Combined Heat and Power (CHP) in Breweries - Better Beer at Lower Costs

Gavin Dillingham, PhD, - Director SW CHP TAP  
Dalia El Tawy - Siemens Energy - Sr. Marketing Manager

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CHP Technical Assistance Partnerships

- **Education and Outreach**
  Providing information on the energy and non-energy benefits and applications of CHP to state and local policy makers, regulators, end users, trade associations, and others.

- **Technical Assistance**
  Providing technical assistance to end-users and stakeholders to help them consider CHP, waste heat to power, and/or district energy with CHP in their facility and to help them through the development process from initial CHP screening to installation.

- **Market Opportunity Analysis**
  Supporting analyses of CHP market opportunities in diverse markets including industrial, federal, institutional, and commercial sectors.
Outline

- What is CHP? - US DOE SW CHP TAP
- CHP in Breweries – US DOE SW CHP TAP
- Specific CHP and Brewery Projects - Siemens Energy
- CHP Project Resources – US DOE Southwest CHP TAP
- Q&A
What is CHP?
CHP: A Key Part of Our Energy Future

- Form of Distributed Generation (DG)
- An integrated system
- Located at or near a building / facility
- Provides at least a portion of the electrical load and
- Uses thermal energy for:
  - Space Heating / Cooling
  - Process Heating / Cooling
  - Dehumidification

CHP provides efficient, clean, reliable, affordable energy – today and for the future.

Source: www.energy.gov/chp
CHP System Schematic

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

Prime Mover
- Reciprocating Engines
- Combustion Turbines
- Microturbines
- Steam Turbines
- Fuel Cells

Generator

Heat Exchanger

Electricity
- On-Site Consumption
- Sold to Utility

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

U.S. Department of Energy
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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
CHP Today in the United States

Existing CHP Capacity (MW)

- **Commercial/Institutional**: 13.8%
- **Oil/Gas Extraction**: 3.4%
- **Other Industrial**: 8.4%
- **Primary Metals**: 4.9%
- **Food Processing**: 7.3%
- **Pulp and Paper**: 13.8%
- **Chemicals**: 28.4%
- **Other/Unknown**: 0.3%
- **Refining**: 19.8%

- **81 GW** of installed CHP at over 4,300 industrial and commercial facilities
- **8%** of U.S. Electric Generating Capacity; **14%** of Manufacturing
- Avoids more than **1.8 quadrillion Btus** of fuel consumption annually
- Avoids **241 million metric tons of CO₂** compared to separate production

Source: U.S DOE CHP Installation Database (U.S. installation as of Dec. 31, 2015)
CHP is used nationwide in several types of buildings/facilities.

- 81 GW installed at >4,300 sites
- Saves 1.8 quads of fuel each year
- Avoids 241 M metric tons of CO₂ each year

Source: U.S. DOE CHP Installation Database (U.S. installations as of Dec. 31, 2015)
Finding the Best Candidates: Some or All of These Characteristics

- High and constant thermal load
- Favorable spark spread
- Need for high reliability
- Concern over future electricity prices
- Interest in reducing environmental impact
- Existing central plant
- Planned facility expansion or new construction; or equipment replacement within the next 3-5 years
CHP in Breweries
# Brewery Installations in the US

