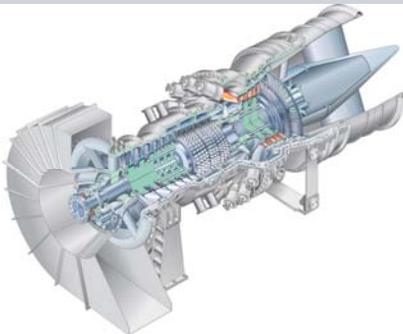


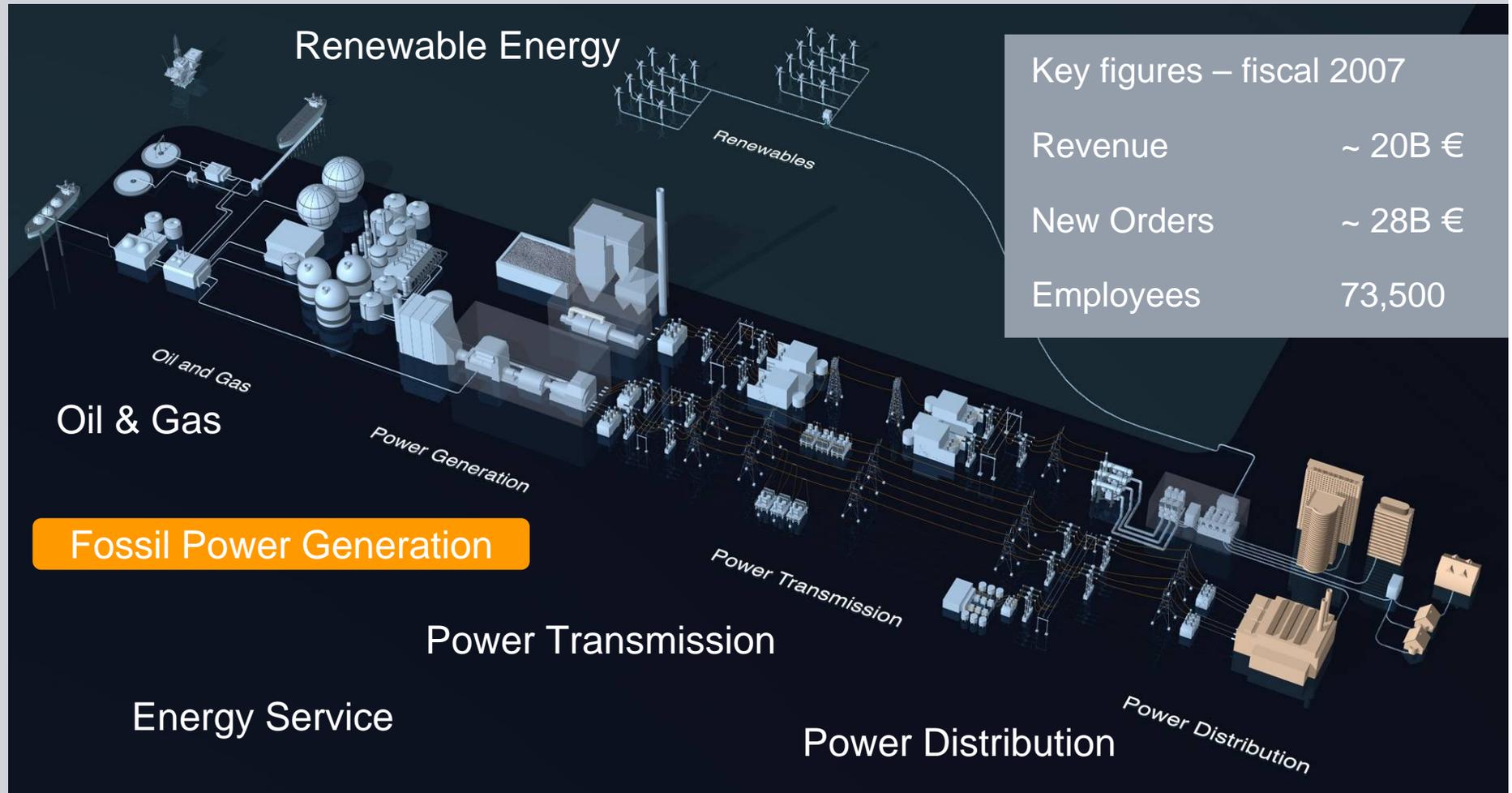
Siemens Gasification and IGCC Update

*Harry Morehead, Manager,
IGCC and Gasification
Business Development*

Presented at
Gasification Technologies 2008
Washington, DC
October 7, 2008



Siemens Energy



Agenda

- Recent Highlights
- Gasification Update
- IGCC Update
- IGCC and Gasification O&M / Gasifier Services
- Conclusions

