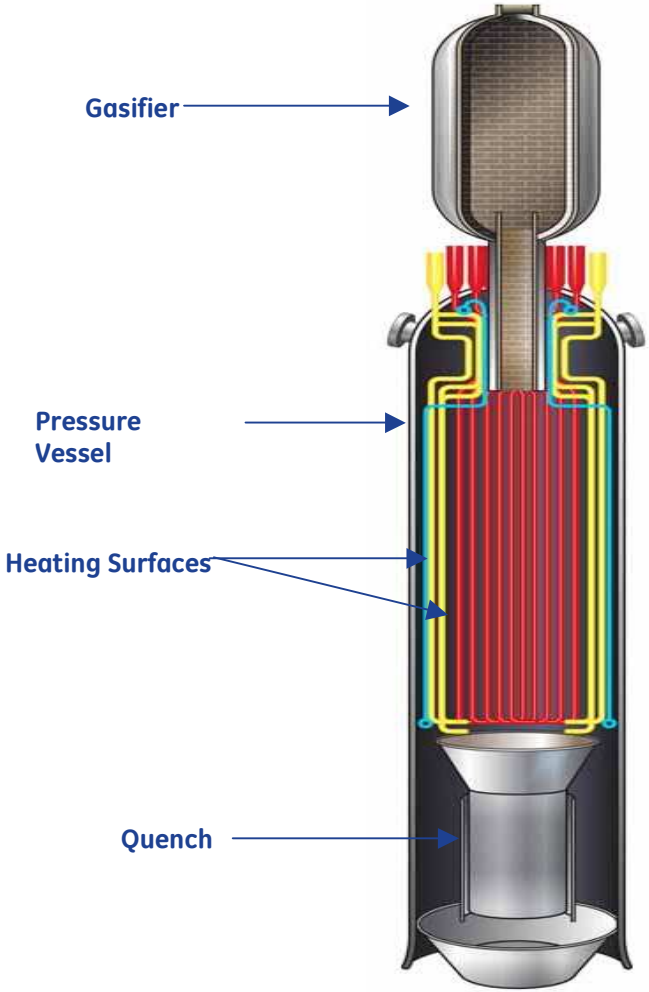
Syngas is cooled creating high pressure steam

Syngas and slag are quenched through water and cooled via a dip and draft tube

imagination at work

© 2010 General Electric Company.

Features



Fuel Flexibility

- Wide bituminous coal fuel envelope
- Petroleum coke blends

Sensible heat recovery

- HP steam generation

Internal water quench

- Robust solids removal via lock-hopper system
- Proven quench technology

Carbon capture ready

- H_20:CO ratio ideal for shift

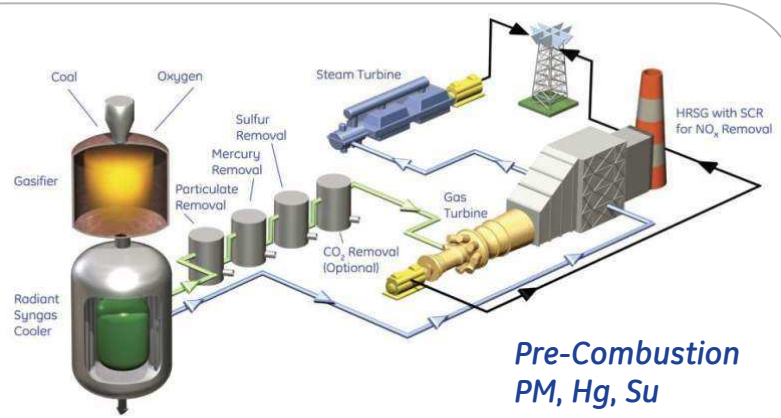
High pressure operation provides downstream efficiencies

Maintenance schedule/availability match GT's

imagination at work

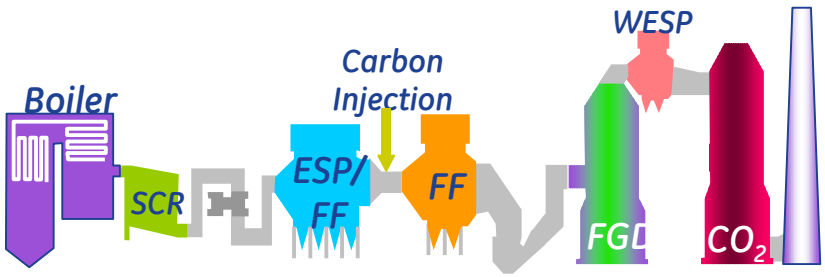
© 2010 General Electric Company.

