Agenda

- Siemens Energy
- Global Market Status and Trends
- Siemens Gasification
  - Projects
  - Technology
- Siemens Power Generation
  - High H2 Turbines
- Conclusions
- Q&A
Siemens Sectors and Divisions

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

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

Healthcare
- Imaging & IT
- Workflow & Solutions
- Diagnostics
Siemens Energy: Innovation fields along the entire energy conversion chain

Longer Term World Energy Megatrends

• Increased energy demand worldwide
• Power supply in urban and rural areas
• Climate change
• Scarcity of fossil fuels
US Power Generation Market

Market Drivers

- Flexibility to meet daily energy demand
- Environmental considerations
  - Improved efficiency
  - Reduced water consumption
  - Reduced air emissions

*Today’s designs must consider tomorrow’s need.*
Siemens Flex-Plant™ Natural Gas Fired Combined Cycle Series

SGT6-5000F is the core of the Flex-Plant™ Series

1x1 SCC6-5000F Flex-Plant™ 10

2x1 SCC6-5000F Flex-Plant™ 30

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Energy Sector
Gasification Plant Design and Applications

Gasification is able to meet the strictest environmental regulations:
- Low emission of particulate matter, organic compounds and easy disposal of sulfur
- Can support the addition of capturing CO₂
Market slow down due to economic recession, lack of financing and uncertainties about CO₂ legislation
- Funding and loan guarantees released in USA/CAN > 5 B USD
- Multiple IGCC projects and Coal to X (CtX) projects supported by US government
- EOR opportunities

Limited by Delayed Climate Legislation and Reduced Access to Debt and Equity for Large Capital Projects

But: Increasing fuel prices (crude oil), security of supply and beginning recovery of economy starts driving new gasification projects primarily in Asia
Siemens Gasifier Activity Landscape

- **Capital Power**: 270 MWth IGCC
  - Secure Energy: 1000 MWth
- **Sustec, Schwarze Pumpe**: 200 MWth, 1984 - 2007
- **NCPP I**: Coal to Polypropylene 2500 MWth
- **JinCheng**: Coal to Ammonia 1000 MWth
- **China JV GSP China**: Liquid feedstock
- **Summit Power, TCE**: Coal to SNG/Power 270 MWth, 1000 MWth
  - Tenaska: 175 MWth, IGCC
  - Confidential Client: Coal to SNG
  - Confidential Client: Coal to Liquids
- **Vresova**: 175 MWth, IGCC
  - Liquid feedstock COD 2008
- **AEC**: Coal to UREA
- **Confidential Client**: Coal to Ammonia 1000 MWth
- **Tenaska**: Coal to SNG/Power 1000 MWth

9 SFG-500 Gasifiers (incl. other key equipment) shipped
Technology selected and pre-selected for additional projects
NCPP I: Largest Coal to Chemical Plant in China
5 x SFG-500 class gasifier: Coal to Polypropylene plant

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

Feedstock:
- Subbituminous Coal
- Ash: ~ 7 wt%
- Moisture: ~ 2 wt%

Status
- Engineering Completed
- All Gasifiers shipped and erected
- Piping installation in progress
- Start up Year: 2010

Gasification Unit
Air Separation Units
Power Station
Methanol to Polypropylene
Black Water Treatment
Gasification Unit (5xSFG-500 class gasifiers)
Location / Fuel: Taylorville, IL  
Illinois coal #6

Power output: 500 MW (net)

Siemens scope: 2 x SFG-500 Gasifier and  
2 x SGT6-5000F

CCS capture rate: > 50% used for EOR

Time schedule: ICC Decision 2010  
Operation total plant: 2015

DOE support: $ 2.5 B loan guarantee
Summit Power Group
Texas Clean Energy Project

- Largest CCPI Award to Date
- 400 MWₑ “Polygen” IGCC project
- 90% carbon capture
  (2.7M tons of CO₂/year; CO₂ emissions only 20 to 30% of a natural gas combined cycle)
- Siemens to supply
  - SFG-500 gasifiers
  - SGCC6-5000F 1x1 operating on high H₂ syngas
  - Plant Operation and Maintenance services
- Located at FutureGen “finalist” site directly atop Permian Basin and CO₂/EOR opportunities
Siemens Fuel Gasification Technology: Cooling screen reactor