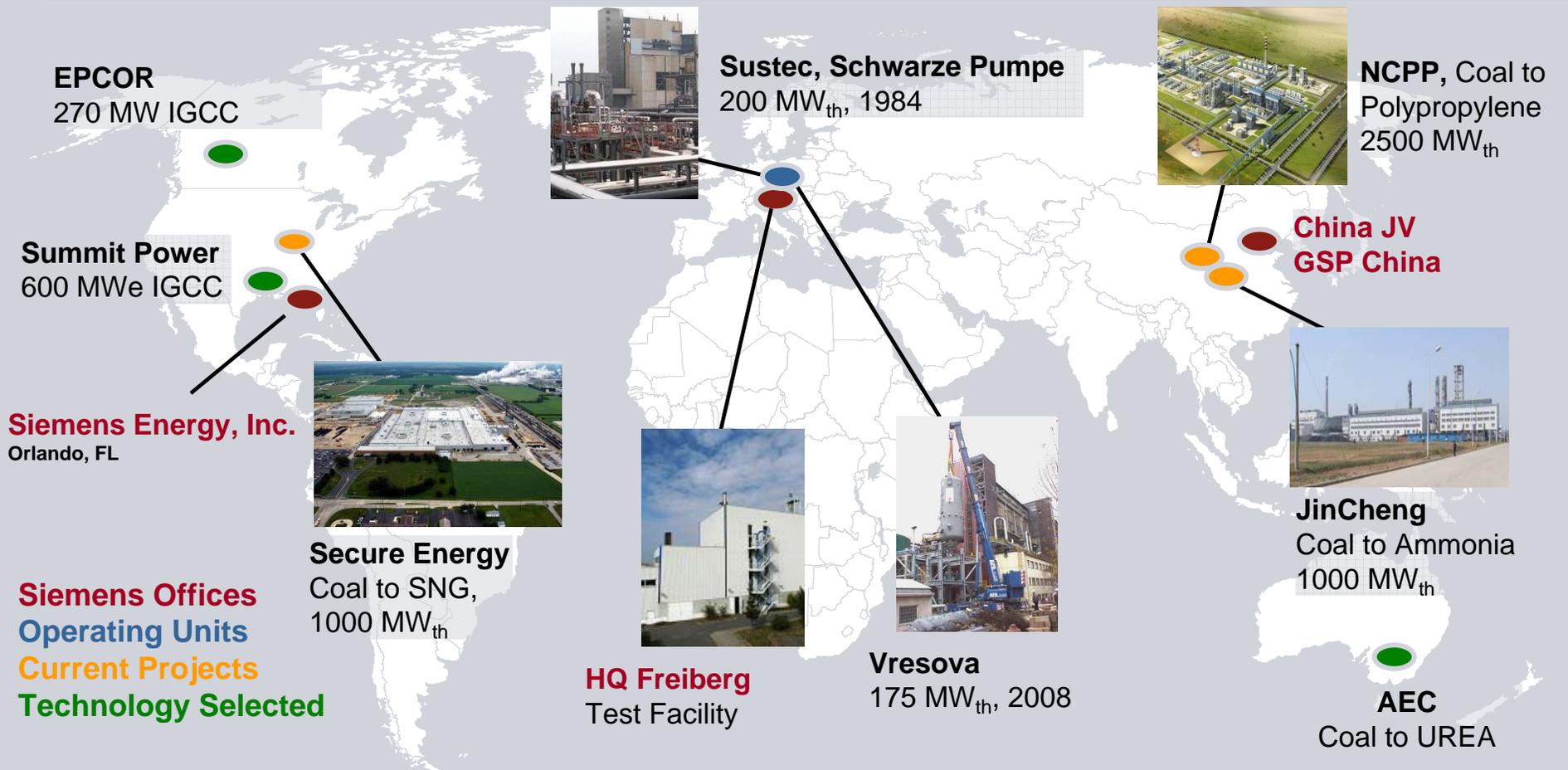
Experience breeds confidence

Recent Siemens IGCC and Gasification Highlights

- 2 SFG-500 gasifiers have arrived in China, two more will ship this month, and two will ship for Secure Energy at end of 2008
- New contracts:
 - EPCOR, Genesee IGCC Project (SFG-500 gasifier)
 - AEC, Latrobe Valley, UREA, Australia
- Technology selected for two IGCCs in the US and Europe
- Vresova refractory lined gasifier in commercial operation
- 4 FEEDs completed
- 10 feasibility studies completed



Gasification Technology - Worldwide Activities



- Two SFG-500 Gasifiers shipped, 7 being manufactured
- Technology selected and in pre-selection in further projects

Siemens SFG Gasification Technology

SFG Gasifiers

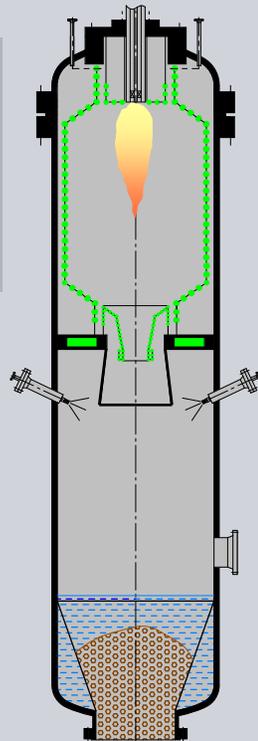
Current Gasifier Products

SFG-500 500 MW_{th}
 • Cooling Screen Design

Refractory Lined Gasifier



Siemens Gasification Test Facility



Highlights

- **OEM Support**
 - Siemens manufactures the critical gasification equipment
 - Siemens invests in R&D to improve both gasifier and gasification island design
 - Siemens provides local sales and gasifier component/service support throughout life of project
- **Project Development Support**
 - Siemens can provide feasibility or pre-FEED information for initial project definition
 - Siemens can provide gasification island basic design and process design packages during FEED
 - Siemens comprehensive gasification test facility is available to confirm gasification characteristics