Efficient Pollutant Removal



IGCC

- Gasification cleans the syngas before combustion
- High pressure & low volume provide favorable economics for pollutant removal
- IGCC offers increased fuel diversity, ***reduced emissions***, and increased siting & permitting flexibility



Pulverized coal

- Pollutants are removed after the coal is burned
- The gas volume treated is 300 times the gas volume of an IGCC plant
- Criteria & HAPS ***emissions are higher*** than an average IGCC plant
- Combustion produces ***large quantities of waste*** and consumes more water than IGCC

© 2010 General Electric Company.

60Hz IGCC standard plant

- 630 MW output*
- 37-39% efficiency HHV*
- 85% coal to power availability*^
- $2.35B total installed cost*
- **Lower emissions** than SCPC
- Wide range of bituminous coals
- **Guaranteed** output, heat rate, emissions & schedule
- Carbon capture ready

Emissions**

- 33% **less** NOx
- 75% **less** SOx
- 40% **less** PM10
- 30% **less** water

Fuel flexibility

- Up to 30% coke blends
- Up to 7.5 lb/MMBTU sulfur, 14% ash
- 2,000 ppm chlorides
- Natural gas or distillate backup fuel

imagination at work

*Coal, site, operating condition dependent
^on syngas, 92% on natural gas
**Compared to SCPC coal plants

© 2010 General Electric Company.

GE IGCC technology experience

Project	GE Scope*	Size (MW)	Feedstock	COD
U.S.A.	Syngas/Power	120	Coal	1984
U.S.A.	Power	250	Coal/Petcoke	1995
U.S.A.	Syngas/Power	250	Coal/Petcoke	1996
U.S.A.	Power	45	Petcoke	1996
Czech Republic	Power	350	Coal	1996
Germany	Power	40	Lignite	1996
Holland	Power	120	Resid Oil	1997
U.S.A.	Power	100	Coal	1998
Italy	Syngas/Power	550	Visbreaker Tar	2001
Italy	Syngas	510	Asphalt	2001
Italy	Syngas	280	Visbreaker Tar	2001
Singapore	Syngas/Power	160	Cracked Tar	2001
U.S.A.	Syngas/Power	160	Fluid Coke	2002
Japan	Syngas	342	Asphalt	2003
Canada	Power	160	Bitumen	2006

