



Packaged CHP Systems

June 28, 2018

Housekeeping

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- All attendees have been muted to minimize background noise.
- 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.
- If you are experiencing any technical difficulties, please contact us and we will try to troubleshoot the issues.

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



Catalog of CHP Technologies

Section 7. Packaged CHP Systems

U.S. Environmental Protection Agency
Combined Heat and Power Partnership



September 2017

Available at:

[https://www.epa.gov/chp/
catalog-chp-technologies](https://www.epa.gov/chp/catalog-chp-technologies)



Packaged CHP Case Study: 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

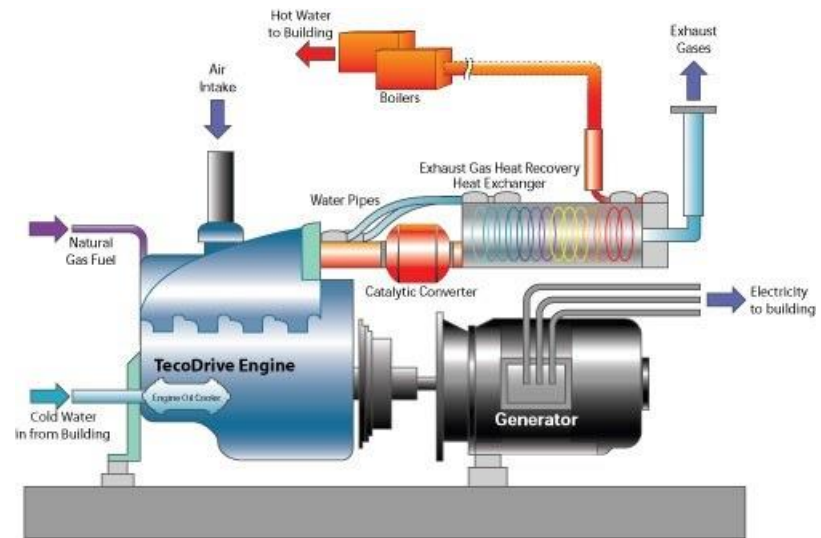
A prime mover (in many cases an internal combustion engine) turns a shaft to produce shaft work, and heat is recovered from the prime mover and purposefully reused.

- **Electrical CHP (“cogeneration”)**

Shaft work turns a generator to create electricity, heat is recovered from prime mover

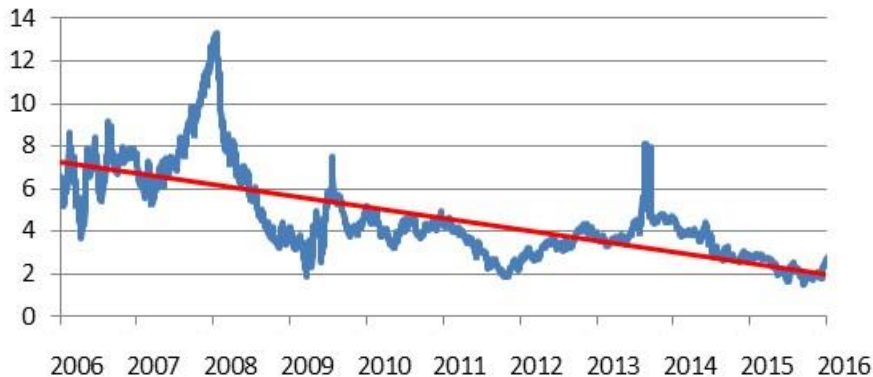
- **Mechanical CHP**

Shaft work turns a device such as a refrigeration compressor to drive a heat pump cycle, heat is recovered from prime mover

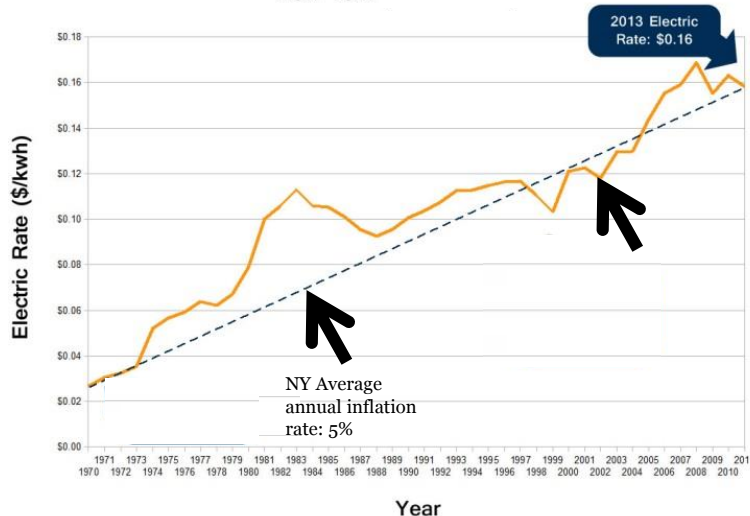


CHP – WHY NOW?