Siemens OEM support before, during and after construction

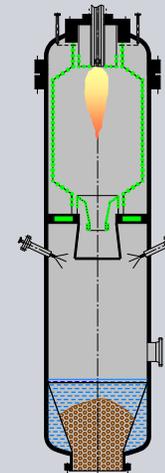
Available Product Designs for Different Feedstocks

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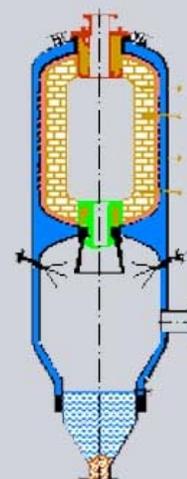
Gasification conditions depend on feedstock characteristics:

- Carbon, hydrogen content, heating value, moisture level
- Ash composition determines ash melting temperature
- Gasification temperature above AMT: 1,300 - 1,800 °C (2,370 - 3,270 F)

Cooling Screen Gasifier



Refractory Lined Gasifier



Feedstock Type

Solid

Pneumatic dense flow feeding system

Dust fuel burner

Liquid

Feed pumping
Liquid spray burner

Ash Content

> 2 %

Reactor wall with cooling screen
Slag layer for thermal protection

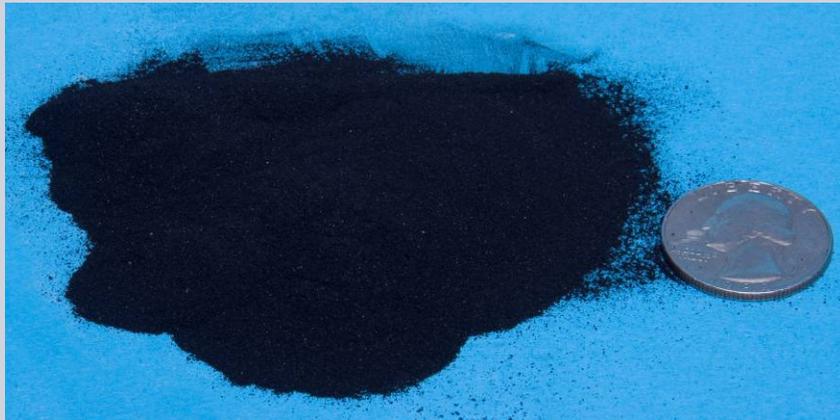
< 2 %

Reactor wall with refractory lining

Typical Design Challenges for Gasification Applications



Typical feedstock characteristics	Siemens design solution
Solids or liquids	Dry and liquid feeding systems available
Low ash content	Mixing with coal or addition of ash
High sulfur content	Tolerant to high sulfur levels
Heavy metals	Captured in slag
Alkali metals, chlorines	Condensed by full quench