<table>
<thead>
<tr>
<th>State</th>
<th>City</th>
<th>Facility</th>
<th>Year Installed</th>
<th>Size (kW)</th>
<th>Engine</th>
<th>Fuel</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA</td>
<td>Santee</td>
<td>Twisted Manzanita Brewery</td>
<td>2015</td>
<td>30</td>
<td>Reciprocating Engine</td>
<td>NG - Natural Gas</td>
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<tr>
<td>PA</td>
<td>Pottsville</td>
<td>Yuengling Brewery</td>
<td>2014</td>
<td>400</td>
<td>Reciprocating Engine</td>
<td>BIOMASS - Digester Gas</td>
</tr>
<tr>
<td>NC</td>
<td>Mills River</td>
<td>Sierra Nevada Brewing Mills River Brewery</td>
<td>2014</td>
<td>400</td>
<td>Microturbine</td>
<td>BIOMASS - Digester Gas</td>
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<tr>
<td>MA</td>
<td>Boston</td>
<td>Mass Bay (Harpoon) Brewery</td>
<td>2013</td>
<td>250</td>
<td>Reciprocating Engine</td>
<td>NG - Natural Gas</td>
</tr>
<tr>
<td>NY</td>
<td>Utica</td>
<td>Matt Brewing Company (Saranac Brewing)</td>
<td>2013</td>
<td>400</td>
<td>Reciprocating Engine</td>
<td>BIOMASS - Digester Gas</td>
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<tr>
<td>NJ</td>
<td>Newark</td>
<td>Brewery Cogeneration Plant</td>
<td>2012</td>
<td>7,650</td>
<td>Combined Cycle</td>
<td>NG - Natural Gas</td>
</tr>
<tr>
<td>HI</td>
<td>Lahaina</td>
<td>Maui Brewing Company</td>
<td>2012</td>
<td>60</td>
<td>Reciprocating Engine</td>
<td>zOTR - Other</td>
</tr>
<tr>
<td>CA</td>
<td>Chico</td>
<td>Sierra Nevada Brewing Co.</td>
<td>2005</td>
<td>2,000</td>
<td>Fuel Cell</td>
<td>NG - Natural Gas</td>
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<tr>
<td>CO</td>
<td>Fort Collins</td>
<td>New Belgium Brewing Company</td>
<td>2003</td>
<td>760</td>
<td>Reciprocating Engine</td>
<td>BIOMASS - Digester Gas</td>
</tr>
<tr>
<td>CA</td>
<td>Irwindale</td>
<td>Miller Brewing - Irwindale</td>
<td>2000</td>
<td>12,500</td>
<td>Combustion Turbine</td>
<td>NG - Natural Gas</td>
</tr>
<tr>
<td>FL</td>
<td>Jacksonville</td>
<td>Anheuser-Busch Brewery</td>
<td>1987</td>
<td>8,600</td>
<td>Combustion Turbine</td>
<td>NG - Natural Gas</td>
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<tr>
<td>GA</td>
<td>Albany</td>
<td>Miller Brewing Co</td>
<td>1978</td>
<td>5,500</td>
<td>Boiler/Steam Turbine</td>
<td>COAL - Coal</td>
</tr>
<tr>
<td>NC</td>
<td>Eden</td>
<td>Miller Brewing Company</td>
<td>1978</td>
<td>7,200</td>
<td>Boiler/Steam Turbine</td>
<td>BIOMASS - Biomass</td>
</tr>
<tr>
<td>CO</td>
<td>Golden</td>
<td>MillerCoors Company Brewery</td>
<td>1976</td>
<td>20,000</td>
<td>Boiler/Steam Turbine</td>
<td>COAL - Coal</td>
</tr>
</tbody>
</table>

December 2015 - https://doe.icfwebservices.com/chpdb/
Brewery Energy Use

- Breweries use particularly large amounts of energy because many steps in the brewing process involve heating or cooling,
  - Kiln-drying and roasting the malt;
  - Heating the mash;
  - Boiling hops;
  - Rapid cooling, and refrigeration or cold storage.
Brewery Energy Use

A. Electricity
- Lighting: 6%
- Boiler house: 5%
- Brewhouse: 7%
- Compressed air: 10%
- Other: 12%
- Refrigeration: 35%
- Packaging: 25%

B. Natural gas
- Space heating: 10%
- Utilities: 20%
- Brewhouse: 45%
- Packaging: 25%

Source: https://www.epa.gov/rhc/rhc-breweries#Footnotes
Why CHP at Breweries?
Production Greater than 5,000 barrels per year?

- Reduce operating costs
- High electricity loads and thermal loads for heating and cooling
- Large number of low temperature thermal processes
- Constant heat and/or cooling demand
- Waste organic material - Biogas Production to offset natural gas use for thermal process
- Utility load shedding
- Improve Power Reliability
- Availability of incentives
- Sustainability planning
- Reduce Carbon Emissions
New Belgium Brewery
Fort Collins, CO

**Application/Industry:** Brewery

**Facility Average Load:** 800 kW

**CHP Capacity:** 290 kW

**Prime Mover:** Reciprocating Engine

**Fuel Type:** Biogas from digester/autolyzed yeast

**Thermal Use:** Heat for the Digestion Process

**Project Costs:** $13 million (water treatment plant and capacity upgrade included)

**Monthly Energy Savings:** $6,300

**Installation Year:** 2014

**Testimonial:** “Creating energy from our process water treatment plant is great because the fuel is created by a waste product. If you have the ability to use a free fuel source, it makes sense to take advantage of it.” - Jenn Orgolini, Sustainability Director, New Belgium Brewing Company
Project Snapshot:

MillerCoors
Golden, CO

Application/Industry: Brewery
Facility Peak Load: 47 MW
CHP Capacity: 20 MW
Prime Mover: Steam Turbines
Fuel Type: Coal and Natural Gas
Thermal Use: Process steam for heating and for refrigeration
Project Costs: $13 million (water treatment plant and capacity upgrade included)
Environmental Benefits: Reduction of CO2 by 250,000 tons/year
Installation Year: 1930

Testimonial: “We have the most efficient energy producing system in the brewery network because of cogeneration.” — Julie Smith Miller Coors Energy Manager

The MillerCoors Brewery in Golden, Colorado, the largest single-site brewery in the world, has used CHP since the 1930s for cost savings and cost management.
Project Snapshot:

Sierra Nevada Brewing Company
Chico, CA

Application/Industry: Brewery
Capacity (MW): 2 MW
Prime Mover: Microturbines
Fuel Type: Biomass / Natural Gas
Thermal Use: Steam for brewing process and other facility heating
Installation Year: 2016

Overview: The 2 MW microturbine system was installed to replace a 1 MW fuel cell CHP system originally installed in 2005. After the brewery’s electric needs are met, the remainder of the power is exported back to the grid.

Project Snapshot:

Yuengling Brewery
Pottsville, PA

Application/Industry: Brewery

CHP Capacity: 400 kW; CHP covers 20% of total electricity needs

Prime Mover: Reciprocating Engine

Fuel Type: Digester gas and natural gas

Thermal Use: Pasteurization

Installation Year: 2014

Testimonial: "It's called combined heat and power because we generate power but also generate waste heat and that waste heat is going to be used to heat our pasteurization process. We'll use less steam to heat our tunnel pasteurizer because we're preheating the water with the heat from the CHP system...It's definitely ahead of the curve on technology, and a huge jump forward," Robert Seaman Jr., Yuengling Plant Manager
Specific CHP and Brewery Projects

Siemens Energy
Dalia El Tawy
Sr. Marketing Manager
A Comprehensive Portfolio of Advanced Technologies for CHP Applications

Guascor Reciprocating Engines

Aeroderivative Gas Turbines

Industrial Gas Turbines

Small Steam Turbines

DR Guascor Rich Burn 280kW / 870kW
DR Guascor Lean Burn 250kW / 1300kW
DR Guascor CHP Systems 250kW / 1300kW
DR KG2 2MW
Industrial 501 4, 5, 6MW
SGT-100 5MW
SGT-200 7MW
SGT-300 8MW
SGT-400 13/15MW
SGT-500 17MW
SGT-600 25MW
Industrial RB211 27/30/32MW
SGT-700 31MW
SGT-750 37MW
SGT-900 47/50/53MW
Industrial Trent 60 54/62/63/66MW
SST-100 8.5MW
SST-150 20MW
SST-200 10MW
SST-300 50MW
SST-400 65MW
SST-500 100MW
SST-600 150MW
SST-700 175MW
SST-800 150MW
SST-900 250MW

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CHP Projects: Key Selection Criteria

- Meeting thermal and power load requirements
- Reducing energy costs
- Availability and reliability
- Lower emissions
- Fuel flexibility
- Enhanced control
- Financing solutions
- Life-cycle support
CHP Projects in Breweries and Distilleries

- **Location:** Scotland, UK
- **Application:** Distillery producing whiskey
- **Challenge:** high and rapidly increasing energy cost
  - process steam supplied by large boilers burning HFO
  - electrical power purchased from local electrical power utility
- **Solution:** CHP plant using SGT-100 gas turbine prime mover
  - 5.25 MW power supply
  - 22,000 lbs/hour of process steam
  - ROI: 4 years since installation due to savings in operating and fuel cost
CHP Projects in Breweries and Distilleries

- CHP plant at a brewery in London, Canada
  Industrial 501-KB7 Aeroderivative Gas Turbine
  4.0 – 6.6 MW(e)

- CHP plants installed in breweries in Brazil
  SGT-100 Industrial Gas Turbine
  5.1 - 5.4 MW (e)
CHP Projects in Breweries and Distilleries

New Belgium Brewing Company
760-kW Biogas CHP System

Quick Facts
LOCATION: Fort Collins, Colorado
MARKET SECTOR: Breweries
FACILITY SIZE: 200,000 sq feet, 570 employees
FACILITY PEAK LOAD: 1,400 kilowatts (kW)
TOTAL PROJECT COST: $12 million (including the original process water treatment plant and capacity upgrade)
ANNUAL ELECTRICITY COST SAVINGS: $100,000-$130,000
EQUIPMENT: 254 kW and 500 kW Guascor engines with heat recovery from Continental Energy Systems
FUEL: Biogas from onsite treatment of brewing process wastewater
CHP IN OPERATION SINCE: 2003

New Belgium Brewery’s two dozen craft beers are brewed with the support of a CHP system fueled by organic waste from the brewing process—saving costs and improving sustainability.

