Packaged CHP Systems

June 28, 2018
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- If you have a question during the presentation, please type it into the questions box on the upper right-hand side of your screen. We will have a dedicated time to answer questions at the end of the presentation.
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EPA’s CHP Partnership

Voluntary Program

- Seeks to reduce the environmental impact of power generation by promoting the use of highly efficient CHP

More than 400 Partners

- CHP project developers, energy engineers and consultants
- Equipment manufacturers
- Energy-using facilities
- Energy services companies
- Energy policy advocates
- Federal, state, and local government agencies

Services & Tools

- Assists with CHP project development, overcomes regulatory barriers, and transforms markets.
- Provides public recognition for CHP projects
CHP Catalog of Technologies: Packaged CHP Systems

Available at:

https://www.epa.gov/chp/catalog-chp-technologies
Packaged CHP Case Study: Interfaith Medical Center

Interfaith Medical Center

EPA CHP PARTNERSHIP WEBINAR
BENJAMIN LOCKE, CEO
JUNE 28, 2018
WHAT IS CHP?

**CHP Definition**: (aka/Combined Heat & power, CHP)

*The simultaneous production of two useful outputs from a single fuel source*

A prime mover (in many cases an internal combustion engine) turns a shaft to produce shaft work, and heat is recovered from the prime mover and purposefully reused.

- **Electrical CHP** ("cogeneration")
  Shaft work turns a generator to create electricity, heat is recovered from prime mover

- **Mechanical CHP**
  Shaft work turns a device such as a refrigeration compressor to drive a heat pump cycle, heat is recovered from prime mover
CHP – WHY NOW?

- Stunning turnaround in natural gas price & availability
  - Low prices likely to persist for many years
- Electric tariffs likely to remain high and generally increasing
  - High demand charges and Time Of Use (TOU) rates
- Long-term pressure for infrastructure upgrades
- Opportunity to take advantage of substantial incentives
Other CHP Drivers

- Resilience to Grid Failure
  - Congested sub-stations
  - Aging grid infrastructure
  - Storm, disaster vulnerability
  - Terrorism concerns
- CHP Better suited for urban environments
  - Wind, Solar not practical
  - Fuel cells cost prohibitive
- Environmental Benefits
  - Reduce Carbon footprint by 50%
  - Ultra low criteria emissions (CO, NOx) on par with Fuel Cell
- Modular Installation
  - Easier to locate
  - Sequential capacity increases
TECOGEN COMPANY OVERVIEW

Tecogen Key Stats
- Headquartered in Massachusetts
- >30 Years of Manufacturing CHP
- Nine USA service centers
- 2300+ units shipped

Largest and longest CHP provider in the small-mid CHP size range in USA

3 SERVICE CENTERS IN NYC

2300 MANUFACTURED UNITS
TECOGEN’S CHP PRODUCT SUITE

Cogen Modules

Ilios Water Heaters

TECOCHILL Chillers

Electricity & Heat

2x Heat Efficiency

Cooling & Heat

Inverde e+ is only system incorporating Variable Speed Operation (VSO) Technology
Inverde Unique Benefits

**Inverde is central microgrid controller**
- CERTS Microgrid accomplishes all load balancing, reactive power controls
- Unique VSO (variable speed operation) for highest part load efficiency
- Seamless energy storage integration via DC input feature
- Ultra-clean emissions on par w/ fuel cell
- Modular units located adjacent to thermal loads for shorter piping runs
- From electric meter perspective, looks like large CHP plant
- Eliminates need for back-up power (e.g. gensets)
“Synchronous generation is prohibited at the grid network (120/208 V) level.”

“All applications are queued when determined to be complete by Con Edison in accordance with its procedures. Each evaluation of synchronous generation will include all prior fault current contributors on the queue. Customer DG’s may require fault mitigation if the resulting fault current exceeds the capacity of the DG’s associated load area.”

DC generation with inverters or induction generation may be installed at all locations.

Interfaith Medical/ConEd Restrictions

Brooklyn

Interfaith Medical Center
PROJECT ROI: 2 years

Scope

- Furnish and install (3) InVerdē 100 e+ kW Outdoor units
- Provide all General Construction
- Provide dedicated gas riser for CHP system
- Furnish and install all piping between the units and the hospital’s DHW and Re-Heat system.
- Furnish and install all controls necessary for proper thermal and electric load following capabilities
- Furnish and install all electric wiring between units and distribution system
- Provide stand-by operation system
SCOPE OF WORK – Site Layout

- (3) INV-100e+ CHP Units
- New Fence
- New Electrical, Mechanical and Plumbing Trench

Existing Gas Service
Water Tank Below

Atlantic Ave
ECONOMIC ANALYSIS BACK UP

### Interfaith Medical Baseline Energy Loads

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Addressable Thermal Load:</td>
<td>139,200 therms/mth</td>
</tr>
<tr>
<td>Electrical Energy:</td>
<td>2,373,000 kWh/yr</td>
</tr>
</tbody>
</table>