Coal



Slag

Siemens SFG-500 Gasification Island with Full Water Quench

SIEMENS

Features

Feedstock flexibility

- Wide range of coals
- Petcoke
- Coal / Petcoke blends
- Liquid Feedstocks

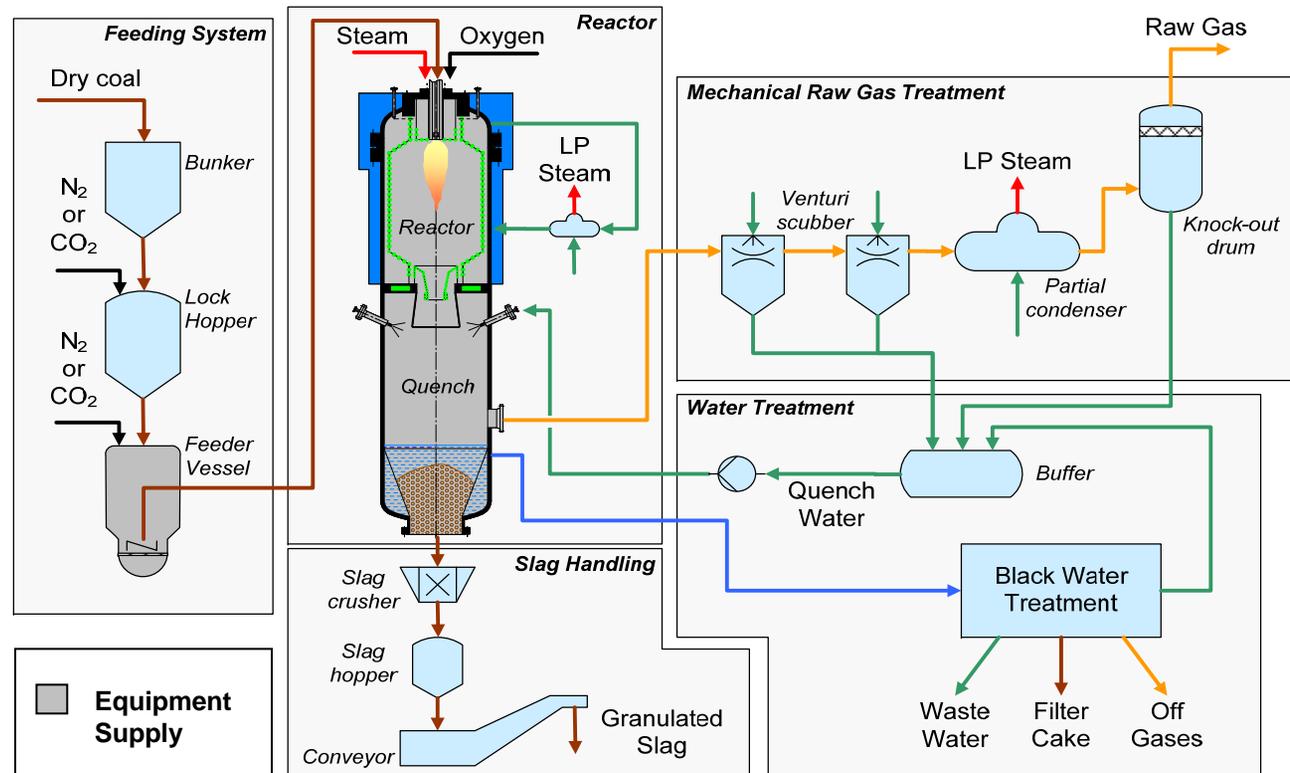
Entrained flow gasifier

- No tars or oils produced
- Vitreous slag

Full Water Quench

- High water content in raw gas

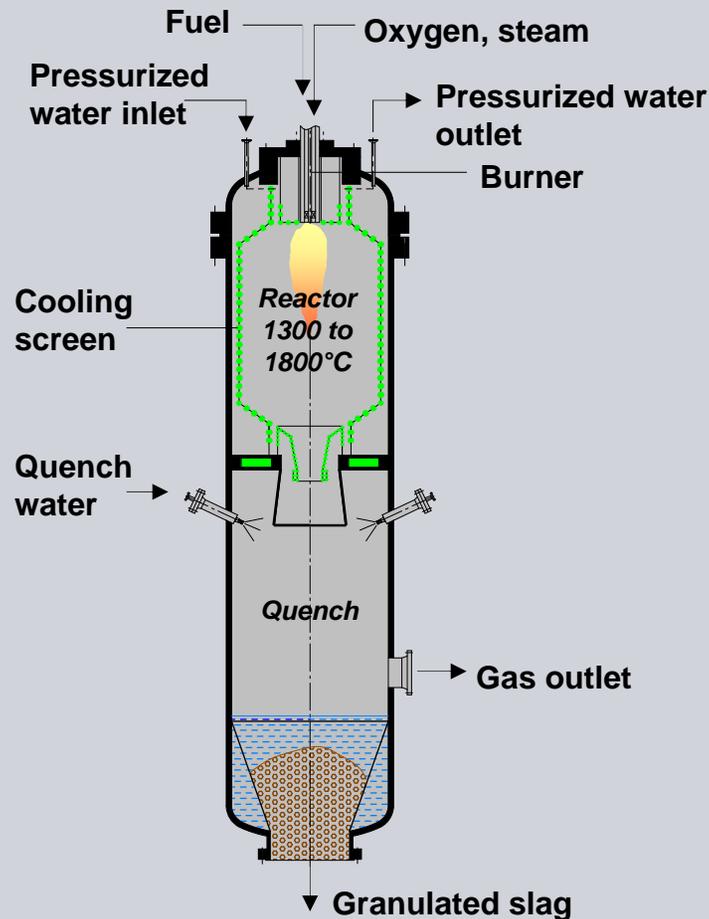
Mechanical syngas cleaning system



Optimized for chemical syntheses and IGCC with CO₂ capture

Siemens Fuel Gasification Technology Highlights SFG-500 Standard Design (Cooling Screen)

SIEMENS



Dry feeding

- High efficiency
- High carbon conversion rate (> 98 %)