Henry Hub Nat. Gas Spot Price (\$/Mill. Btu)



Annual Avg. Electric Prices: Commercial
New York

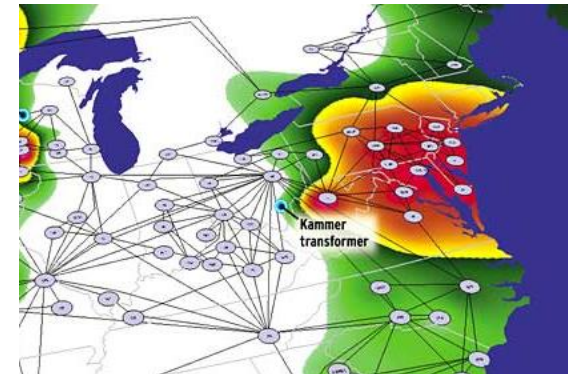


- **Stunning turnaround in natural gas price & availability**
 - Low prices likely to persist for many years
- **Electric tariffs likely to remain high and generally increasing**
 - High demand charges and Time Of Use (TOU) rates
- **Long-term pressure for infrastructure upgrades**
- **Opportunity to 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, NO_x) on par with Fuel Cell
- Modular Installation
 - Easier to locate
 - Sequential capacity increases



TECOGEN COMPANY OVERVIEW

Tecogen Key Stats

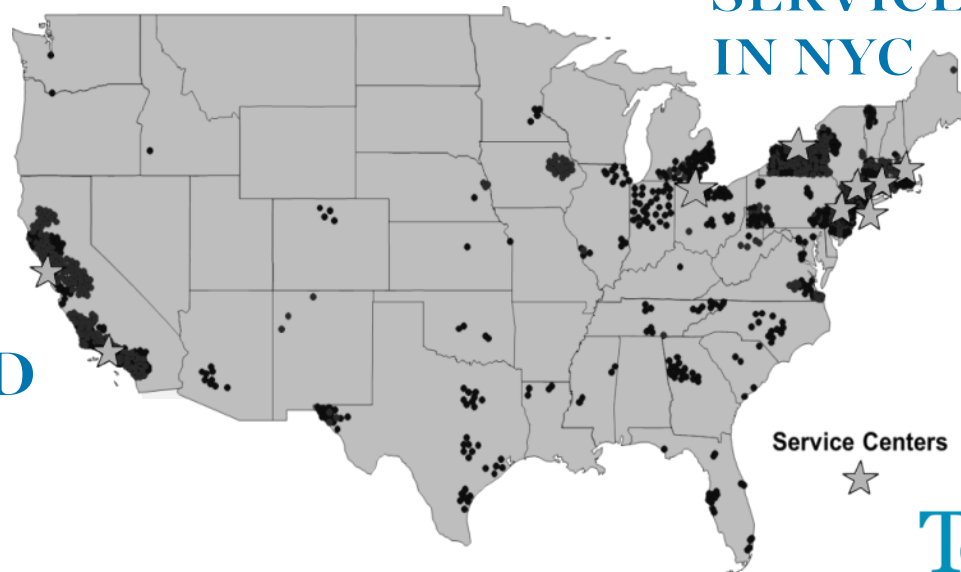
- Headquartered in Massachusetts
- >30 Years of Manufacturing CHP
- Nine USA service centers
- 2300+ units shipped

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

3

SERVICE CENTERS
IN NYC

2300
MANUFACTURED
UNITS



Service Centers
★

TECOGEN'S CHP PRODUCT SUITE

Cogen Modules



Electricity & Heat

Ilios Water Heaters



2x Heat Efficiency

TECOCHILL Chillers



Cooling & Heat

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

Tecogen

Advanced Modular
CHP Systems

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)



CA Rule 21 - Certified
NJDEP - Air Permit Exempt
NYSIR - Certified

UL 2200 Certified & TYPE 10 EPSS Rated
for Emergency Power

Interfaith Medical/ConEd Restrictions

Brooklyn

Synchronous generation is prohibited at the grid network (120/208 volt) level.

DC Generation with inverters (Fuel Cells, Photovoltaic, Micro Gen, Microturbines) or induction generation may be installed at all locations.

Notwithstanding the available margin or type of generation, each proposed location and installation must be evaluated for eligibility.

