CHP in the Hospitality Industry

Gavin Dillingham, PhD, - Director SC CHP TAP
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Thanks to our Partners

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CHP Technical Assistance Partnerships
UPPER-WEST
DOE CHP Technical Assistance Partnerships (CHP TAPs)

- **End User Engagement**
  Partner with strategic End Users to advance technical solutions using CHP as a cost effective and resilient way to ensure American competitiveness, utilize local fuels and enhance energy security. CHP TAPs offer fact-based, non-biased engineering support to manufacturing, commercial, institutional and federal facilities and campuses.

- **Stakeholder Engagement**
  Engage with strategic Stakeholders, including regulators, utilities, and policy makers, to identify and reduce the barriers to using CHP to advance regional efficiency, promote energy independence and enhance the nation’s resilient grid. CHP TAPs provide fact-based, non-biased education to advance sound CHP programs and policies.

- **Technical Services**
  As leading experts in CHP (as well as microgrids, heat to power, and district energy) the CHPTAPs work with sites to screen for CHP opportunities as well as provide advanced services to maximize the economic impact and reduce the risk of CHP from initial CHP screening to installation.

www.energy.gov/chp
Agenda

- CHP Overview
- The State of CHP
- CHP Opportunities for the Hospitality Industry
- CHP Project Snapshots
- Working with the CHP TAP to Assess Project Opportunity
CHP Overview
CHP Recaptures Heat of Generation, Increasing Energy Efficiency, and Reducing GHGs

- **Power Plant**: 32% efficiency (Including T&D)  
  - **Fuel Input**: 94 units  
  - **Electricity Output**: 30 units

- **Onsite Boiler**: 80% efficiency  
  - **Fuel Input**: 56 units  
  - **Heat Output**: 45 units

- **CHP**: 75% efficiency  
  - **Fuel Input**: 100 units  
  - **Heat Output**: 45 units

**Total Efficiency**
- **~ 50%** (94 units of fuel, 30 units of electricity, 56 units of fuel, 45 units of heat)
- **~ 75%** (100 units of fuel, 45 units of heat)

**30 to 55% less greenhouse gas emissions**
CHP System Schematic

Prime Mover
Reciprocating Engines
Combustion Turbines
Microturbines
Steam Turbines
Fuel Cells
ORC turbine

Generator

Electricity
On-Site Consumption
Sold to Utility

Thermal
Steam
Hot Water
Space Heating
Process Heating
Space Cooling
Process Cooling
Refrigeration
Dehumidification

Fuel
Natural Gas
Propane
Biogas
Landfill Gas
Coal
Steam
Waste Products
Others

Heat Exchanger
What Are the Benefits of CHP?

- **CHP is more efficient** than separate generation of electricity and heating/cooling.

- Higher efficiency translates to **lower operating costs** (but requires capital investment).

- Higher efficiency **reduces emissions** of pollutants.

- CHP can also increase **energy reliability** and enhance power quality.

- On-site electric generation can **reduce grid congestion** and avoid distribution costs.
Emerging National Drivers for CHP

- Benefits of CHP recognized by policymakers
  - State Portfolio Standards (RPS, EEPS), Tax Incentives, Grants, standby rates, etc.
- Favorable outlook for natural gas supply and price in North America
- Opportunities created by environmental drivers
- Utilities finding economic value
- Energy resiliency and critical infrastructure

DOE / EPA CHP Report (8/2012)

Critical Infrastructure and Resiliency Benefits of CHP

“Critical infrastructure” refers to those assets, systems, and networks that, if incapacitated, would have a substantial negative impact on national security, national economic security, or national public health and safety.”
Patriot Act of 2001 Section 1016 (e)

Applications:
- Hospitals and healthcare centers
- Water / wastewater treatment plants
- Police, fire, and public safety
- Centers of refuge (often schools or universities)
- Military/National Security
- Food distribution facilities
- Telecom and data centers

CHP (if properly configured):
- Offers the opportunity to improve Critical Infrastructure (CI) resiliency
- Can continue to operate, providing uninterrupted supply of electricity and heating/cooling to the host facility
The State of CHP
Total CHP by Application

