Combined Heat & Power (CHP)
US Market Overview

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Power & Water diverse solutions

$28B ‘12 revenue >40,000 employees 700 locations

Wind

Renewables

Solar

Water & Process Technologies

Nuclear

Power Gen Products

Power Gen Services

Jenbacher gas engines

Waukesha gas engines

Aeroderivative gas turbines

Distributed Power

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Spanning industrial/municipal, grid building/stabilizing, and fast power applications GE’s portfolio of innovative distributed power solutions, including gas engines, small gas turbines, waste heat recovery technologies, energy storage capabilities, and micro-grid controller systems, is well-positioned to serve this emerging opportunity.
Global CHP potential

850 GW of incremental power ... ~600 GW of these, are found in China, the EU, and the US.

Canada 25 GW
US 150 GW
Mexico 7 GW
Brazil 15 GW
Russia 87 GW
China 332 GW
EU 122 GW
India 85 GW
South Africa 12 GW
Japan 26 GW

Source: International Energy Agency, European Information Administration

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CHP as proportion of national power generation

Accounts for only ~10% of the world's PG capacity

Room for growth
US CHP Installed Capacity ...
83GW ... ~4,000 sites

Source: ICF CHP Installation Database

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Combined Heat & Power – U.S. Market

Existing CHP Segment
- 83 GW installed at ~4,000 sites
  - ~85% of capacity in industrial apps
  - ~70% of capacity is fueled by gas
- 10% of total U.S. generating capacity (12% of generation)
- 1.9 QBTU’s of fuel use saved per year
- 240 Mtons of CO2 emissions eliminated annually

Potential CHP Segment
- 132 GW (64 GW industrial, 68 GW commercial)
- 47% (62 GW) is found in sites between 1 – 20 MW in output size
- 1 – 20 MW is GE Jenbacher focus

US CHP Segment Potential by Industry and Size Class

In Megawatts, MW

Industrial

- >20 MW
- 5 - 20 MW
- 1 - 5 MW
- 50 - 1000 kW

Commercial

- >20 MW
- 5 - 20 MW
- 1 - 5 MW
- 50 - 1000 kW
US CHP Market Potential (1-20 MW Segment)

Top Sectors, 1 – 20 MW

- **Industrial** 36 GW
  - Textiles 4%
  - Primary Metals 4%
  - Petroleum Refining 4%
  - Other 21%
  - Food 13%
  - Paper 15%

- **Commercial** 30 GW
  - Data Centers 2%
  - Multifamily Buildings 4%
  - Other 5%
  - Hotels 6%
  - Prisons 7%
  - Govt. Buildings 8%
  - College/Universities 11%
  - Hospitals 13%

Top States, 1 – 20 MW

- **CA, NY, TX = 20%**
  - California 8%
  - New York 4%
  - Texas 6%

- **CA, NY, TX = 33%**
  - California 11%
  - New York 12%
  - Texas 6%

ICF International

1 GW (Gigawatt) = 1000 MW (Megawatt)

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Key drivers for CHP Projects

It's all about the spark spread + incentives

- Customer Electricity Rate
- Fuel Cost
- Capex
- O&M

Cost of Electricity (CoE)

- Capacity Payment
- Clean Energy Credit or FIT
- Property Tax Exemption or Tax Credit

Possible Incentives

Margin

Spark Spread

Cents/kWh
US CHP Installations
Spark Spread and Policy main drivers for CHP growth

Post-PURPA surge with favorable Spark Spread
Overcoming barriers to deployment

Energy standards
• Renewable & efficiency mandates

Awareness & understanding
• Outreach & education

Utility practices
• Interconnection rules
• Standby & buyback rates

Emissions permitting & trading
• On-site emissions
Emerging drivers for US CHP Market

- **CHP benefits getting recognition at federal & state levels**
  - Federal Executive order for 40 GW
  - Key states pursuing energy efficiency
  - Environmental policy ... Boiler MACT

- **DP / CHP for grid resiliency (reliability)**

- **Abundance of Natural gas ...**
  - Increase supply keeps low stable pricing
  - Increase pace of industrialization
Aeroderivative Gas Turbines
CHP Case Studies
### Aero GT Typical Cogeneration Configurations

**Example:** 30 °C /80 % RH ambient, dry saturated steam @ 10-35 bar abs; unfired HRSG; 8 / 6 °C HRSG pinch/approach; net output after total plant aux loads

#### LM1800e range
- **13.3 – 14.3 MW net output**
- **32 – 36.5 tph steam production**
- **30.5 – 31.2 % net LHV efficiency**
- **83 – 87 % net CHP efficiency**

#### LM2500 range
- **19.5 – 27.5 MW net output**
- **42 – 61 tph steam production**
- **34 – 35 % net LHV efficiency**
- **86 – 89 % net CHP efficiency**

#### LM6000 range
- **33 – 42.5 MW net output**
- **53 – 73 tph steam production**
- **38 – 39 % net LHV efficiency**
- **78 – 86 % net CHP efficiency**

**NOTE:** For best plant control, HRSG should have supplementary firing, with GT selection based on achieving 80 – 90 % of normal steam demand in unfired operation. Such solution will further increase CHP efficiency, and allow more constant GT load operation.
In 2010, at the University of Texas in Austin, this LM2500+ cogeneration power plant replaced an aged steam power plant. GE’s Aero technology got an outstanding grade for generating 32 MW of power and steam, while reducing water consumption, demonstrating +70% efficiency, and reducing emissions by 80% vs. prior power plant.
Texas Medical Center in Houston
LM6000 providing CHP to critical infrastructure

TECO’s total plant capacity

- 122,000 tons chilled water
- 850,000 PPH steam
- 61MW power generation
- 82% energy efficiency
- Substantial environmental benefits

✓ 6,500 hospital beds
✓ 900 bassinets
✓ $1B of medical research
✓ 5.5 million patient visits
✓ 8 hospitals
✓ 8 colleges/universities

New LM6000-PC ... for additional CHP
Two GE Aero LM6000s are producing 74 MW in combined cycle, sending 7,000 tons of chilled water to keep 9 million passengers per year cool while powering the infrastructure that gets 31,000 flights on their way each year.
Connecting customers with advanced technologies to help solve their toughest challenges...

Thank You...

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