Cooling screen

- Short start-up / shut-down
- Low maintenance
- High availability

Full quench

- Simple and reliable
- Ideal for CO sour shift

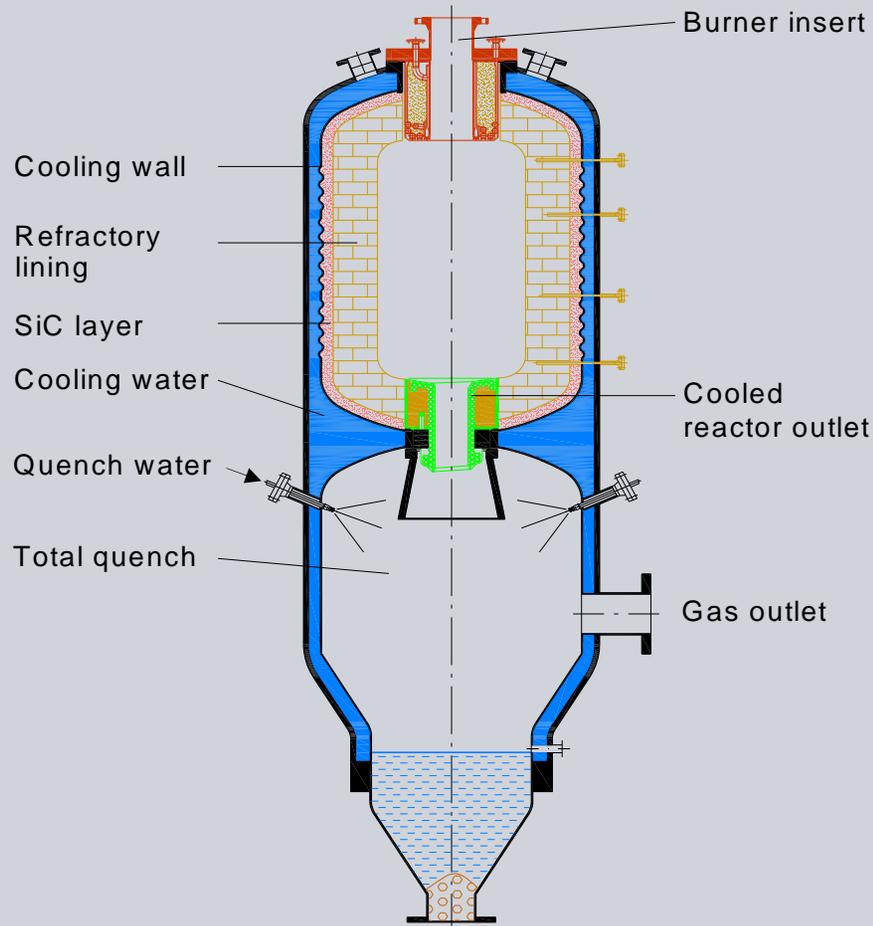
Multi-fuel gasifier

- Accepts a wide variety of fuels (e.g., bituminous & sub-bituminous coal, lignite, biomass, liquid wastes)
- Tar free raw gas

Siemens Fuel Gasification Technology Highlights

Refractory Lined Gasifier Design

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Liquid feeding

- High efficiency
- High carbon conversion rate (> 98 %)

Refractory lined

- Accommodates low ash feedstocks

Full quench

- Simple and reliable
- Ideal for CO sour shift

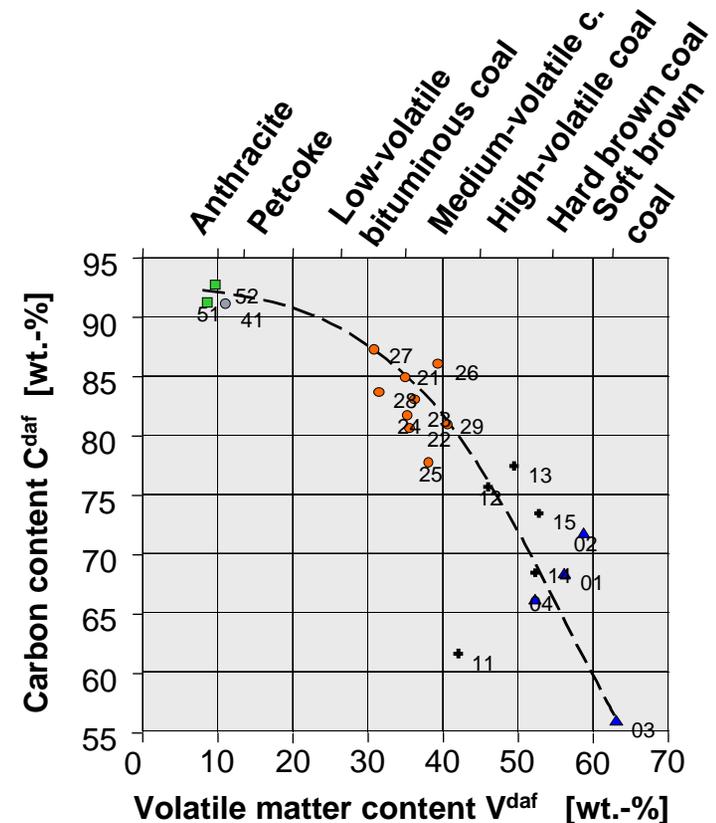
Multi-fuel gasifier

- Accepts a variety of low-ash fuels (e.g., tars, oils, and other liquid wastes)
- Tar free raw gas

Siemens Gasification Test Facility



- Gasifier reactor with cooling screen, 3-5 MW, max. 30 bar
- Different fuel feeding systems (300 kg/h)
 - Pulverized fuel dosing & feeding system
 - Slurry feeding
- Full gas treatment
 - Desulphurization unit (Sulferox)
 - COS hydrolysis
 - HCN hydrolysis
- Waste water treatment



**Over 60 feedstocks tested in over 100 tests
provides valuable design data for better FEEDs**

Siemens Gasification Test Facility

Gasification Test Results

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Recent Feedstocks Tested:

- Bituminous Coal
- PRB
- Lignite
- Petcoke
- Biomass
- Pyrolysis oil

Information Generated:

- Syngas Compositions
- Carbon Conversion Rates
- Specific O₂ Consumption
- Optimized Gasification Temperatures
- Slag Composition
- Waste Water and Soot Compositions

Results used for:

- Research and development
- Project development support
 - Design input
 - Permitting support

