Siemens IGCC and Gasification Update

Harry Morehead
Director, IGCC & Gasification Sales and Marketing, Americas

November 1, 2010
## Siemens

### Industry Divisions
- Drive Technologies
- Industry Automation
- Building Technologies
- Mobility
- Lighting (OSRAM)
- Industry Solutions

### Energy Divisions
- Fossil Power Generation
- Renewable Energy
- Oil & Gas
- Energy Service
- Power Transmission
- Power Distribution

### Healthcare Divisions
- Imaging & IT
- Workflow & Solutions
- Diagnostics

---

Copyright © Siemens AG 2010. All rights reserved.

Energy Sector
# Siemens Gasification and IGCC Products and Services

## Gasification Products

<table>
<thead>
<tr>
<th>Gasifier Island Design</th>
<th>State of the Art Gas Turbines</th>
<th>FG/IGCC Plant Instrumentation and Controls</th>
<th>SFG Gasifiers</th>
<th>Total IGGC Plant O&amp;M Services / Gasifier Services &amp; Power Island Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>IGCC Power Island Reference Plants</td>
<td>Steam Turbine Generator</td>
<td>Air / N2 / O2 / CO2 / Syngas Compressor Trains</td>
<td>Plant Solutions</td>
<td>Product Services &amp; LTP Agreements</td>
</tr>
</tbody>
</table>

### Gasification Services
- Gasifier Island Design
- State of the Art Gas Turbines
- FG/IGCC Plant Instrumentation and Controls
- SFG Gasifiers
- IGCC Power Island Reference Plants
- Steam Turbine Generator
- Air / N2 / O2 / CO2 / Syngas Compressor Trains
- Plant Solutions
- Automated Drives
- Water Treatment
- Building Automation
- Power Electrics & Distribution
- Total IGGC Plant O&M Services / Gasifier Services & Power Island Services
- SFG Gasifier
- Gas Turbine
- Steam Turbine
- Generator
- Control Systems
- IGCC
- Air / N2 / O2 / CO2 / Syngas Compressor Trains
Gasification Market & SFGT Project Landscape

NORTH AMERICA

Canada
- Oil sands projects moving again

USA
- Funding and loan guarantees released in USA/CAN > $ 5 B
- A number of IGCC and CtX projects supported by US government
- EOR opportunities
- Rising interest in biomass and refinery residue gasification

CHINA

- Largest gasification market worldwide
- Strong IGCC activities (e.g. Greengen)
- Mega CtX projects under development (X…mainly fuels & SNG)
- Rising interest in EOR and CO₂ separation and sequestration

9 SFG-500 Gasifiers shipped/ installed for 3 projects
License agreements signed for 4 additional projects
## NCPP I: Largest Coal to Chemical Plant in China

5 x SFG-500 Siemens gasifiers for Coal to Polypropylene plant

### Siemens Scope:
- Engineering
- Equipment Supply
  - Gasifiers, Burners, Feeder Vessels, ...
- Training (Freiberg Simulator)
- Technical Field Assistance

### Feedstock:
- Sub-bituminous Coal
  - Ash: ~ 7 wt%
  - Moisture: ~ 2 wt%

### Status
- Mechanical Completion
- Gasification Commissioning Started

### Map

![Map of China and Mongolia Highlighting China](image)

- Air Separation Units
- Power Station
- Methanol to Polypropylene
- Black Water Treatment
- Gasification Unit (5xSFG-500 class gasifiers)
Focus Areas for Successful NCPP Implementation

- Local Technical Field Assistance support by Siemens commissioning experts (local and home office)
  - German / Chinese mixed team
  - 10-15 engineers frequently on-site for hot commissioning with 24h support from Freiberg HQ

- Establishment of Siemens service infrastructure
  - Qualifying and furnishing of Chinese repair shops
Secure Energy, Inc.
Decatur Gasification Plant

Location / Fuel: Decatur, IL
Illinois coal

Gasoline output: 10,200 BBL/d
(1,750 BBL/d LPG)

Siemens scope: 2 x SFG-500 gasifiers

Project Status: Detailed engineering, and project financing

Changing from SNG to gasoline significantly improved plant economics

Copyright © Siemens AG 2010. All rights reserved.
Energy Sector
Tenaska, Inc.
Taylorville Energy Center

Location / Fuel: Taylorville, IL
Illinois coal #6

Size: 600 MW (net)

Siemens scope: 2 x SFG-500 gasifiers and 2 x SGT6-5000F GT-Gs

Timing: Legislative decision: 2010
Operation total plant: 2015

Plant Concept: CCS capture rate: > 50%
sequestered or used for EOR

DOE support: loan guarantee

IGCC with intermediate SNG production and standard natural gas fired gas turbines
Summit Power Group,
Texas Clean Energy Project

- **Location:** Located at FutureGen “finalist” site directly atop Permian Basin and CO$_2$/EOR opportunities

- **Size:** 400 MW$_e$ “Polygen” IGCC project

- ** Siemens Scope:**
  - SFG-500 gasifiers
  - SGCC6-5000F 1x1 operating on high H$_2$ syngas
  - Plant operation and maintenance services

- **Timing:** FEED complete by Jun 11, CO date in 2014

- **Plant Concept:** 90% carbon capture (2.7M tons of CO$_2$/year; CO$_2$ emissions or only 20 to 30% of a natural gas combined cycle)
Huaneng Greengen Co. Ltd.
Tianjin IGCC Project

