Siemens Oil and Gas

Answers for Enhanced Oil Recovery
December 6, 2012
Topics

• Review CES Inc. (Tuesday)
• Review Siemens Energy
• Oxy-Fuel Solutions
• CO₂ Concepts to Accelerate the Expansion of CO₂ EOR
• Oil and Gas Cases
• Conclusion
Recap from Tuesday


October 1st, 2010
Enabling of Unique and Unconventional Solutions for EOR

- **Component Portfolio**

- **Coal-Bed Methane**
- **Pipeline Natural Gas**
- **Off-Spec Raw Gas**
- **CO₂ EOR Recycle**
- **UCG Gas**
- **CO₂-Contaminated NG**
- **Wet Gas**

**Innovative Solutions**

- **200 MWₜ Gas Generator**
- **50,000 lb/h PHRSG**
- **30 MWₜ Re-Heater**
- **50,000 lb/h G²S²³**

**Additional Resources**

- Incremental Oil
- CO₂ Supply
- Power
- Water
- Steam/Heat
- Dry-Gas Conversion
- NG-Liquids Recovery
Siemens Expander Turbine-150 for CO$_2$-EOR

Core Technology Based on Innovation of Proven Product
Template Oxy-Fuel Plant – The Power Block

- Natural Gas/
- Contaminated Gas/
- Associated Gas

Air → ASU → GG → RH → Condenser → CO₂

- O₂

- O₂

- HP

- OFT

- LP → Power

- Water
Build up from Product to Solution

SXT150 Turbine Product by IP…
…match to CES Inc (1) Main Gas Generator & (8) Reheaters

Core Technology

New products packaged as “Core Technology”

Power Block Solution = add conventional Steam
.Turbines, generators, heat exchanger, condenser, control and safety systems

Power Block

IP Core Integrated into overall OxyFuel Solution by C&S

EOR Solution = Plant Engineering and Products for O₂ and Fuel, CO₂, Electricity, Water… Interface to Onshore or Offshore Oil or Gas field and related markets

EOR System

Oil Company Reservoir and Facilities Engineering

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## Resources

### Engineering Team

<table>
<thead>
<tr>
<th>Company</th>
<th>Headcount</th>
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</thead>
<tbody>
<tr>
<td>Clean Energy Systems</td>
<td>2</td>
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<tr>
<td>Siemens Houston</td>
<td>15</td>
</tr>
<tr>
<td>Siemens Finspang Sweden</td>
<td>13</td>
</tr>
<tr>
<td>Siemens Rio De Janeiro</td>
<td>24</td>
</tr>
<tr>
<td>Siemens Orlando</td>
<td>2</td>
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<tr>
<td>External Engineering</td>
<td>6</td>
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### Current Tasks Load

<table>
<thead>
<tr>
<th>Task</th>
<th>Headcount</th>
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</thead>
<tbody>
<tr>
<td>Product Development</td>
<td></td>
</tr>
<tr>
<td>Product and System Technical Readiness</td>
<td></td>
</tr>
<tr>
<td>Oilfield Conceptual Development</td>
<td></td>
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<tr>
<td>Feasibility Studies</td>
<td></td>
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<tr>
<td>Pre-FEED Design</td>
<td></td>
</tr>
<tr>
<td>FEED Design</td>
<td></td>
</tr>
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</table>

**Headcount 62, ~50% are Fulltime**
Oxy-Fuel Solutions

Integrated Oilfield Solution

Siemens Oxy-fuel Solution + CES Inc. Products

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Strategic Drivers for CO₂ Solutions, USA

- CO₂ supply alternatives and shortages
- Infrastructure limitations
- Fuel flexibility
- Fuel sourcing alternatives / resource asset strategy
- Gas and recycle gas treatment
- NG liquid recovery, dry gas utilization
- Global CO₂ management
- Regulatory
- Tax Incentives
- Addressing not only the needs of operators but also local authorities and NGOs

CO₂ Commodity Facility
50,000 MScfd+ CO₂, 200 MWₑ, 500 k gpd, 7-8,000 BOEPD
Incremental Off-Infrastructure EOR Anchor Reservoir

CO₂ Recycle Gas Processing Facility
Commercial Exploitation of HC Content in Recycle Gas

Direct Use of Off-Spec or Stranded Natural Gas Resource
High-CO₂ Content, CBM, UCG, etc
Strategic Drivers for CO₂ Solutions

- Low CAPEX
- Meets CO₂ Market Price Requirements
- Not Tax or Incentive Driven
- CO₂ Power Water
### CO₂-EOR in North America compared to Rest of the World

<table>
<thead>
<tr>
<th>North America</th>
<th>Rest of the World</th>
</tr>
</thead>
<tbody>
<tr>
<td>• CO₂-EOR is an established business</td>
<td>• Ambitious CO₂-EOR pilot projects are evolving worldwide.</td>
</tr>
<tr>
<td>• Policies governing CO₂-EOR value-chain is in formative stages.</td>
<td>▪ Regulations governing CO₂ capture, transportation and injection are not defined.</td>
</tr>
<tr>
<td>• CO₂-EOR potential is scoped.</td>
<td>▪ Limited study for CO₂-EOR potential, learning the technology</td>
</tr>
<tr>
<td>• Operators: IOC’s and independent companies</td>
<td>▪ Operators: IOC’s and NOC’s, NOC’s have strong expectations</td>
</tr>
<tr>
<td>• Driver: CO₂ supply is limited.</td>
<td>▪ Driver: Carbon reduction programs and mature oil fields assets needs CO₂-EOR.</td>
</tr>
<tr>
<td>• DOE Grants to develop CO₂-EOR technologies is available.</td>
<td>▪ Limited funding for CO₂-EOR research and technology development.</td>
</tr>
</tbody>
</table>
US CO₂ Availability for EOR