### Rates Used in Analysis

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Rate:</td>
<td>$0.116/kWh</td>
</tr>
<tr>
<td>Demand Rate:</td>
<td>$20.00/kW</td>
</tr>
<tr>
<td>Boiler Gas Rate:</td>
<td>$1.00/therm</td>
</tr>
<tr>
<td>Cogen Gas Rate:</td>
<td>$0.75/therm</td>
</tr>
</tbody>
</table>

### Proposed System Configuration

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of CHP modules:</td>
<td>3</td>
</tr>
<tr>
<td>kW per CHP module:</td>
<td>100 kW</td>
</tr>
<tr>
<td>Total system size:</td>
<td>300 kW</td>
</tr>
<tr>
<td>System run hours</td>
<td>7,449 hrs/yr</td>
</tr>
<tr>
<td>Months of demand savings</td>
<td>9 months</td>
</tr>
</tbody>
</table>
Performance - CHP Insight

Unit: Interfaith Medical 3

Details
- Model: Tecogen
- Last Known Status: Running

Speed
- Range: 0 to 1300 RPM

Power
- Range: 0 to 100%

Stats
- Heat Output: 5.0 MW
- Gas Used (HHV): 9.37 TWh
- Electrical Eff. (HHV): 28.9%
- Overall Eff. (HHV): 63.4%

Historical Summary 6/2015 - 6/2018

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Power</td>
<td>75 kW</td>
</tr>
<tr>
<td>Total Energy</td>
<td>462,340 kWh</td>
</tr>
<tr>
<td>Total Hours</td>
<td>201 h</td>
</tr>
<tr>
<td>Total Gas</td>
<td>59,621 Th</td>
</tr>
<tr>
<td>Total Run Hours</td>
<td>5,443 h</td>
</tr>
</tbody>
</table>

Electric Power (KW)

[Graph showing electric power output from 6/2015 to 5/2016]
Cloud Based Monitoring Capability

Instant access to any machine anywhere
- Access customizable so owners and energy managers can only see their equipment
- Service tech's utilize same service for dispatching
# Fleet Monitoring Capability

## Tecogen Confidential

## CHP Insight

<table>
<thead>
<tr>
<th>Unit</th>
<th>Overview</th>
<th>Site Overview</th>
<th>Change Password</th>
<th>Log Out</th>
<th>Filter</th>
</tr>
</thead>
</table>

## Brooklyn

<table>
<thead>
<tr>
<th>Facility</th>
<th>Location</th>
<th>Capacity</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brooklyn 1</td>
<td>123 St</td>
<td>98.4 kW</td>
<td>80.00%</td>
</tr>
<tr>
<td>Brooklyn 2</td>
<td>456 Av</td>
<td>76.4 kW</td>
<td>76.00%</td>
</tr>
<tr>
<td>Brooklyn 3</td>
<td>789 Blvd</td>
<td>54.3 kW</td>
<td>65.00%</td>
</tr>
<tr>
<td>Brooklyn 4</td>
<td>012 Rd</td>
<td>32.1 kW</td>
<td>50.00%</td>
</tr>
</tbody>
</table>

## Connecticut

<table>
<thead>
<tr>
<th>Facility</th>
<th>Location</th>
<th>Capacity</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hartford 1</td>
<td>111 Ave</td>
<td>28.9 kW</td>
<td>80.00%</td>
</tr>
<tr>
<td>Hartford 2</td>
<td>333 Blvd</td>
<td>22.1 kW</td>
<td>75.00%</td>
</tr>
<tr>
<td>Hartford 3</td>
<td>555 St</td>
<td>16.8 kW</td>
<td>60.00%</td>
</tr>
</tbody>
</table>

## Massachusetts

<table>
<thead>
<tr>
<th>Facility</th>
<th>Location</th>
<th>Capacity</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boston 1</td>
<td>101 St</td>
<td>28.9 kW</td>
<td>75.00%</td>
</tr>
<tr>
<td>Boston 2</td>
<td>202 Blvd</td>
<td>22.1 kW</td>
<td>60.00%</td>
</tr>
</tbody>
</table>

## New Jersey

<table>
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<th>Facility</th>
<th>Location</th>
<th>Capacity</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Jersey 1</td>
<td>123 St</td>
<td>98.4 kW</td>
<td>80.00%</td>
</tr>
<tr>
<td>New Jersey 2</td>
<td>456 Av</td>
<td>76.4 kW</td>
<td>76.00%</td>
</tr>
</tbody>
</table>