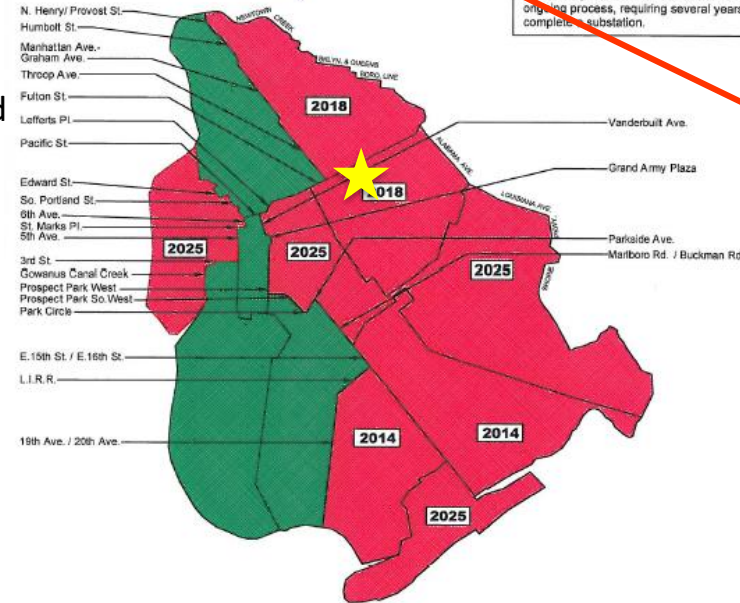
All applications are queued when determined to be complete by Con Edison in accordance with its procedures. Each evaluation of synchronous generation will include all prior fault current contributors on the queue. Customer DG's may require fault mitigation if the resulting fault current exceeds the capacity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

Brooklyn Key

Potential areas for synchronous generation without fault current mitigation*

2025 Synchronous Generation requires fault mitigation. The number indicates the planned year for upgrade completion

All boundaries are approximate. Contact your CPM for exact boundary details. Upgrade years and boundaries are subject to change without notice. Breaker replacement at substations is an ongoing process, requiring several years to complete a substation.



“Synchronous generation is prohibited at the grid network (120/208 V) level”

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

★ Interfaith Medical Center

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



45 FIRST AVE, WALTHAM, MA 02451
(781) 466-8400
WWW.TECOGEN.COM

MECHANICAL ENGINEER

ELECTRICAL ENGINEER

BY STAMP/SCALE

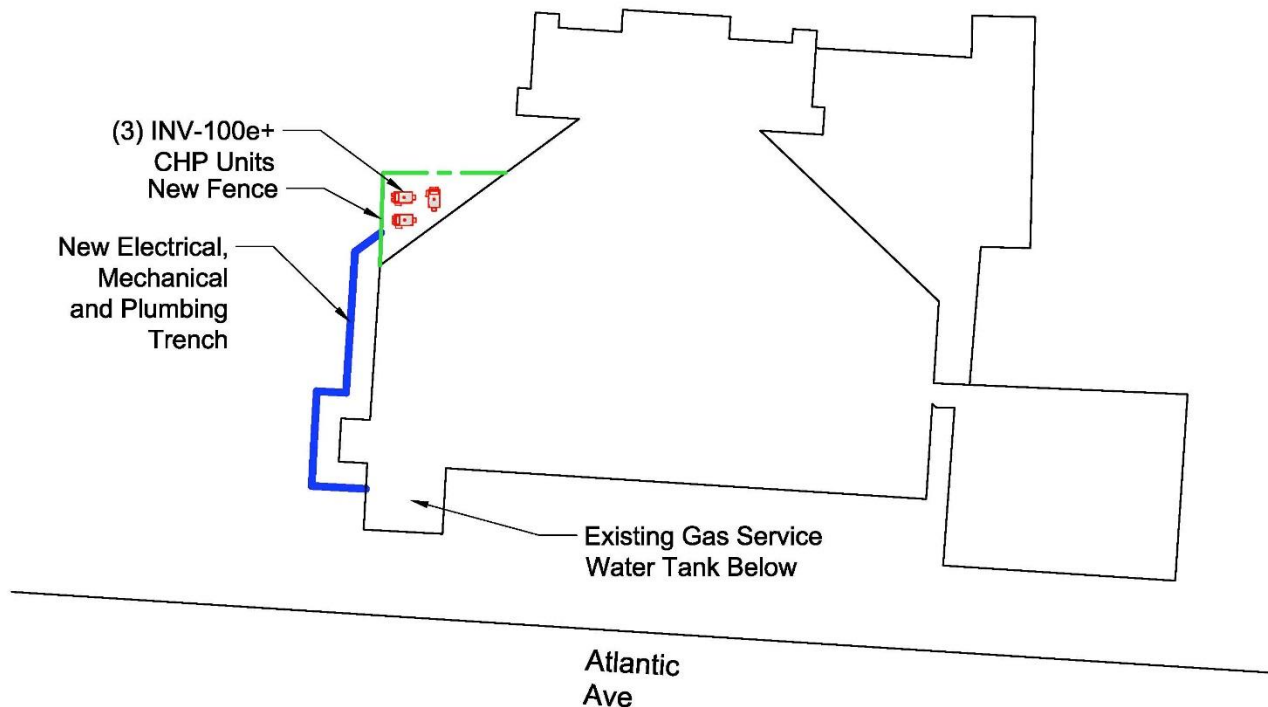
DATE	REV	DESCRIPTION
4/16/16	0	SCHEMA DES.