By Capacity - 82.6 GW
- Refining: 16,305 MW
- Food Processing: 5,777 MW
- Primary Metals: 3,837 MW
- Pulp and Paper: 11,246 MW
- Other Industrial: 6,676 MW
- Colleges/Universities: 2,654 MW
- Other/Unknown: 167 MW
- Chemicals: 24,028 MW
- Other Comm./Inst. 9,148 MW

By Site - 4,395 Sites
- Multi-Family Buildings: 333 Sites
- Other Industrial: 1,017 Sites
- Other Comm./Inst.: 1,300 Sites
- Food Processing: 244 Sites
- Hospitals/Healthcare: 220 Sites
- Treatment Plants: 220 Sites
- Schools: 254 Sites
- Colleges/Universities: 272 Sites
- Chemicals: 267 Sites
- Other/Unknown: 268 Sites

Source: DOE CHP Installation Database (U.S. installations as of December 31, 2016)
**CHP Additions by Application (2013-2016)**

- **By Capacity - 3 GW**
  - Utilities: 334 MW
  - Food Processing: 330 MW
  - Chemicals: 498 MW
  - Refining: 446 MW
  - Pulp and Paper: 498 MW
  - Other/Unknown: 22 MW
  - Other Comm./Inst.: 426 MW
  - Wood Products: 109 MW
  - Other Industrial: 123 MW

- **By Site - 696 Sites**
  - Food Processing: 31 Sites
  - Agriculture: 37 Sites
  - Other Industrial: 80 Sites
  - Colleges/University: 48 Sites
  - Hospitals/Healthcare: 45 Sites
  - Multi-Family Buildings: 131 Sites
  - Hotels: 32 Sites
  - Wastewater Treatment: 53 Sites
  - Other/Unknown: 16 Sites
  - Other Comm./Inst.: 223 Sites

*Source: DOE CHP Installation Database (U.S. installations as of December 31, 2016)*

*This includes 91 expansions to existing CHP systems*
Total CHP Installations per Year

Source: DOE CHP Installation Database (U.S. installations as of Dec. 31, 2016)
Average Size of CHP Installations per Year

Source: DOE CHP Installation Database (U.S. installations as of Dec. 31, 2016)
# Upper-West CHP TAP Region

## Onsite Technical Potential

<table>
<thead>
<tr>
<th>State</th>
<th>Industrial (MW)</th>
<th>Commercial (MW)</th>
<th>Total (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colorado</td>
<td>642</td>
<td>1,077</td>
<td>1,719</td>
</tr>
<tr>
<td>Montana</td>
<td>198</td>
<td>179</td>
<td>377</td>
</tr>
<tr>
<td>North Dakota</td>
<td>228</td>
<td>218</td>
<td>446</td>
</tr>
<tr>
<td>South Dakota</td>
<td>153</td>
<td>225</td>
<td>378</td>
</tr>
<tr>
<td>Utah</td>
<td>501</td>
<td>618</td>
<td>1,119</td>
</tr>
<tr>
<td>Wyoming</td>
<td>733</td>
<td>115</td>
<td>848</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,455</strong></td>
<td><strong>2,432</strong></td>
<td><strong>4,887</strong></td>
</tr>
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</table>

CHP Opportunities for the Hospitality Industry
Total Site Potential for CHP in Hotels for Upper West

788 sites in Upper West with 179 MW potential

CHP Technical Potential in Hospitals

- Wyoming
- Utah
- South Dakota
- North Dakota
- Montana
- Colorado

Number of Potential CHP Sites

Source: DOE CHP Technical Potential Study, 2016
Generating Capacity Potential for CHP in Hotels for Upper West

788 sites in Upper West with 179 MW potential

Source: DOE CHP Technical Potential Study, 2016
Hotels are Ideal Candidates for CHP

- **Practical**
  - Hotels with installed CHP systems experience reduced operating costs and higher reliability of continued service

- **Proven**
  - 139 hotels and resorts nationwide currently operate CHP systems

- **Economical**
  - Efficient CHP systems can lead to attractive investments with electric and thermal energy savings, especially in areas with high electric rates and lower natural gas costs

- **Reliable/Resilient**
  - In contrast to emergency generators that may not able to operate as expected over the full duration of an outage, hotels with CHP are able to maintain both power and heat during storms and other climate events, providing a “dynamic asset” with an economic return running every day