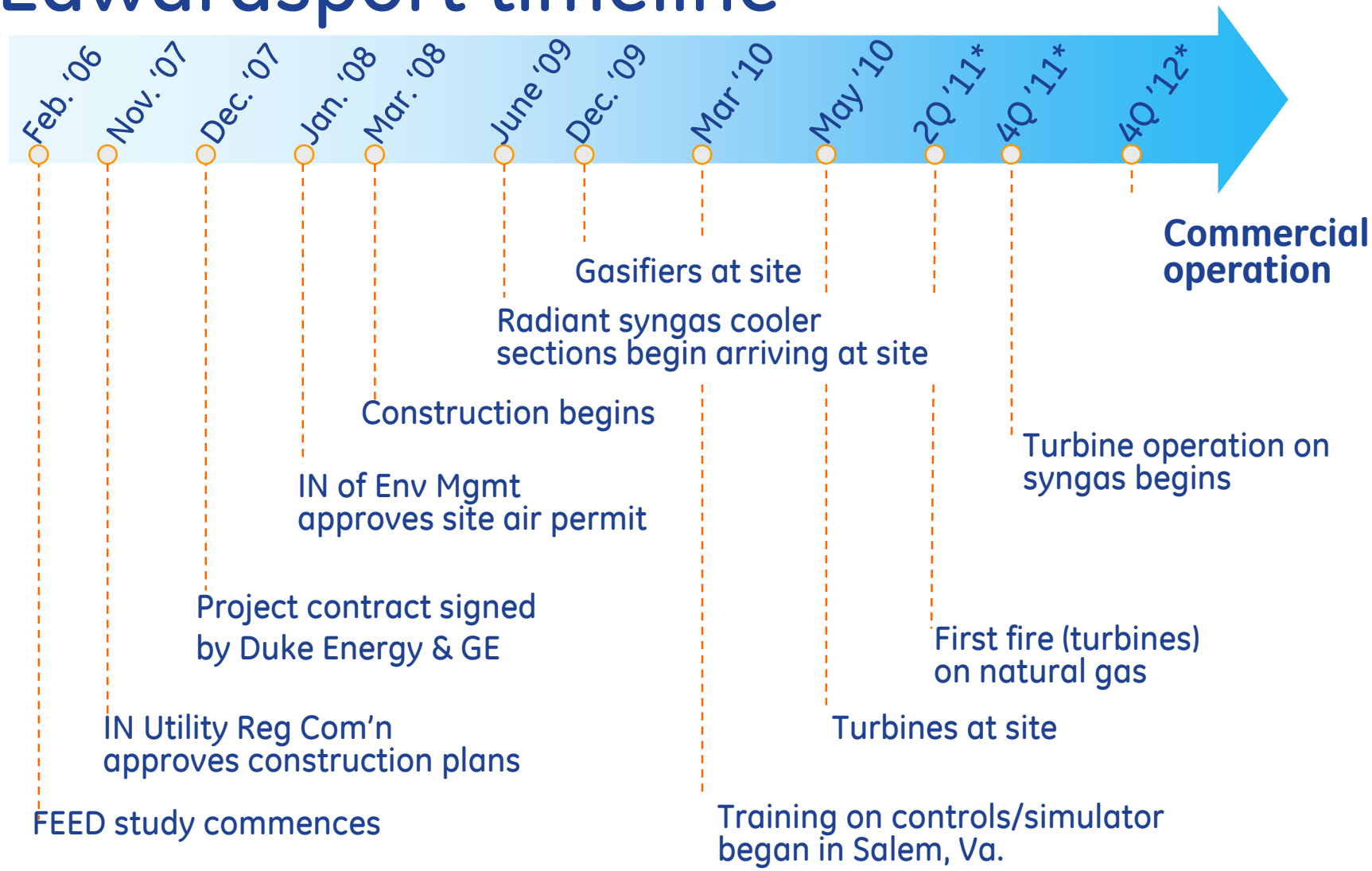
3,457 MW *> 2 Decades*

imagination at work

*GE Scope:
Power = GE provided power generation equipment
Syngas = GE provided gasification license

© 2010 General Electric Company.

Edwardsport timeline



*expected

imagination at work

© 2010 General Electric Company.

Duke Energy: Edwardsport IGCC plant

Duke Energy: Edwardsport IGCC plant

Duke Energy: Edwardsport IGCC plant

- 618MW using Indiana coal
- COD in 2012

Technology applied to Duke

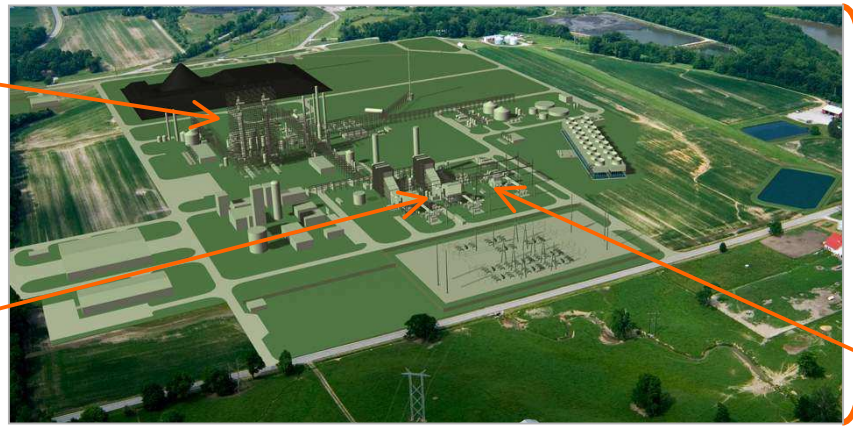
Focused plant investments to:

- Drive down cost … **RSC**
- Enhance efficiency … **GT/RSC**
- Enhance component life … **feed injectors, refractory**
- Extend reliability, availability & maintainability … **controls, operability**

RSC

Injectors

Refractory



Controls & systems integration

7F syngas turbine

Steam turbine

imagination at work

© 2010 General Electric Company.

Contacts

TIM HUSKEY
Sales Director
T | 832-295-7605
E | Timothy.Huskey@ge.com

GIUSEPPE DILIETO
Commercial Director - Asia
T | +86-21-3877-7236
E | Giuseppe.DiLieto@ge.com

JERRY GARDNER
Commercial Director - Americas
T | 713-803-0468
E | Jerry.Gardner@ge.com

ILYA SOLOVEV
Commercial Director – Europe & CIS
T | +7-495-937-19-06
E | Ilya.Solovev@ge.com

Tampa Electric Power Polk 6 IGCC Plant

imagination at work

© 2010 General Electric Company.