INTERFAITH MEDICAL
CENTER
1545 ATLANTIC AVENUE
BROOKLYN, NY 11213

PROJECT
4/19/16 JEG
DATE PROJECT BY

SITE LAYOUT
DRAWING TITLE

S-1
DRAWING NUMBER



ECONOMIC ANALYSIS BACK UP

Interfaith Medical Baseline Energy Loads			
Addressable Thermal Load:		139,200 therms/mth	
Electrical Energy:		2,373,000 kWh/yr	

Rates Used in Analysis			
Electrical Rate:		\$0.116/kWh	
Demand Rate:		\$20.00/kW	
Boiler Gas Rate:		\$1.00/therm	
Cogen Gas Rate:		\$0.75/therm	

Proposed System Configuration			
No. of CHP modules:		3	
kW per CHP module:		100 kW	
Total system size:		300 kW	
System run hours		7,449 hrs/yr	
Months of demand savings		9 months	

Performance - CHP Insight

CHP Insight

All Units
All Sites
Change Password
Log Out
Options



Unit: Interfaith Medical 3

Details

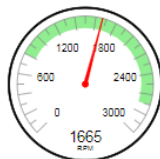
Model

InVerde e+

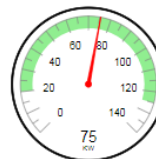
Last Known State

Running

Speed



Power



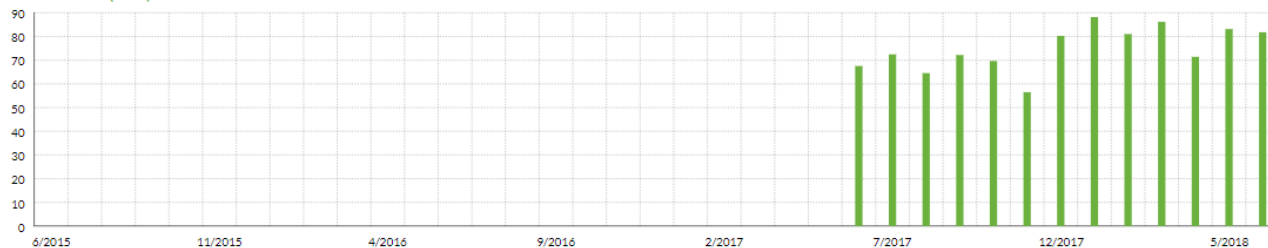
Stats

Heat Output	5.0 Th/Hr
Gas Used (HHV)	9.3 Th/Hr
Electrical Eff (HHV)	28.9 %
Overall Eff (HHV)	83.4 %

Historical Summary 6/2015 - 6/2018

Average Power	75 KW
Total Energy	402,340 KWH
Total Heat	201 Th
Total Gas	39,621 Th
Total Run Hours	5,443 Hrs

Electric Power (KW)



Navigation Site

[Interfaith Medical](#)

Units

[Interfaith Medical 1](#)

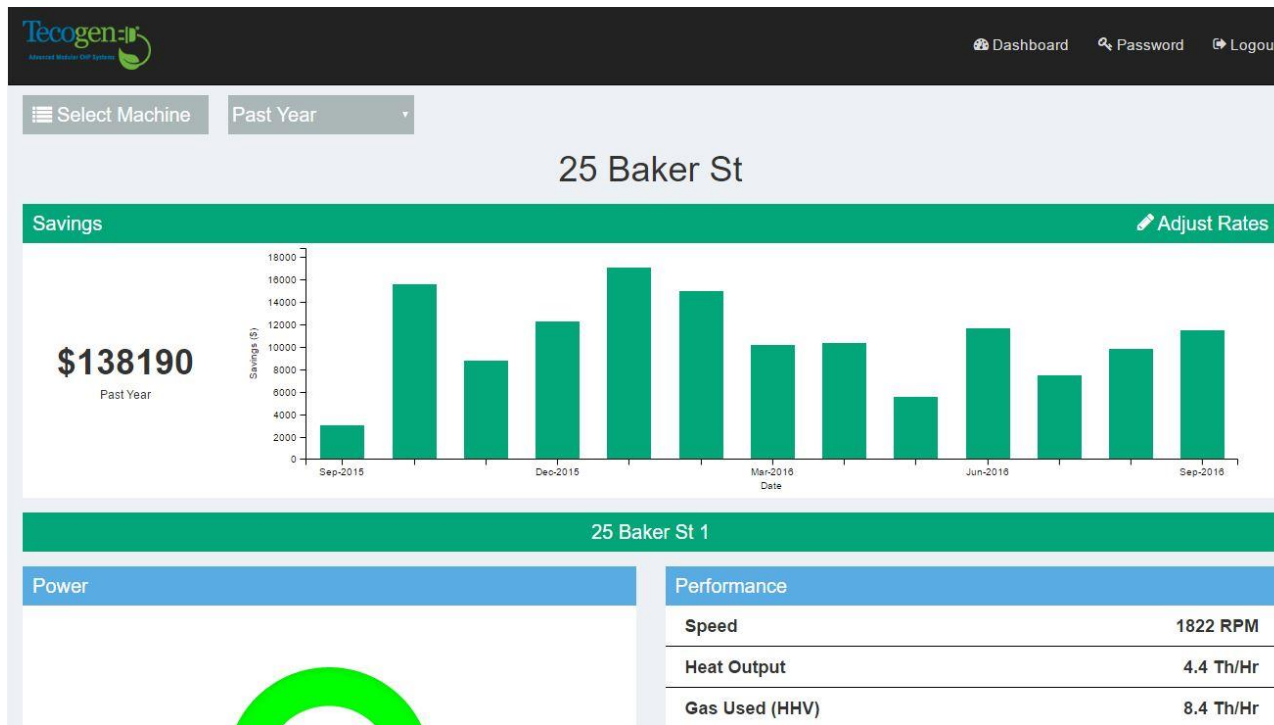
[Interfaith Medical 2](#)

