Cogeneration in Energy & Sustainability Strategies

Monthly Partner Web Conference
February 17, 2010

Call-in number: 888 299 3188
Conference Code 202 343 9965#
About The Web Conferences

- Monthly
- Topics are structured on a strategic approach to energy management
- Help you continually improve energy performance
- Opportunity to share ideas with others
- Slides are a starting point for discussion
Web Conference Logistics

• **Phones will be Muted**
  To ask a question use **# 6 to un-mute**
  and *** 6 – to mute**

• **Questions** – use the chat window or ask question during the Q & A period.

• **Presentation slides** will be sent by email to all participants following the web conference.
Today’s Web Conference

Speakers:

• Neeharika Naik-Dhungel, US EPA
• Gaston Silva, Vornado
• Tom Smith & Dave Yanni, Endurant Energy
• Questions & Discussion
• Announcements
CHP: Overview and Trends

Neeharika Naik-Dhungel
Combined Heat and Power Partnership Program
February 17, 2010
CHP and Conventional Generation – A Comparison

**Conventional Generation**

- Power Station Fuel: 98 Units Fuel
- Boiler Fuel: 55 Units Fuel
- Efficiency: 31%

**Combined Heat & Power**

- 5 MW Natural Gas Combustion Turbine
- Efficiency: 80%
- 30 Units Electricity
- 45 Units Steam
- Combined Heat & Power CHP
- 100 Units Fuel

**Overall Efficiency**

- **CHP**: 75%
- **Conventional Generation**: 49%
# CHP System Benefits

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency</td>
<td>Requires less fuel to produce a given energy output. Avoids transmission and distribution losses.</td>
</tr>
<tr>
<td>Reliability</td>
<td>Can be designed to provide high-quality electricity and thermal energy to a site regardless of what might occur on the power grid, decreasing the impact of outages and improving power quality for sensitive equipment.</td>
</tr>
<tr>
<td>Environmental</td>
<td>Less fuel is burned to produce each unit of energy output which results in overall less air pollution and greenhouse gas emissions.</td>
</tr>
<tr>
<td>Economic</td>
<td>Can save facilities considerable money on their energy bills due to its high efficiency and can provide a hedge against unstable energy costs.</td>
</tr>
</tbody>
</table>
CHP System Configuration Example

- Gas turbine or engine with heat recovery unit
CHP’s Contribution to US Generation

CHP Growth 1970 to Present

Cumulative Capacity Additions (GW)


88% Industrial 12% Commercial/Institutional

Source: EEA/ICF International
<table>
<thead>
<tr>
<th>State</th>
<th>CHP Capacity (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Texas</td>
<td>7,498</td>
</tr>
<tr>
<td>Louisiana</td>
<td>3,085</td>
</tr>
<tr>
<td>New York</td>
<td>805</td>
</tr>
<tr>
<td>Oregon</td>
<td>1,361</td>
</tr>
<tr>
<td>California</td>
<td>1,372</td>
</tr>
<tr>
<td>Alabama</td>
<td>1,969</td>
</tr>
</tbody>
</table>

Remaining States: 7,910 MW

Source: CHP Installation Database – ORNL/DOE
But Other States Have Active Markets

- New Jersey: 54 Sites
- Texas: 64 Sites
- Massachusetts: 337 Sites
- California: 83 Sites
- Connecticut: 217 Sites
- New York: 512 Sites
- Remaining States: 512 Sites

CHP System Additions: 2000 - 2009

Source: CHP Installation Database – ORNL/DOE
Heavy Steam Users Dominate Industrial Applications

CHP Capacity Additions: 2000 - 2009

- 7,693 MW Chemicals
- 7,285 MW Refining
- 1,957 MW Paper
- 1,466 MW Fabrication
- 1,062 MW Food Processing
- 898 MW Other Mfg
- 700 MW Other Industrial

Source: CHP Installation Database – ORNL/DOE
Universities and District Energy Represent Two Thirds of the Commercial/Institutional Capacity

- Universities: 1,060 MW
- District Energy: 1,333 MW
- Hospitals: 125 MW
- Utilities: 601 MW
- WWT: 101 MW
- Other: 477 MW

CHP Capacity Additions: 2000 - 2009

Source: CHP Installation Database – ORNL/DOE
Non-Traditional Users Are Growing

6% Other Industrials
42% Manufacturing
52% Commercial/Institutional

7% Other Industrials
27% Manufacturing
66% Commercial/Institutional

Up to 1999: 2,585 sites
2000-2009: 1,374 sites

Source: CHP Installation Database – ORNL/DOE
CHP Technical Potential

- LBNL (2005): 95 GW (unconventional CHP)
- EEA (2006): 135 GW
- DOE/ORNL (2008) 170 – 250 GW

Source: EEA/ICF International
The Potential for Additional CHP Is Nationwide

Source: CHP Effective Energy Solutions for a Sustainable Future, December 2008, DOE/ORNL
Incentives to System Adoption

• Interconnection Standards
  – The ability of a nonutility generator to operate while connected to the electric transmission/distribution system.