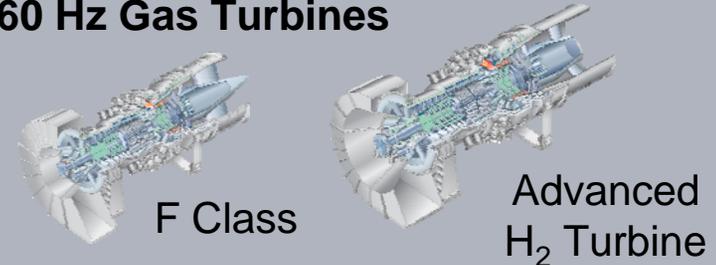


Next Steps R&D Focus Areas

- Gasifier Scale-up
- Partial quench with heat recovery for IGCC applications
- Biomass feedstocks
- Higher operating pressures with CO₂ carrier gas

Objective is to improve plant economics for a range of application

60 Hz Gas Turbines



50 Hz Gas Turbines



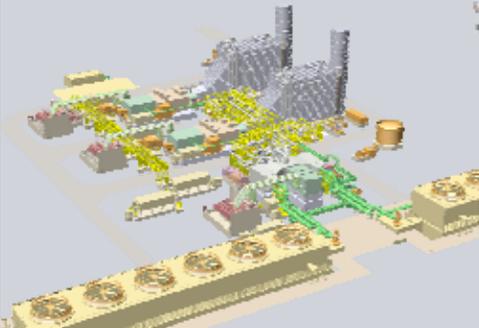
Chemicals



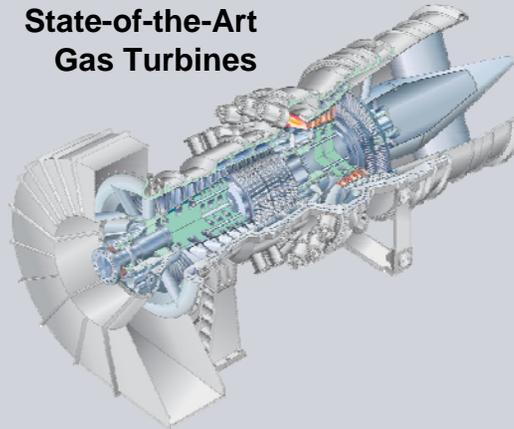
Liquids

Siemens IGCC Plant Solutions

IGCC Power Island Reference Plant



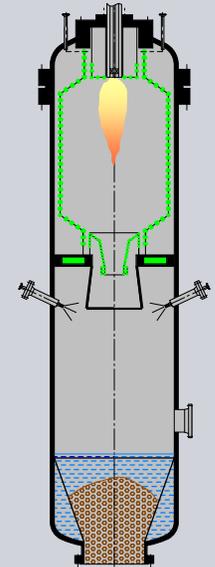
State-of-the-Art Gas Turbines



IGCC Plant Instrumentation and Control Systems



SFG Gasifiers



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Steam Turbine Generators



Siemens O&M Services / Gasifier Services

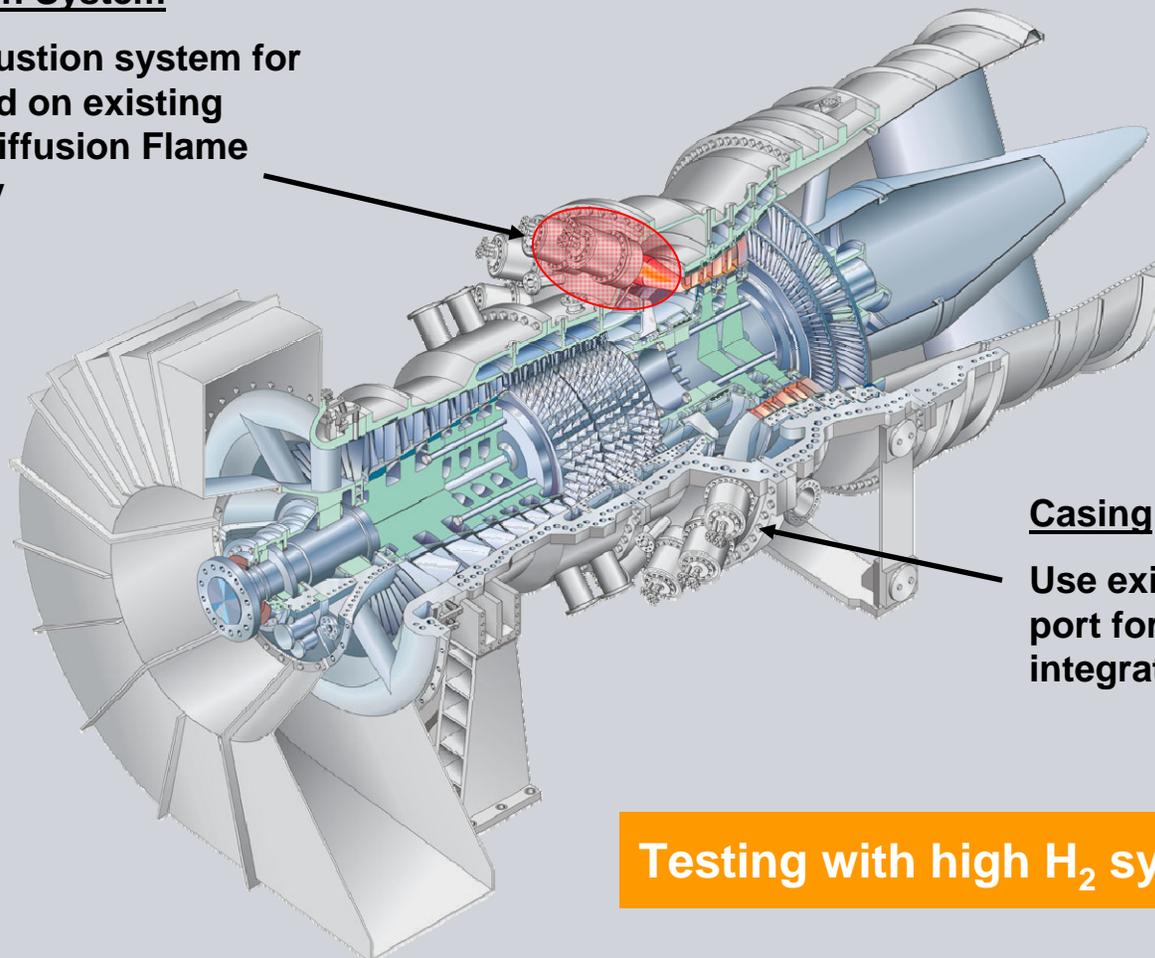


Air / N₂ / O₂ / CO₂ / Syngas Compressor Trains

SGT6-5000F for IGCC Applications

Combustion System

New combustion system for IGCC based on existing Siemens Diffusion Flame technology



Auxiliary Systems

Fuel handling auxiliaries and engine control system modified for IGCC application