[Interfaith Medical 3](#)

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

CHP Insight

Unit Overview
Site Overview
Change Password
Log Out
Filter



Helio, Joseph E. Getrost

Brooklyn

40 Water Street 79.4 KW	Acadia Apts #1 0.0 KW	Acadia Apts #2 73.6 KW	Americana #1 54.0 KW	Americana #2 79.4 KW	Americana #3 81.9 KW	Brewster Rose 69.1 KW	City Ice 17.4 °F	Comstock HS 73.8 KW
Cumberland CU1 0.0 °F	Cumberland CU2 0.0 °F	Eastport HS 136 0.0 KW	Eastport HS 137 0.0 KW	Eastport HS 138 72.1 KW	Farmdale HS 0.0 KW	Great Neck Chiller 15.6 °F	Greenpark 1 49.8 KW	Hall Hollow Hills 47.2 KW
Holliswood Care 1 60.4 KW	Holliswood Care 2 60.0 KW	Jamaica DTK1 64.7 °F	Jamaica DTK2 47.6 °F	Jamaica Hosp 7 43.9 °F	Lana Towers 1 66.9 KW	Lana Towers 2 62.2 KW	Union Plaza 1 89.0 KW	Union Plaza 2 100.9 KW
Union Plaza 3 90.3 KW	Union Plaza 4 100.7 KW	Union Plaza 5 0.0 KW	Macedonia Plaza 1 82.9 KW	Macedonia Plaza 2 0.0 KW	Myrtle #1 82.9 KW	Myrtle #2 83.3 KW	Myrtle #3 86.0 KW	Myrtle #4 83.2 KW
Myrtle #5 0.0 KW	Phoenix Beverages 1 45.7 KW	Phoenix Beverages 2 43.7 KW	Phoenix Beverages 3 40.8 KW	Phoenix Beverages 5 0.0 KW	Phoenix Beverages 6 44.4 KW	Prospect Park ADG 54.7 KW	Queens Library 2 43.8 °F	Roosevelt Landfill 1 98.9 KW
Roosevelt Landfill 2 100.7 KW	Roosevelt Landfill 3 0.0 KW	TopMerr 46.8 °F	Ultra Flex 1 100.4 KW	Ultra Flex 2 100.3 KW	Ultra Flex 3 100.3 KW	Union Plaza 1 52.7 KW	Union Plaza 2 54.5 KW	Ward Mallville HS 76.4 KW

Wyckoff 1 76.1 °F Warragah High School 74.1 KW

Connecticut

Brockfield YMCA 29.8 KW	Candid #1 58.7 KW	Candid #2 44.3 KW	Candid #4 0.0 KW	Candid #5 0.0 KW	Capital Prep 0.0 KW	CHG East Hartford 75.0 KW	Danbury High School 70.0 KW	Fairfield Police 49.9 KW
Gardner Housing 59.9 KW	Greenwich YMCA 75.1 KW	Hampshire College 2 60.0 KW	Hampshire House 58.1 °F	Innsworth House 40.0 KW	Mandell JCC 45.6 °F	Minefield Cnty Cir 0.0 KW	Mary Hooker 0.0 KW	Martinez YMCA 0.0 KW
Hillside Town YMCA 74.8 KW	Hillside YMCA 60.2 KW	Newport Athletic 0.0 KW	Response Insurance 70.0 °F	Southern YMCA 50.0 KW	Southern CT Natural Gas 74.9 KW	St Elizabeth Bl ADG 75.6 KW	UCONN 1 67.4 °F	UCONN 3 65.5 °F
UCONN South 43.9 °F	Veteranscom HS 75.0 KW	West Village YMCA 0.0 KW	Winchester Housing Authority 0.0 KW	Worcester State Dowdell 0.0 KW	Worcester State Sheehan 59.6 KW	WPI Gateway #1 74.9 KW	WPI Gateway #2 74.4 KW	John Trumbull 50.0 KW