- **Location:** Tanggu District, Tianjin, China
- **Size:** 250 MW IGCC plant
- **Siemens scope:** 1 x SGT5-2000E gas turbine and auxiliaries
- **Gas turbine main fuel:** Coal-based syngas diluted with N₂
- **Gas turbine secondary fuel:** Fuel oil
- **Plant concept:** without CCS
- **Timing:**
  - Startup on Fuel Oil expected in May 2011
  - Startup on Syngas expected in March 2012
Siemens Fuel Gasification Technology: Cooling Screen Gasifier

**Features**

**SFG Gasifier (> 2% ash)**
- Fuel flexibility
  - Lignite, bituminous & sub-bituminous coal, hard coal, pet-coke (w/o flux), biomass
- Dry feeding
  - high efficiency (>80%),
  - high carbon conversion rate (> 98%)
- Cooling screen
  - short start-up / shut-down (~ 2h)
  - high lifetime and high availability
- Full quench
  - simple and reliable
  - ideal for CO sour shift
- Single main burner with integral pilot burner
  - Eliminates the need to disassemble start-up burner(s)
  - Facilitates maintenance
    (downtime for burner change one day)
- Advanced Controls
  - increased availability
- Standard Sizes
  - SFG-500, SFG-850, and SFG-1200

**Quench water**

**Gas outlet**

**Pressurized water inlet**

**Pressurized water outlet**

**Burner**

**Reactor 1300 to 1800°C**

**Granulated slag**
R&D Improves Gasification Economics
New Gasification Design Features and Capabilities

Advanced sensors and CFD analysis
Advanced ph sensors, spectroscopical flame analysis, advanced coal feed and raw gas dust sensors, online coal humidity sensor
CFD analysis to optimize reactor and quench geometries and to calculate heat flux

SFG with Heat Recovery
Efficiency improvement potential:

IGCC w/o CO2 capture
Plant net efficiency
Approx. + > 3.5 %
(depending upon coal type, water/steam condition, gas turbine)

IGCC with CO2 capture
Plant net efficiency
Approx. + > 1.5 %
(depending upon process conditions of CO-shift, coal type, water/steam condition)
R&D Expands Feedstock Capability
Biomass and Blends

- Testing indicates blends of non pre-treated biomass with coal or petcoke up to approx. 20% depending on the biomass type are possible.

- Pre-treatment is necessary for pure biomass feedstocks or blends with a significant portion of biomass.
  - Siemens is investigating the development of large scale pre-treatment processes.

 Siemens is investigating pure biomass feedstocks and blends with coal or petcoke.
Mississippi Power
Kemper County IGCC Project

- 582 MW\textsubscript{net} IGCC project
- 65+\% carbon capture
  (3 M tons of CO\textsubscript{2}/year)
- Siemens will supply 2 SGT6-5000F gas turbine generators
  - Will operate on high H\textsubscript{2} syngas as the primary fuel and natural gas as the backup/startup fuel
  - Will include capability to extract air for integration with the air-blown gasifier
- Located in Kemper Co., Mississippi
Siemens and US DOE’s Advanced H₂ Turbine Program

Over 50% of the CCS penalty can be recovered

Advanced gas turbines with:
- Higher inlet temperatures
- Low NOx combustion with reduced N₂ dilution
- Advanced sealing technology
- Advanced cooling technology
- Advanced materials and coatings to allow higher temperature operation with high H₂ syngas
Conclusions

- While global gasification based project activity is down from two years ago, there is significant activity in the US and Chinese markets
  - Hauneng Greengen, Tianjin
  - Mississippi Power, Kemper IGCC Project
  - Secure Energy, Decatur Gasification Project
  - Shenhua, NCPP
  - Summit Power, Texas Clean Energy Project
  - Tenaska, Taylorville Energy Center

- Lessons learned from the current wave of projects combined with R&D investments will play a significant role in lowering the cost of IGCC for future projects

- However, support for gasification based solutions is only possible if the industry sees a future. Growth is only possible if demand for these solutions exist and there is a clear and comprehensive energy policy that supports them
Questions?

Contact Information
Harry Morehead
Siemens Energy, Inc.

harry.morehead@siemens.com
(407) 736-3322
Disclaimer

This document contains forward-looking statements and information – that is, statements related to future, not past, events. These statements may be identified either orally or in writing by words as “expects”, “anticipates”, “intends”, “plans”, “believes”, “seeks”, “estimates”, “will” or words of similar meaning. Such statements are based on our current expectations and certain assumptions, and are, therefore, subject to certain risks and uncertainties. A variety of factors, many of which are beyond Siemens' control, affect its operations, performance, business strategy and results and could cause the actual results, performance or achievements of Siemens worldwide to be materially different from any future results, performance or achievements that may be expressed or implied by such forward-looking statements. For us, particular uncertainties arise, among others, from changes in general economic and business conditions, changes in currency exchange rates and interest rates, introduction of competing products or technologies by other companies, lack of acceptance of new products or services by customers targeted by Siemens worldwide, changes in business strategy and various other factors. More detailed information about certain of these factors is contained in Siemens' filings with the SEC, which are available on the Siemens website, www.siemens.com and on the SEC's website, www.sec.gov. Should one or more of these risks or uncertainties materialize, or should underlying assumptions prove incorrect, actual results may vary materially from those described in the relevant forward-looking statement as anticipated, believed, estimated, expected, intended, planned or projected. Siemens does not intend or assume any obligation to update or revise these forward-looking statements in light of developments which differ from those anticipated.

Trademarks mentioned in this document are the property of Siemens AG, it's affiliates or their respective owners.