• Investment Tax Credits (ITC)
  – Address financial risk in capital-intensive projects

• Renewable Portfolio Standards (RPS)
Continuing Challenges to CHP Adoption

- Electric rate structures
  - Regulated Fees and Feed-In Tariffs
- Interconnection Issues
- Environmental Permitting
- Tax Treatment
- Technological Constraints
The EPA Combined Heat and Power Partnership

- Launched in 2001
- Goal to reduce the environmental impact of energy generation by promoting higher efficiencies
- Increase market penetration in sectors where there is a large CHP potential but little use.
- The Partnership is technology, fuel, and vendor neutral.
EPA’s CHP Partners

- Industrial, commercial, institutional energy users
- Project developers
- Equipment manufacturers
- Gas and electric utilities
- State, city, and local agencies
- NGOs and industry associations
Partnership Focus

- Raise awareness of the inclusion of CHP in measurement and performance tools (ENERGY STAR Portfolio Manager, LEED, ASHRAE)
- Raise awareness in the environmental benefits of CHP (output based regulations)
- Outreach to increase market penetration in target market sectors
Project Resources

- Project Development Process Guides
- CHP Emissions Calculator
- Funding Resources
ENERGY STAR CHP Award

- Recognize exceptional CHP facilities that reduce emissions
- Are in commercial operation
- Use 5% less fuel than state-of-the-art separate heat-and-power generation
CHPP Website: www.epa.gov/chp

Neeharika Naik-Dhungel:
Naik-Dhungel.Neeharika@epa.gov

Claudia Tighe: Tighe.Claudia@epa.gov

CHPP Help Line: 703/373-3108
Cogeneration from an Owner’s Perspective
Gaston Silva, COO
Vornado Realty Trust
ENERGY STAR
Monthly Partner Meeting

Combined Heat and Power in Commercial Office Buildings

Thomas Smith
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Endurant Energy LLC
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David Yanni
Director, Business Development and Operations
Endurant Energy LLC
david.yanni@endurantenergy.com
Why Distributed Generation?

The benefits of Cogeneration stack up handsomely against conventional utility power supply...

- Environmental Credits
- Heat Energy Available on Site (CHP)
- Reliability and Backup Power (add'l revenue)
- T&D Deferments, Released Capacity
- Loss Reduction
- Energy Produced

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CHP in Commercial Buildings-Benefits

• High coincidence of electricity and thermal demand
• Predictable load profiles
• Redundant source of backup power
• Improved power quality and reliability
• Better load profile for purchasing electric power
• Improvement of ENERGY STAR/LEED rating
• Reduction of Carbon Footprint/GHG Emissions
• Tenant retention
CHP in Commercial Buildings—Considerations

- Are electricity/thermal prices high?
- Is there coincidence of electric and thermal demand?
- Is there economic/market support?
  - State/Federal Incentives Available?
  - Ancillary Services/Capacity Markets?
- Are HVAC systems centralized?
- Are local electricity prices tied to CHP fuel?
- Is there sufficient space in the facility for a plant?
- Does the local utility allow for interconnection?
Domestic Market Opportunities

Legend:
- High Prices
- Medium Prices
- Low Prices

Source: Energy Information Administration; Energyguide.com

Building Sustainable Power...
A 2001 study by Pace University found that the technical potential for Cogeneration in New York office buildings is over 1,600MW.
Natural Gas and Electricity Commodity Prices Move in Lockstep

NYISO Zone J On-Peak Electric Commodity vs. NYMEX NG Futures Prices
February 2008 - August 2009

Building Sustainable Power…

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Time of Use Commodity Pricing-NYC Example

Day Ahead Zone J (NYC) LBMP Pricing
Winter Hourly Averages (Dec-Feb)

Summer Hourly Averages (Jun-Aug)

Source: NYISO Day-ahead LBMP database (http://nyiso.com)

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Post-CHP Commercial Load Profiles