**SFG Gasifier (> 2% ash)**

- Fuel
- Oxygen, steam
- Pressurized water inlet
- Pressurized water outlet
- Burner
- Cooling screen
- Quench water
- Gas outlet
- Granulated slag
- Reactor 1300 to 1800°C

**Features**

**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

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Siemens Fuel Gasification Technology
Verified Performance with Different Feedstocks

More than 100 gasification tests performed with more than 60 different feedstocks including coals from Australia, Germany, Canada, South Africa, China,…
## Optimized Family of Gasifier Sizes for Today’s Range of Gasification Based Projects

<table>
<thead>
<tr>
<th>Model</th>
<th>Capacity Range</th>
<th>Gas Composition</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>SFG-200</td>
<td>35-50,000 Nm³/h</td>
<td>(H₂+CO)</td>
<td>Best for low ash feedstocks</td>
</tr>
<tr>
<td>SFG-500</td>
<td>100-130,000 Nm³/h</td>
<td>(H₂+CO)</td>
<td>-sized to match today’s 60 Hz F Class gas turbines</td>
</tr>
<tr>
<td>SFG-850</td>
<td>180-210,000 Nm³/h</td>
<td>(H₂+CO)</td>
<td></td>
</tr>
<tr>
<td>SFG-1200</td>
<td>280-310,000 Nm³/h</td>
<td>(H₂+CO)</td>
<td></td>
</tr>
</tbody>
</table>
SFG with Heat Recovery

Design features

- Radiant Cooler followed by full quench of raw gas
- Efficient use of the high temperature heat in the steam generator for HP steam generation (optional: IP steam)
- High raw gas water content benefits CO-shift
- Proven reactor and quench design extended by Radiant Cooler

Efficiency improvement potential:

- IGCC w/o CO$_2$ capture
  
  **Plant net efficiency** ca. + > 3.5%
  (depends upon coal type, water/steam condition, gas turbine)

- IGCC with CO$_2$ capture
  
  **Plant net efficiency** ca. + > 1.5%
  (depends upon process conditions of CO-shift, coal type, water/steam condition)
Siemens Fuel Gasification
Complete Life Cycle Support

Project Evaluation & Technology Selection

- Feasibility Studies
- Gasification Tests
- Licensing

Project Execution

- Engineering Packages (Process Design & Basic Engineering Design Package)
- Critical Gasification Equipment Supply
- Detailed Engineering
- Construction

Start-up and Operation

- Technical Field Assistance
- Parts, Maintenance, Diagnostics, O&M

OEM for key gasification island components: Burner, Gasifier, Feeder Vessel, Burner Management and Safety System

Process engineering/license and basic engineering service provider

Service provider for gasification island scope, using the Siemens Energy service infrastructure

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60 Hz IGCC Power Island Solutions

SGT6-PAC 5000F
- 232 MWe GT-G for low-BTU fuel applications (ISO conditions)
- 15 ppm NO\textsubscript{x}
- Can be integrated with wide range of gasifiers operating with a broad range of feedstocks

SGCC6-5000F 1x1 or 2x1
- 300-400 and 630 MWe combined cycle reference plant concept
- Based on standard SCC6-5000F based combined cycle design

• Completed 3 IGCC Power Block Pre-FEEDs and 1 FEED
• 1 IGCC Power Block FEED in progress
Today’s Fuel Flexible SGT6-5000F

SGT6-5000F for IGCC Applications

• Based on proven standard product and fleet experience
• Lessons learned from over 650,000 hours of prior and current IGCC plants experience
• Full scale testing forms the basis for new technology improvements

94% Fleet Availability
229 Units in Operation

Testing with high H2 syngas completed
Mississippi Power
Kemper County IGCC Project

- 582 MW_{enet} IGCC project
- 65% carbon capture
  (3 M tons of CO_2/year)
- Siemens will Supply 2 SGT6-5000F Gas Turbine Generators
  - Will Operate on high H_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’ US DOE Advanced H2 Turbine Program

Over 50% of the CCS Penalty can be Recovered
Conclusions

- Near term global demand for gasification based solutions is focused on projects that produce high value products and can address climate change now
  - Near Term: Using EOR for CO₂ storage
  - Longer Term: Price signal for carbon is necessary
- Economic hurdles still exist for gasification based projects that the next wave of projects will address
  - Government financial support for commercial scale demonstration projects will help accelerate deployment
- Longer term energy megatrends will drive demand for gasification based solutions for power, chemicals and clean transportation liquids
Questions ?