Siemens Energy

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Siemens Energy
Fossil Power Generation
Stationary Fuel Cells

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### Answers provided by 15 Divisions in three Sectors

<table>
<thead>
<tr>
<th>Sectors</th>
<th>Divisions</th>
<th>Former Groups</th>
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<tbody>
<tr>
<td><strong>Industry</strong></td>
<td>- Industry Automation&lt;br&gt;- Drive Technologies&lt;br&gt;- Building Technologies</td>
<td>- Automation and Drives (A&amp;D)&lt;br&gt;- Industrial Solutions and Services (I&amp;S)&lt;br&gt;- Siemens Building Technologies (SBT)&lt;br&gt;- Osram&lt;br&gt;- Transportation Systems (TS)</td>
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<tr>
<td><strong>Energy</strong></td>
<td>- Oil &amp; Gas&lt;br&gt;- Fossil Power Generation&lt;br&gt;- Renewable Energy</td>
<td>- Power Generation (PG)&lt;br&gt;- Power Transmission and Distribution (PTD)&lt;br&gt;- Industrial Solutions and Services (I&amp;S OGM)</td>
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<tr>
<td><strong>Healthcare</strong></td>
<td>- Imaging &amp; IT&lt;br&gt;- Workflow &amp; Solutions&lt;br&gt;- Diagnostics</td>
<td>- Medical Solutions (Med)</td>
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Energy is an essential part of our daily lives

Industry

Education

Mobility

Workplace

Entertainment

Homes

Recreation

Cities

Lighting
Siemens is committed to profit and growth

Active in three Sectors
- Healthcare: €11.2 billion (14.3%)
- Energy: €22.6 billion (29%)
- Cross-Sector Businesses: €6 billion (49%)
- Industry: €38 billion (27%)

Revenue by region
- Asia, Australia, Middle East: 21%
- Americas: 26%
- Europe, CIS, Africa (excl. Germany): 36%
- Germany: 17%

Revenue and employees
- Employees in thousands (FY1985 to FY2008)
- Revenue in millions of euros (FY1985 to FY2008)

Key figures
- Continuing operations (in millions of euros)
  - Revenue: FY2008: 77,327, FY2007: 72,448
  - Employees: FY2008: 427,000, FY2007: 398,000
Siemens around the world: Snapshot

U.S. Fast Facts Fiscal Year 2008:
- Revenues: $22.4 billion
- Orders: $26.3 billion
- Employees: 69,000
- R&D Employees: 7,760
- Global HQs: 9
- Patents: 13,200

Worldwide Fast Facts Fiscal Year 2008:
- Revenues: $116.6 billion
- Orders: $140.9 billion
- Employees: 428,000
- R&D Employees: 32,300
- Countries of Operation: 190
- Patents: 55,000
Solid oxide fuel cells offer great value proposition ...

### Trends / Drivers / Benefits
- Green technology
  - Low emissions
  - CO₂ capture potential
  - Renewable fuel
- High quality heat & power
- High efficiency
- High reliability/availability
- Low O&M cost, minimal moving parts
- Low degradation
- No water consumption (except startup)
- Quiet (65 DBA @ 10 m)
- Recyclable at the end of useful life
- Siting flexibility, easily permitted
- Enhances energy independence and security

### Value Proposition

<table>
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<tr>
<th><strong>Central Power Station</strong></th>
<th><strong>T &amp; D</strong></th>
<th><strong>End User</strong></th>
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<tbody>
<tr>
<td>• Ave. η=45%</td>
<td>• Ave. loss: 10-15%</td>
<td>• Ave. η = 30-35%</td>
</tr>
<tr>
<td>• BAT η=60%</td>
<td>• Reliability risk</td>
<td>• BAT η = 45-50%</td>
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<tr>
<td>• Significant investment</td>
<td>• No available heat</td>
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**DOE SECA Coal-based power system**
- > 90% carbon capture
- Water neutral
- > 60% efficiency
- < $400/kW
- η = 46% electricity
- η = 40% thermal
- η = 86% total
- No risk of T&D interruptions
- No T&D investment

SOFC is the best solution for cost effective, secure & robust electricity supply

... but achieving cost targets are their hurdle to commercialization
Welcome to SFC Headquarters

Bldg. 304 High Pressure Test Lab

Bldg. 801 Engineering and Administration

Bldg. 601 Manufacturing and Development

George Westinghouse Science and Technology Park
SFC Technology has demonstrated Best-in-Class performance

Developed over 25 fully integrated SOFC power generating systems, including the world's first pressurized hybrid demonstration unit
What are our origins?

- Siemens Fuel Cell (SFC) has been the leading developer of Solid Oxide Fuel Cell (SOFC) technology since the 1950s
- Westinghouse and Siemens have provided a rich scientific / R&D ancestry
- Commitment to SOFC development has led to many scientific milestones
- Key personnel and development team intact for 20+ years
- SFC has operated within Siemens largely as a standalone unit
- U.S. Department of Energy (DOE) has been a partner in developing the technology for 20+ years
Where are we heading?

2008
- Established viability of Delta8 cell
- Demonstrated voltage stability
- Improved manufacturing process yields
- Enhance power density

2009
- April 2009 – Phase I stack test successfully completed (5,000+ hours)
- September 2008 – Start-up of Phase I stack test (10kW) with new Delta8 technology

2010
- 2010
- Start-up of Phase II stack test (25+ kW)
- Continued Pressurized testing of Delta8 cells
- Start-up of Second Generation stack test (25+ kW)
- October 2010 – DOE Phase II Deliverable

The SFC technology roadmap is closely aligned with the DOE SECA Coal-based Systems Program
SFC SECA Coal-based program highlights and accomplishments
Acknowledgements

- DOE-NETL. Contact No.DE-FC26-05NT42613
- Wayne Surdoval, Travis Shultz, Heather Quedenfeld - NETL
- Siemens Stationary Fuel Cells Team