- **Clean**
  - High efficiency, low emissions CHP systems have been recognized as the centerpiece of sustainability strategies at hotels and resorts.
  - A hotel can reduce its greenhouse gas emissions with a single investment in high efficiency CHP
CHP is PRACTICAL for Hotels/Resorts

- 24/7 operations
- Significant and coincidental needs for electric power, heating, and cooling
- To ensure guest comfort and safety there is a significant requirement for high power quality and reliability of continued service
- Hotels with installed CHP systems experience reduced operating costs
CHP Project Snapshots
Project Snapshot: Hotel and Hospitality

Snowbird Ski and Summer Resort
Snowbird, Utah

Application/Industry: Hotels/Resorts
Capacity: 2 MW
Prime Mover: Reciprocating Engine
Fuel Type: Natural gas
Thermal Use: Steam for heating rooms, pools, restaurants, meeting spaces; snow melting on walkways; A/C in summer
Installation Year: 1987

Highlights: As the ski resort grew, the utility’s 25k-volt power line running up the canyon to the resort became inadequately small. Faced with otherwise paying the cost of the line upgrade, Snowbird decided that on-site power and a new gas line was an attractive alternative

“Cogen is a good way to go for a large facility with a heat load like ours. We’ve hardly ever been without power. If you want high reliability, especially in outlying areas, cogen can be a good alternative or supplement to the utility.” — Jerry Giles Director of Village Operations
Project Snapshot: Sustainability

MGM International (CityCenter)
Las Vegas, NV

Application/Industry: Hotels/Casinos
Capacity: 8 MW
Prime Mover: Gas turbine
Fuel Type: Natural gas
Thermal Use: Domestic hot water
Installation Year: 2009

Highlights: MGM Resorts developed the CityCenter project with an eye on sustainability and functional design. Resort operations require consistent and reliable access to electricity and hot water for guest services and hotel security functions so CHP was an integral component to the campus’ development. The installed CHP plant provides more than 25 percent of the annual electricity used at the CityCenter campus and gives MGM Resorts a measure of resiliency from the local electricity grid not available at other resorts. In the event of a grid failure, CityCenter has the ability to maintain operations of critical functions.

In 2009, CityCenter was awarded six Gold LEED certifications from the U.S. Green Building Council, in part due to its superior energy performance.


Slide prepared 6/2017
**Project Snapshot:**

**Hospitality/Hotels**

*The Westin Princeville Ocean Resort Villas*

Kauai, Hawaii

**Application/Industry:** Hospitality/Hotels

**Capacity:** 1 MW

**Prime Mover:** 5 x 200 kW microturbines

**Fuel Type:** Propane

**Thermal Use:** Absorption cooling and pool heating

**Testimonial:** “We recognize that the vitality of the resort is directly linked to the vitality of the community where it operates...In addition to doing the right thing for the environment, Westin Princeville Ocean Resort Villas is proud of the economic benefits that our project provided to Kaua‘i’s local contractors and vendors.”

– Denise Wardlow, General Manager, Westin Princeville Ocean Resort Villas

Source: [The Westin Princeville Ocean Resort and Villas](#)

Source: [Hawaii Business Magazine issued April 2015 “More Efficient Power”](#) By Chris Oliver

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**CHP Technical Assistance Partnerships**

*UPPER-WEST*

Slide prepared 6/2017
Working with the CHP TAP to Assess Project Opportunity
CHP TAP Technical Assistance

US DOE CHP TAP Services:
- Quick screening questions with spreadsheet payback calculator.
- Uses available site information. Estimate: savings, installation costs, simple paybacks, equipment sizing and type.
- Review specifications and bids. Limited operational analysis.
DOE TAP CHP Screening Analysis

- High level assessment to determine if site shows potential for a CHP project
  - Qualitative Analysis
    - Energy Consumption & Costs
    - Estimated Energy Savings & Payback
    - CHP System Sizing
  - Quantitative Analysis
    - Understanding project drivers
    - Understanding site peculiarities