Massachusetts

311 Arsenal #1 0.0 KW	311 Arsenal #2 0.0 KW	Carlton Willard 0.0 KW	Comberland Jail 2 72.2 KW	Curry College DTK 46.2 °F	Doubletree Hotel 0.0 KW	Duller Village 0.0 KW	Harvard Biotech 60.0 KW	Harvard Medical 73.0 KW
Hydco Hotel 99.8 KW	Longfellow Hotel 0.0 KW	Manchester Housing 58.7 KW	Melville Towers 73.4 KW	Hilton Academy 44.5 °F	Natick Labs #1 73.8 KW	Natick Labs #2 75.2 KW	NE Sports Comp. #1 77.2 °F	NE Sports Comp. #2 0.0 KW
NE Sports Comp. #3 75.1 KW	New England Rehab 53.3 KW	North Hill Nursing 75.1 KW	Panacook 0.0 KW	Shenell House 62.0 KW	Somerville-Bryant 30.1 KW	Somerville-Prosper 0.0 KW	Stirling YMCA 0.0 KW	Sweetsercott HS 0.0 KW
			Waltontown Housing 0.0 KW	Weymouth Club 1 57.9 KW	Salem State O'Keefe 73.8 KW			

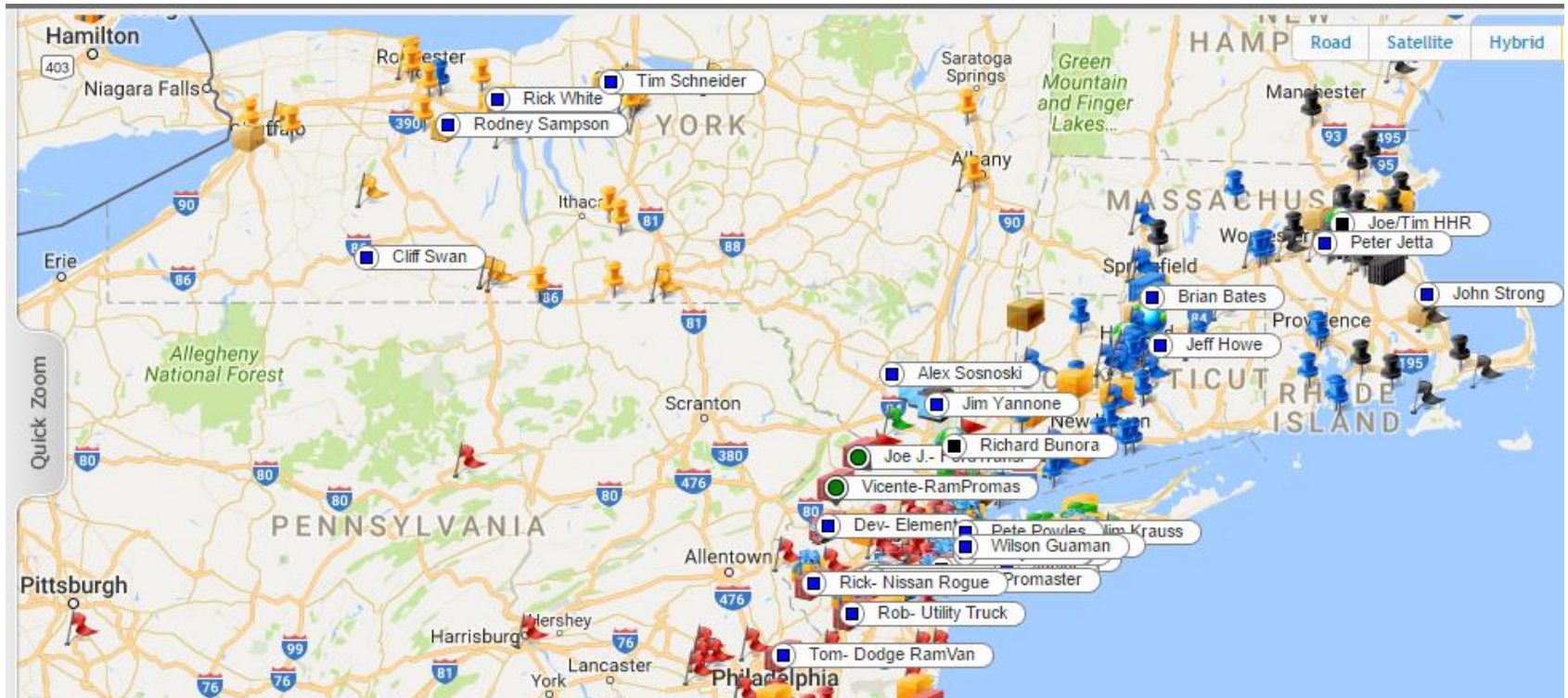
New Jersey

100 Chadwick 75.1 KW	11 Fifth Ave 1 0.0 KW	11 Fifth Ave 2 84.5 KW	11 Fifth Ave 3 62.8 KW	11 Fifth Ave 4 22.9 KW	205 West End Ave 1 0.0 KW	205 West End Ave 2 0.0 KW	500 West 30th 76.3 KW	77 East 12th Street 0.0 KW
AGL Elizabethtown 1 64.6 °F	AGL Elizabethtown 2 64.1 °F	AGL Stewartville 0.0 °F	AM Best #2 60.1 °F	AM Best #3 57.2 °F	Amsterdam Nursing 78.8 °F	Bayonne CC 1 0.0 KW	Bayonne CC 2 50.1 KW	Brewster East 1 62.7 KW
Brewster East 2 0.0 KW	Brewster East 3 40.4 KW	Broad Street 1 62.9 KW	Broad Street 2 73.4 KW	Broad Street 3 43.0 KW	Broad Street 4 55.4 KW	Camden County 1 0.0 KW	Camden County 2 0.0 KW	Chancellor HS 0.0 KW
Georgetown Plaza 1 0.0 KW	Georgetown Plaza 2 80.6 KW	Green Hill Nursing 0.0 KW	Haltmark House 90.1 KW	Hill School 64.2 °F	Hillborough MS 0.0 KW	Howland Hook 1 48.3 °F	Howland Hook 2 60.2 °F	Howland Hook 3 61.9 °F
Howland Hook 5 50.9 °F	Independence Visitor 75.8 KW	JCC Tenby 1 59.8 KW	Jersey Shore Arena 11.4 °F	Kean Univ Heating 67.6 °F	Greenon View 0.0 KW	Legans 76.6 KW	Logan Square 51.2 °F	McShay Elementary 74.9 KW