Dresser-Rand
Reciprocating Gas Engines

D.R Guascor
Rich Burn
Engine Only

D.R Guascor
Lean Burn
Genset

D.R Guascor
Packaged
CHP Systems

High efficiency and Fast Load Acceptance

Guascor® Engines & Gensets

A Siemens Business

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Portfolio of Services and Options for CHP Applications

Financing Options
Siemens has a strong suite of financing options including:
- Zero capital solutions with power purchase agreements (PPA)
- Guaranteed performance-based solutions using funds saved from reduced energy use
- Asset ownership financing
- Bonds for public sector
- Options tailored to your needs

Distributed Energy Systems
- Cogeneration / Combined Heat & Power
- Small Power
- Microgrids
- Energy Storage

Life Cycle Support
Long Term Programs (LTPs)
How to Implement a CHP Project with the Help of the CHP TAP
CHP TAP Technical Assistance

US DOE
CHP TAP Services:
- Screening and Preliminary Analysis: Quick screening questions with spreadsheet payback calculator.
- Investment Grade Analysis: 3rd Party review of Engineering Analysis. Review equipment sizing and selection.
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

<table>
<thead>
<tr>
<th></th>
<th>Base Case</th>
<th>CHP Case</th>
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<tbody>
<tr>
<td>Purchase Electricity</td>
<td>88,250,160</td>
<td>5,534,150</td>
</tr>
<tr>
<td>Generated Electricity</td>
<td>426,000</td>
<td>0</td>
</tr>
<tr>
<td>On-site Thermal</td>
<td>0</td>
<td>18,872</td>
</tr>
<tr>
<td>CHP Thermal</td>
<td>0</td>
<td>407,128</td>
</tr>
<tr>
<td>Boiler Fuel</td>
<td>532,500</td>
<td>23,500</td>
</tr>
<tr>
<td>CHP Fuel</td>
<td>0</td>
<td>969,845</td>
</tr>
<tr>
<td>Total Fuel</td>
<td>532,500</td>
<td>993,435</td>
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</table>

### Annual Operating Costs

<table>
<thead>
<tr>
<th></th>
<th>Base Case</th>
<th>CHP Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase 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>
</tr>
<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>
</tr>
<tr>
<td>Total Operating Costs</td>
<td>$10,255,013</td>
<td>$7,809,514</td>
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### Simple Payback

<p>| | |</p>
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<tr>
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<tbody>
<tr>
<td>Annual Operating Savings</td>
<td>$2,445,499</td>
</tr>
<tr>
<td>Total Installed Costs</td>
<td>$1,400,000</td>
</tr>
<tr>
<td>Simple Payback, Years</td>
<td>5.3</td>
</tr>
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</table>

### Operating Costs to Generate

<p>| | |</p>
<table>
<thead>
<tr>
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</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>
A Feasibility Analysis Typically Involves:

- Electrical load profiling
- Thermal load profiling
- Unit sizing
- Thermal use determination (what to do with the heat)
- Installation cost estimations
- Financial calculations (simple payback, ROI, etc.)
- Cost/savings information compared to what your facility would pay if the CHP system were not installed
CHP Project Resources

**DOE Project Profile Database**
(150+ case studies)

[Image of Doe Project Profile Database]

**DOE Database of Incentives & Policies (DSIRE)**

[Image of DSIRE]

energy.gov/chp-projects

www.dsireusa.org
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/chp-contacts
Next Steps

Resources are available to assist in developing CHP Projects.

Contact the Southwest CHP TAP to:

- Perform CHP Qualification Screening for a particular facility
- Identify existing CHP sites for Project Profiles
- Additional Technical Assistance
Summary

- CHP is a proven technology in breweries providing energy savings, reduced emissions, and opportunities for resiliency
- Emerging drivers are creating new opportunities to evaluate CHP and numerous example exist to learn more how other breweries have incorporated CHP
- Engage with the US DOE Southwest CHP TAP to learn more about the technical assistance offerings in evaluating CHP in your brewery
Thank You!

Gavin Dillingham, PhD, Director
HARC
gdillingham@harcresearch.org
281-216-7147