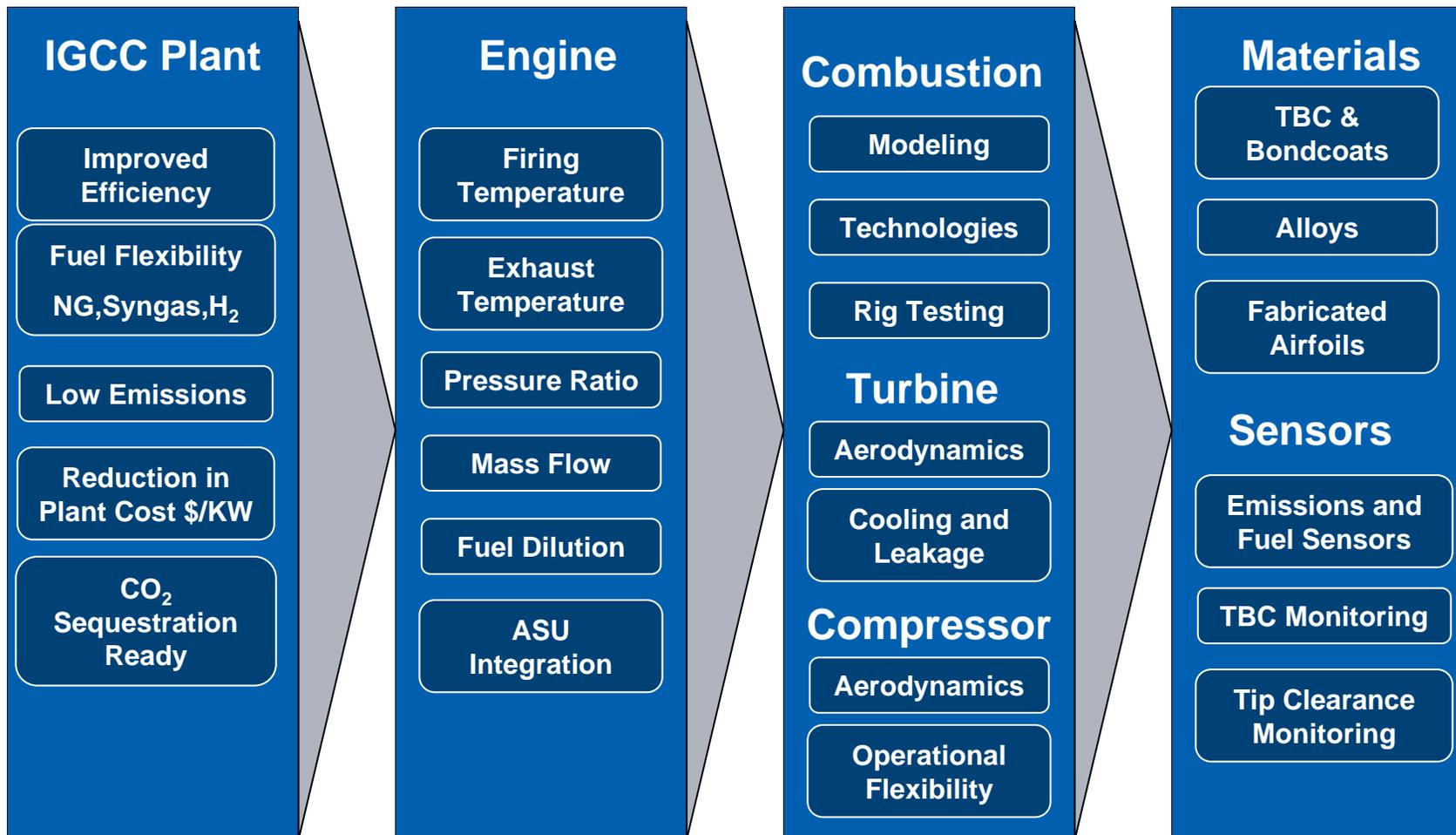
Casing

Use existing access port for air extraction / integration purposes

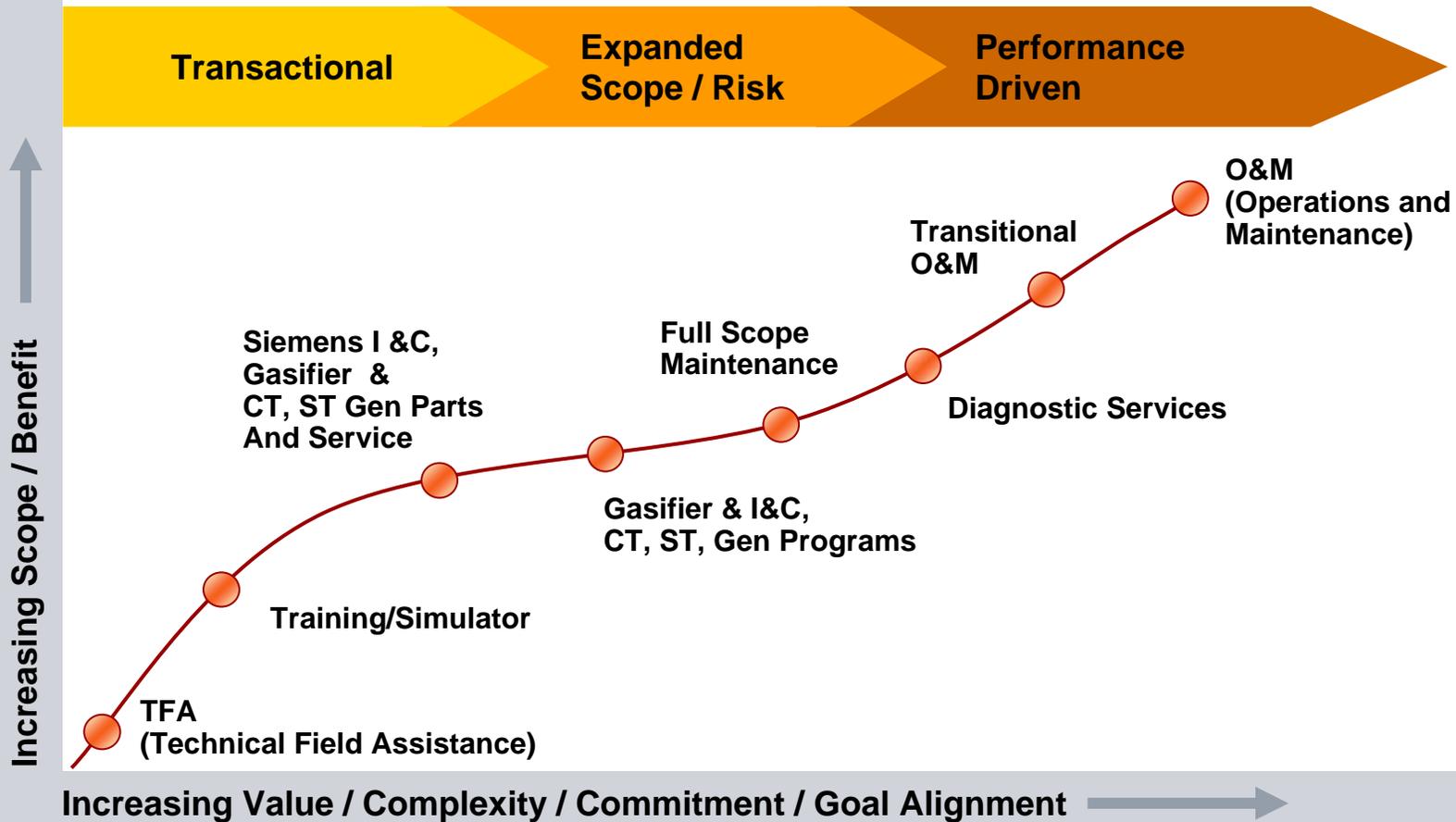
Testing with high H₂ syngas completed

Siemens – DOE Advanced H2 Turbine Program

Technology Development is Key to Meeting Program Goals



Siemens OEM Services for IGCC and Gasification Islands



Active involvement by OEM after the commercial operation date can help improve plant availability and reliability in the early years of operation

Conclusions

Global demand for gasification is still strong

- Chemicals / SNG
- Transportation liquids
- IGCC + CCS

Better technology will provide more options and improved plant economics

- Today's F class turbines are ready for high H₂ syngas
- Better gasification technologies being developed based on lessons learned allowing the use of lower rank coals
- H class gas turbine technology being developed for IGCC + CCS

OEM business model well accepted in market

Siemens is leveraging its 150 years of OEM and 45+ years of gasification know-how to develop gasification based solutions for tomorrow



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