### Annual Energy Consumption

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<th>Base Case</th>
<th>CHP Case</th>
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<tbody>
<tr>
<td>Purchased Electricity, kWh</td>
<td>88,250,160</td>
<td>5,534,150</td>
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<tr>
<td>Generated Electricity, kWh</td>
<td>0</td>
<td>82,716,010</td>
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<tr>
<td>On-site Thermal, MMBtu</td>
<td>426,000</td>
<td>18,872</td>
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<tr>
<td>CHP Thermal, MMBtu</td>
<td>0</td>
<td>407,128</td>
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<tr>
<td>Boiler Fuel, MMBtu</td>
<td>532,500</td>
<td>23,590</td>
</tr>
<tr>
<td>CHP Fuel, MMBtu</td>
<td>0</td>
<td>969,845</td>
</tr>
<tr>
<td>Total Fuel, MMBtu</td>
<td>532,500</td>
<td>993,435</td>
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### Annual Operating Costs

<table>
<thead>
<tr>
<th></th>
<th>Base Case</th>
<th>CHP Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchased Electricity, $</td>
<td>$7,060,013</td>
<td>$1,104,460</td>
</tr>
<tr>
<td>Standby Power, $</td>
<td>$0</td>
<td>$0</td>
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<tr>
<td>On-site Thermal Fuel, $</td>
<td>$3,195,000</td>
<td>$141,539</td>
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<tr>
<td>CHP Fuel, $</td>
<td>$0</td>
<td>$5,819,071</td>
</tr>
<tr>
<td>Incremental O&amp;M, $</td>
<td>$0</td>
<td>$744,444</td>
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<tr>
<td>Total Operating Costs, $</td>
<td>$10,255,013</td>
<td>$7,809,514</td>
</tr>
</tbody>
</table>

### Simple Payback

- Annual Operating Savings, $ $2,445,499
- Total Installed Costs, $/kW $1,400
- Total Installed Costs, $/k $12,990,000
- Simple Payback, Years 5.3

### Operating Costs to Generate

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel Costs, $/kWh</td>
<td>$0.070</td>
</tr>
<tr>
<td>Thermal Credit, $/kWh</td>
<td>($0.037)</td>
</tr>
<tr>
<td>Incremental O&amp;M, $/kWh</td>
<td>$0.009</td>
</tr>
<tr>
<td>Total Operating Costs to Generate, $/kWh</td>
<td>$0.042</td>
</tr>
</tbody>
</table>
Screening Questions

- Do you pay more than $.06/kWh on average for electricity (including generation, transmission and distribution)?
- Are you concerned about the impact of current or future energy costs on your operations?
- Are you concerned about power reliability? What if the power goes out for 5 minutes... for 1 hour?
- Does your facility operate for more than 3,000 hours per year?
- Do you have thermal loads throughout the year? (including steam, hot water, chilled water, hot air, etc.)
Screening Questions (cont.)

- Does your facility have an existing central plant?
- Do you expect to replace, upgrade, or retrofit central plant equipment within the next 3-5 years?
- Do you anticipate a facility expansion or new construction project within the next 3-5 years?
- Have you already implemented energy efficiency measures and still have high energy costs?
- Are you interested in reducing your facility's impact on the environment?
- Do you have access to on-site or nearby biomass resources? (i.e., landfill gas, farm manure, food processing waste, etc.)
CHP Project Resources

DOE CHP Technologies Fact Sheet Series

Good Primer Report

www.energy.gov/chp-technologies

www.eere.energy.gov/chp
CHP Project Resources

DOE Project Profile Database

EPA dCHPP (CHP Policies and Incentives Database)

energy.gov/chp-projects

https://www.epa.gov/chp/dchpp-chp-policies-and-incentives-database

CHP Technical Assistance Partnerships
UPPER-WEST
CHP Project Resources

DOE CHP Installation Database
(List of all known CHP systems in U.S.)

Low-Cost CHP Screening and Other Technical Assistance from the CHP TAP

energy.gov/chp-installs
energy.gov/CHPTAP
Next Steps

Resources are available to assist in developing CHP Projects.

Contact the DOE CHP TAPs to:

- Perform a no-cost CHP Qualification Screening for a particular hotel
- Identify existing CHP in hotels/resorts for new Project Profiles
- Need an unbiased 3rd Party Review of a CHP proposal
Summary

- CHP works in hotels very well
- CHP gets the most out of a fuel source, enabling
  - High overall utilization efficiencies
  - Reduced environmental footprint
  - Reduced operating costs
- CHP can be used in different strategies, including critical infrastructure resiliency and emergency planning
- **Proven technologies** are commercially available and cover a full range of sizes and applications
Thank You!

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