Office buildings tend to consume most electric and thermal energy when power is most expensive; a CHP system can displace a large portion of the expensive on-peak electric power (as shown by the areas shaded in green and orange).
• ENERGY STAR Award for Buildings
  – Given jointly by US EPA and US DoE
  – ENERGY STAR Awarded to Top 25% Energy Performers by Building Class Each Year (Portfolio Manager Score of 75 or above for 12-month period)

• ENERGY STAR CHP Awards
  – Given by US EPA CHP Partnership to buildings with qualifying CHP Systems (after 5,000 hours ops)
  – Program Distinct from ENERGY STAR for Buildings
  – Separate Application, Does Not Involve Portfolio Manager Score

Building Sustainable Power…
CHP can dramatically improve a building’s ENERGY STAR rating, making the building eligible for ENERGY STAR awards (75 points) as well as LEED certification. The chart to the right shows how a typical building could benefit from cogeneration.

<table>
<thead>
<tr>
<th>ENERGY STAR Rating</th>
<th>Additional LEED O&amp;M Points</th>
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<tbody>
<tr>
<td>69 (pre-req)</td>
<td>N/A</td>
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<tr>
<td>71</td>
<td>1</td>
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<tr>
<td>73</td>
<td>2</td>
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<td>95</td>
<td>18</td>
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</table>

The example building’s current ENERGY STAR rating is 80 (yellow). The proposed CHP system could enhance that score by 7-9 points, ensuring that the building remains over the 75 points (orange) required for the annual ENERGY STAR Award for Buildings. In addition, an ENERGY STAR score of 87 points, for example, translates to 14 additional LEED O&M points (green) under the US Green Building Council’s most recent LEED for Existing Buildings (LEED-EB) guidelines. This could make the difference between basic certification and silver or gold LEED classification.
Project Case Study: One Market Plaza, San Francisco

1.5 Million square foot office tower located in the heart of San Francisco

Building Sustainable Power…
One Market
System Description

• 1.5 MW System Utilizing 3 500kW Wakeshaw reciprocating natural gas engines.
• Heat recovery via 3 heat recovery steam generators (HRSG)
• First ever CHP system to parallel and interconnect with Pacific Gas and Electric (PG&E) San Francisco network grid
• Provides approximately 30% of the building’s electric needs and 85% of the building’s steam needs (100% during most months of the year)

• Engines installed in former backup generator room, heat recovery equipment installed one level up.

Building Sustainable Power…
© 2010 Endurant Energy LLC
Building Sustainable Power…

One Market System Operations

- System was designed to offset building’s peak power demands
- Two engines dispatched 8AM-8PM, Monday through Friday, third engine dispatched 24 hours Monday through Friday—this is due to the need to coordinate building electric and thermal demand with CHP system output

*Building total load is ~7MW, CHP system only connects to 3 of 9 services*
One Market

Why CHP at One Market?

• Previous Owner (Equity Office Property-EOP) was pursuing an aggressive energy program which included development of onsite generation

• Driven by high cost of power in San Francisco and California credits for self-generation (covered approximately 30% of project cost)

• Natural gas prices at the time were moderate and enhanced project returns (“spark spread”)

• Building utilized low-pressure steam for heating which could easily be produced through CHP by HRSG

• Space was available for installation of system

• Local utility—PG&E—worked with EOP on establishing first network grid paralleling interconnection
One Market
CHP Implementation Challenges

• First Local Network Grid Interconnection-No “road map” or interconnection standards to go by

• Due to available space for plant, combustion air and exhaust were difficult to provide (had to be routed up to 7th floor of building)

• Rigging large equipment into lower levels of building proved challenging
One Market
Other Challenges

• Building ownership has changed multiple times—new ownership requires learning curve on system needs and benefits

• Coordination of system dispatch with fluctuating building electric and thermal load requires continuous monitoring

• Uncertainty in California market complicates spark spread calculations
Questions?
Combined Heat and Power in Commercial Office Buildings
Questions & Discussion

• Use # 6 to un-mute phone

• * 6 to mute phone.
Upcoming Web Conferences

March – Leveraging Geothermal
April – Constant Commissioning
May – Award Winning Energy Programs
June – Driving Responsibility for Energy Use
July – How to Launch an Energy Competition

Register online at:
energystar.webex.com/meetings
Announcements:

• March 3 – ENERGY STAR Communications Web Conference:

“Celebrate Earth Day with ENERGY STAR”

Sign-up at energystar.webex.com on the training calendar.

Bring your communications people!
• Thank you