Oxy Fuel Turbine Technology Development Program Overview

Siemens Energy
Clean Energy Systems
# Siemens Energy Sector – Answers for Energy

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<td>Industry Automation, Drive Technologies, Building Technologies</td>
<td>Automation and Drives (A&amp;D), Industrial Solutions and Services (I&amp;S), Siemens Building Technologies (SBT), Osram, Transportation Systems (TS)</td>
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<td>Healthcare</td>
<td>Imaging &amp; IT, Workflow &amp; Solutions, Diagnostics</td>
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Innovation fields along the entire energy conversion chain:

- Nuclear Power Generation
- Wind Power Generation
- Solar Power Generation
- HVDC-Transmission and HVDC Grids
- Smart Grid incl. Energy Storage, E-Mobility
- Offshore & Subsea Oil & Gas
- Pipeline Transportation and Gas Liquefaction
- Highly Efficient Coal- and gas fired Power Plants
- Gasification
- Carbon Capture and Storage

Clean Energy Systems
Innovation fields along the entire energy conversion chain
Oxy Fuel Plant Concept

Flexible Fuels, including:
- High CO2 gas
- Flare gas
- Non-merchant associated gas

*CH₄, CO, H₂, etc.
Gas Generator

- Combustion Technology for injector design promotes intimate mixing and cooling
Oxy Fuel Plant Concept

Flexible Fuels, including:
- High CO2 gas
- Flare gas
- Non-merchant associated gas
Power Turbine

1 - MATERIALS RESEARCH FOR CO2/STEAM PROCESS
2 – OXYFUEL REHEATER DEVELOPMENT
3 – POWER TURBINE DESIGN AND MANUFACTURE

OXYFUEL REHEATERS

POWER TURBINE

NO COMPRESSOR

PLENUM – HOT GAS INTAKE

SIEMENS
- Past Development:
  - 1999: First demonstration of CES oxy fuel technology done under CEC grant
  - 2000-2003: 20MWt generator tested under DOE grant
  - 2002-2006: 2.7 MWe pilot-scale oxy fuel plant commissioned and connected
    > Over 400 starts and 2,000 running hours
  - 2006-2010: 170 MWt CES combustor tested with 1st generation oxy fuel turbine
- Current: DOE grant awarded to CES in partnership with Siemens
  - USD $30M awarded Sep 2010
  - Goal: Development of 2nd generation oxy fuel gas turbine technology
  - CES to further enhance combustor technology
  - Siemens to design, manufacture, and package oxy fuel turbine
  - DOE project completion: 2012
Turbo Care Houston – Oxyfuel Core Manufacture
• 140,000 Sq. Ft. Facility, 100 Ton Capacity
• Full machine shop with lathes capable to work 130” diameter and 75 Tons
• Full in-house disassembly, reassembly and alignment capability of turbomachinery
• Operating speed rotor balance bunker
• Advanced welding capabilities

Oil & Gas Houston – Oxyfuel Packaging Assembly
• 50,000 Sq. Ft. Shop Bays, 100 Ton Capacity
• Sales, Engineering, Project Management, Procurement, and Packaging of Turbomachinery for the Americas
• Gas turbines, compressors, generators, motors, and auxiliary and balance of plant systems
• Full load package string test facility up to 16MW
Technology Targets

2nd generation Oxy Fuel Turbine Cycle capable of producing:

- Up to 150 to 200 MWe net power = 200,000 to 270,000 hp compression
- Start and synchronize to grid within 10 minutes
- No NO\textsubscript{x}

- 30-40% cycle efficiency
  - Includes CO\textsubscript{2} capture/compression, and O\textsubscript{2} separation/compression
  - Use of low calorific and non-merchant fuels (25%-90% CO\textsubscript{2})

- 2,500 tonnes/day or 48 MMSCFD CO\textsubscript{2} → Enhanced Oil Recovery

- 13,000 BWPD net produced, or 190 kpph steam → net water

- 500 MMSCFD N\textsubscript{2} → ??

Plant Size Scalable Up or Down.
CO2 Compression

Compressor Conditions:
P1 = 15 psia (1 bar)
P2 = 2,165 psia (150 bar)
Flow = 100 MMSCF
T1 = 43 F
MW = 43.9 (CO2)
Power = 23,600 HP
Questions?

Industry
- We solve the challenges of a booming population

Healthcare
- We supply better and affordable healthcare

Energy
- We lower CO₂ emissions with our energy solutions

Source: Siemens

Rising temperatures

GDP increase in developing countries

Increasing life expectancy

Population growth

CO₂ emissions

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