New Bruns 18 School 100.3 KW	New Bruns Mid School 55.1 KW	Princeton Club 1 0.0 KW	Princeton Club 2 0.0 KW	Rose Garden 48.9 °F	Seaford 0.0 KW	Shady Spring 59.8 KW	Silver Towers 1 0.0 KW	Silver Towers 2 0.0 KW
Silver Towers 3 59.2 KW	St Joachim 1 64.3 KW	St Joachim 2 0.0 KW	St Joachim 3 70.6 KW	Stevens House Chll 62.9 °F	Stevens Public Chiller 43.4 °F	Stevens Public Cig 0.0 KW	Stevens Chemistry 91.8 KW	Stevens House #1 HS 0.0 KW
Stevens House #2 HS 0.0 KW	Stevens Library 0.0 KW	Stevens McLean 92.4 KW	Stevens Rec Ctr 0.0 KW	Stockton College 1 59.9 °F	Stockton College 2 63.2 °F	Supreme Sports Club 46.4 KW	Sutton Terrace 0.0 KW	Weyne Cogen 1 55.7 KW
	Weyne Cogen 2 59.6 KW	Westfield YMCA 1 74.8 KW	Westin Jersey City 1 0.0 KW	Westin Jersey City 2 100.4 KW	Wolman Hall 51.3 KW	The Plaza 70.0 °F	Decker 2 80.6 KW	

New York

Balston Spa 01 75.0 KW	Balston Spa 02 75.4 KW	Balston Spa 03 74.9 KW	Balston Spa 04 55.5 KW	Balston Spa 05 75.3 KW	Balston Spa 06 0.0 KW	Balston Spa 07 74.6 KW	Balston Spa 08 74.8 KW	Balston Spa 09 0.0 KW
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Technician Dispatching





Questions?

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Capstone®

Turbine Corporation



Capstone EPA Success Story

E-Finity Distributed Generation

an authorized Capstone distributor

Power to be Independent

E-FINITY
DISTRIBUTED GENERATION

Capstone Turbine Corporation



- Founded in 1988
- World leader in microturbine technology
- Headquartered in Southern California
- American Made
- Over 80 distribution partners
- 10,000+ units worldwide



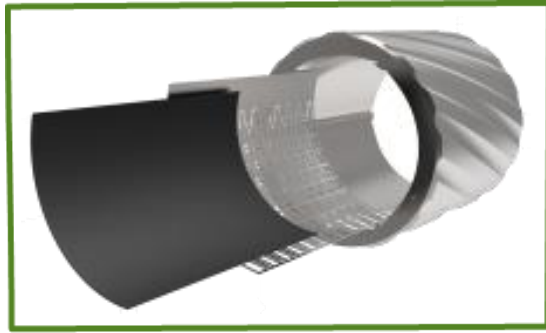
About E-Finity



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”