[Map of active U.S. CO₂ pipeline and injection site infrastructure with key areas highlighted: Wy/Rockies, Permian Basin, and Gulf Coast.]
World CO₂ Availability for EOR

Source: Shelagh J. Baines (BP Exploration and Production) & Richard H. Worden (Department of Earth and Ocean Sciences, University of Liverpool)
Oxy-Fuel Oil and Gas Cases
# Opportunity Assessment

## Field Assessment

<table>
<thead>
<tr>
<th>Reservoir Type</th>
<th>Greenfield / Brownfield?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth, Temperature, Pressure, Permeability</td>
<td>Has it undergone water flood?</td>
</tr>
<tr>
<td>Minimum miscibility pressure?</td>
<td>Number of wells, production rate</td>
</tr>
</tbody>
</table>

## Site Assessment

<table>
<thead>
<tr>
<th>CO₂ requirements? (purity, pressure)</th>
<th>Is there a need of Power? What are the grid limitations?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power export conditions (KV rating, generating frequency for transmission, distribution, MV, LV, etc)</td>
<td>Any natural source of water nearby? Can it be used as cooling medium?</td>
</tr>
<tr>
<td>Disposal conditions for produced water</td>
<td>Fuel specifications</td>
</tr>
<tr>
<td>Are there any other utilities available?</td>
<td>Location of Equipment: Altitude, Wind, Snow load, Earthquake factor</td>
</tr>
<tr>
<td>Atmospheric Conditions: Temperature</td>
<td>Humidity and Barometric Pressure</td>
</tr>
<tr>
<td>Facility Life Time design</td>
<td></td>
</tr>
</tbody>
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Opportunity Assessment: PEST Analysis

**Political aspects** - e.g. Government gatekeepers, Ministries of Oil, Power, Water, Transportation, strong single point leadership?

**Environmental aspects** – e.g. Diplomatic Policy, Endangered species, Infrastructure capability

**Societal aspects** – e.g. potential neighbors, community sentiments, Perceptions and Impacts, Long Term economic development (Single product economy)

**Technical aspects** – e.g. Field and Site Assessments, Siemens is to implement PES requirements, in the domain of plant design
Other business aspects (Tax Credit Implications, Business Partners)
Concept Selection Process

Brainstorming possibilities

Selected Concept

DFS development

Concept 1

Concept 2

Concept 3

Fuel specs

Water supply

Grid restrictions

CO₂ requirements

PEST aspects

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Oxy-Fuel Solutions: Case 1, Oil

Location: Onshore

Transportation: Oilfield receiving CO₂ is < 50km distant

Fuel Gas: Clean Pipeline Gas

CO₂ spec: Acceptable

Power generation: 50 to 150 MW, 3 to 5 years

Power grid spec: 50 Hz 132 kV/230 kV

Template: One System, phased development

DFS Deliverables:
- Process Design Basis
- Process Description
- Utility Report
- Equipment List
- Block Flow Diagram
- Process Control
- Philosophy
- Plot Plan
- PFDs
- Cost Estimate

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Oxy-Fuel Solutions: Case 1, Oil

- 1 Point Decision Maker
- CO₂ Policy not aligned
- No CO₂, No Water
- High production demand
- Low EOR experience
- ASU Location

Local Connect to Grid

Pipeline Fuel Gas

Proposed Oxy-Fuel Facility

Oil Fields

CO₂ EOR

50 km
Oxy-Fuel Solutions: Case 2, Gas and Oil

Location: Onshore and Offshore
(130 km, 80 m)

Transportation: Transport of Oxygen, CO₂, and/or Power

Fuel Gas: CO₂ Contaminated gas, 30% to 60%, increasing over life

CO₂ spec: Acceptable

Power generation: Varies

Power grid spec: 50 Hz 132 kV/230 kV

Template: Power Station 1 (400MW), PS 2 (800MW), PS 3 (1140MW)

Grid capacity limit?
Oxy-Fuel Solutions: Case 2, Gas and Oil

- Electric Power for Grid
- Proposed Oxy-Fuel Solutions Facility
- Petrochemical Complex
- Gas Field
- Oil Field
- 30% to 60% CO₂ Fuel Gas
- CO₂ EOR
- 50 km

- 2 Point Decision Maker, Gas & Power
- CO₂ Policy not present
- Stranded Asset
- Low EOR experience
Oxy-Fuel Solutions: Case 3, Gas and Oil

Location:  Onshore

Transportation: Fuel gas, CO₂ pipeline

Fuel Gas:  30% CO₂ Gas

CO₂ spec: Acceptable

Power generation: 150 MW

Power grid spec: 50 Hz  110 kV
Loop Feed to city substation

Template: Single plant, produced Water contamination
Oxy-Fuel Solutions: Case 3, Gas and Oil

Gas Field

30% CO₂ Fuel Gas

Oxy-Fuel Facility

Oil Field

Electric Power to Grid

CO₂ EOR

- Asset straddles 2 countries
- Old infrastructure
- Low economic development
- Low data set

5 km
Conclusion

**Alignment**
The building blocks of the system are ready, and the resources are working

**Business Case**
The economics fit with current and future expectations

Smallest CAPEX of any in this plant capacity

**Technology**
The plant solution is inherently flexible, within the current template size.

Flexibility adapts to unique characteristics of the reservoirs