## New York

<table>
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<th>Facility</th>
<th>Location</th>
<th>Capacity</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>New York 1</td>
<td>111 Ave</td>
<td>28.9 kW</td>
<td>80.00%</td>
</tr>
<tr>
<td>New York 2</td>
<td>333 Blvd</td>
<td>22.1 kW</td>
<td>75.00%</td>
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**Tecogen Confidential**

**Advanced Modular CHP Systems**
Technician Dispatching
Questions?

Benjamin Locke, CEO
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781-466-6402
Capstone EPA Success Story

E-Finity Distributed Generation
an authorized Capstone distributor

Power to be Independent
- Founded in 1988
- World leader in microturbine technology
- Headquartered in Southern California
- American Made
- Over 80 distribution partners
- 10,000+ units worldwide
E-Finity Distributed Generation
Exclusive Capstone Distributor Since 2007

- E-Finity has deployed and operates a fleet approaching 600 microturbines
- More than 150 microturbines are used in CHP or CCHP application
- 98% operate 24x7
- Nearly 75% of the turbine fleet is “Island Capable”
Environmental Friendly

- Air Permitting & Pollution
  - Prime Mover with low emissions:
  - Low emissions < 9 ppm NOx
  - Oil free system
    - air cooled, air lubricated

- Environmental noise
  - 65 DBA @ 10 Meters

- Onsite generation
  - Offset older diesel standby gensets
Capstone CHP & CCHP Offering

- Integrated hot water heat exchanger available for all turbines
- Hot water or flue gas fired absorption chillers (up to 700 ton available)
- Steam or Steam with Duct Burner (up to 32,000 lbs available)
- Direct exhaust applications
Resiliency (N+ Redundancy)

C600 Power Package

C800 Power Package

C1000 Power Package
Turbine Array Reaches 16 Years Continuous Operation

Masonic Village – Elizabethtown, Pennsylvania
Masonic Village

- Continuing-care retirement community
- Children’s home
- Community service organization
- Opened in 1910
- 1,400-acre complex
- Serves more than 1,700 + residents
- Continues to expand
For decades, the facility was driven by a coal-fired plant

- Burned 5,000 tons of coal/yr
- Steam-driven generators produced electricity for the entire campus
- Generated steam distributed through a 4,800-foot-long underground piping network
- Barely 35% efficient
- Lasted for more than 50 years
2001 – officials at Masonic Village knew it was time to:
- Lower their carbon footprint
- Move to a next-generation technology for their heating and electric needs
- Converted the steam loop to a hot water loop

2002 – Masonic Village selected & installed (5) low emission C60 Capstone Microturbines with 3rd party heat exchanger.
Masonic Village

- For (5) years, the natural gas units ran 24x7 / 365
- Provided electric power to the power plant’s operation
- Supplied 90% of the hot water for the campus during the summer
- In winter months, hot water from the microturbines augmented the three 12-million-BTU boilers connected to the campus’ central hot-water loop
2007 – E-Finity Upgraded the units:
- Replaced engines with C65 models
- Added onboard heat exchangers (ICHP)
- Added new PLC-based control system
- Signed 9 year fixed cost maintenance program
- Supplied 24/7 remote monitoring via the internet
Remote Monitoring

Allows for:

- Instant alarming
- Remote troubleshooting
- Continues data logging
- Customer view of real time system performance
- Less windshield time
2012 – It was determined that Masonic Village could use more BTUs

- Added a 6th C65 ICHP microturbine to the existing array

- This additional microturbine

  - increased electrical generation of the array to nearly 400 kW
  - boost thermal output to nearly 2.5 million BTUs per hour
  - reduce carbon emissions an additional 2,270 tons a year
Length of Time Project Has Been Operational:
- 16 years

System Run Hours
- Exceeding 725,000 run hours

Current System efficiency
- 74.4%

Estimated annual savings:
- energy 2,648,342 kWh
- electric $238,350*

* $.09kWh
When compared to the original coal-fired plant over its 16 years the Capstone installation has:

- drastically reduced carbon emissions by approx. 59,136 tons
- equivalent to removing approx. 8700 cars from the road
- or planting approx. 13,800 acres of forest
For Further Information

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jbeiter@e-finity.com • www.e-finity.com

Power to be Independent
Market Overview

- Through 2017, more than 1,100 packaged systems were installed in the United States, totaling 261 MW of capacity.
- Annual packaged systems deployments have increased from less than 500 kW in 2000 to more than 20 MW in 2015.
- More than 90% of installations are in the commercial/institutional/multifamily sectors.
- ~90% of systems are less than 500 kW.
- There is currently 21.3 GW of technical potential for systems under 500 kW in the commercial, institutional, and multifamily sectors at >100,000 facilities.
Packaged CHP Systems by Market

Source: ICF/U.S. DOE Combined Heat and Power Installation Database, February 2017
https://doe.icfwebservices.com/chpdb/.
Contact Information

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