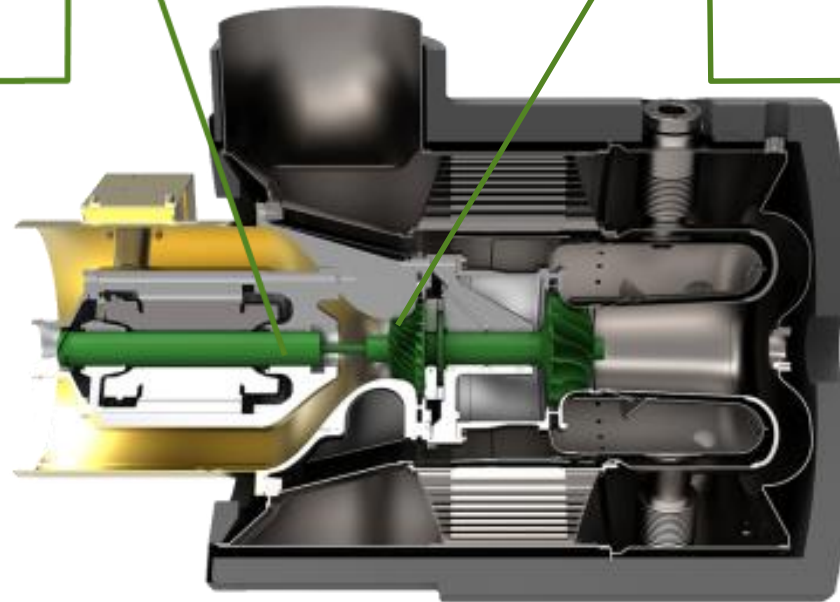
Environmental Friendly



Air Foil



Rotor Group



- 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



C65 ICHP



C200S ICHP



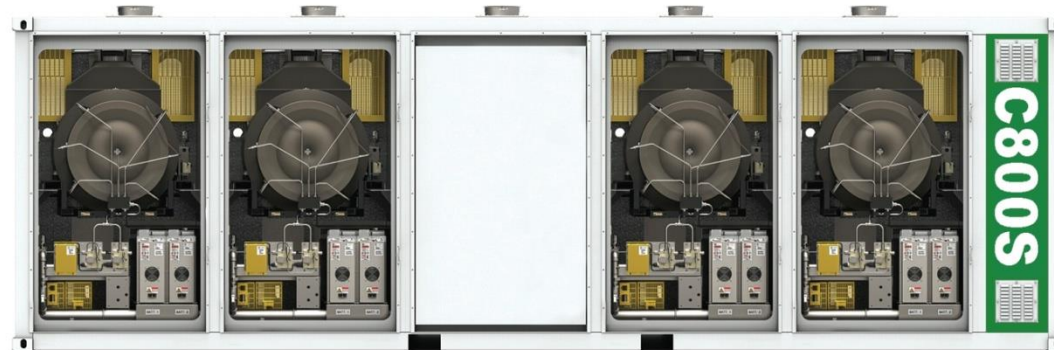
C1000 Series ICHP

- Integrated hot water heat exchanger available for all turbines
- Hot water or flue gas fired absorption chillers (up 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



Masonic Village



- 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



Masonic Village



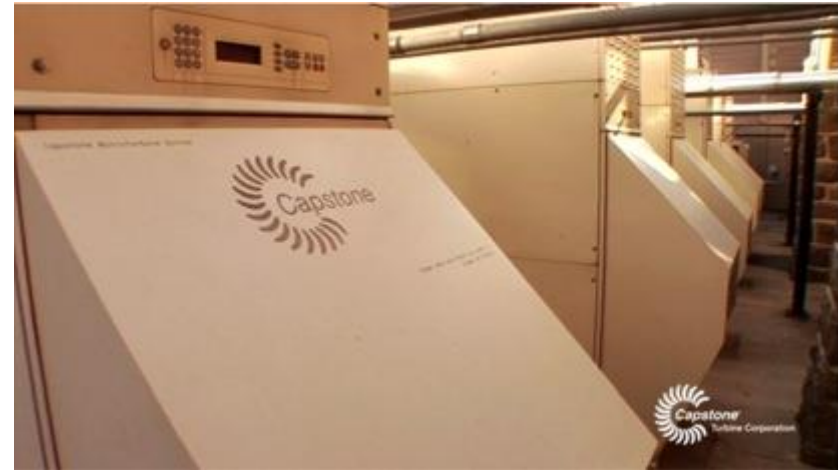
- 2001 – officials at Masonic Village knew it was time to
 - Lower their carbon footprint
 - Move to a next-generation technology for their heating and electric needs
 - Converted the steam loop to a hot water loop
- 2002 – Masonic Village selected & installed (5) low emission C60 Capstone Microturbines 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



Masonic Village



- 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



Masonic Village



- 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



Masonic Village – Metrics



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



Masonic Village – Environmental



When compared to the original coal-fired plant over it's 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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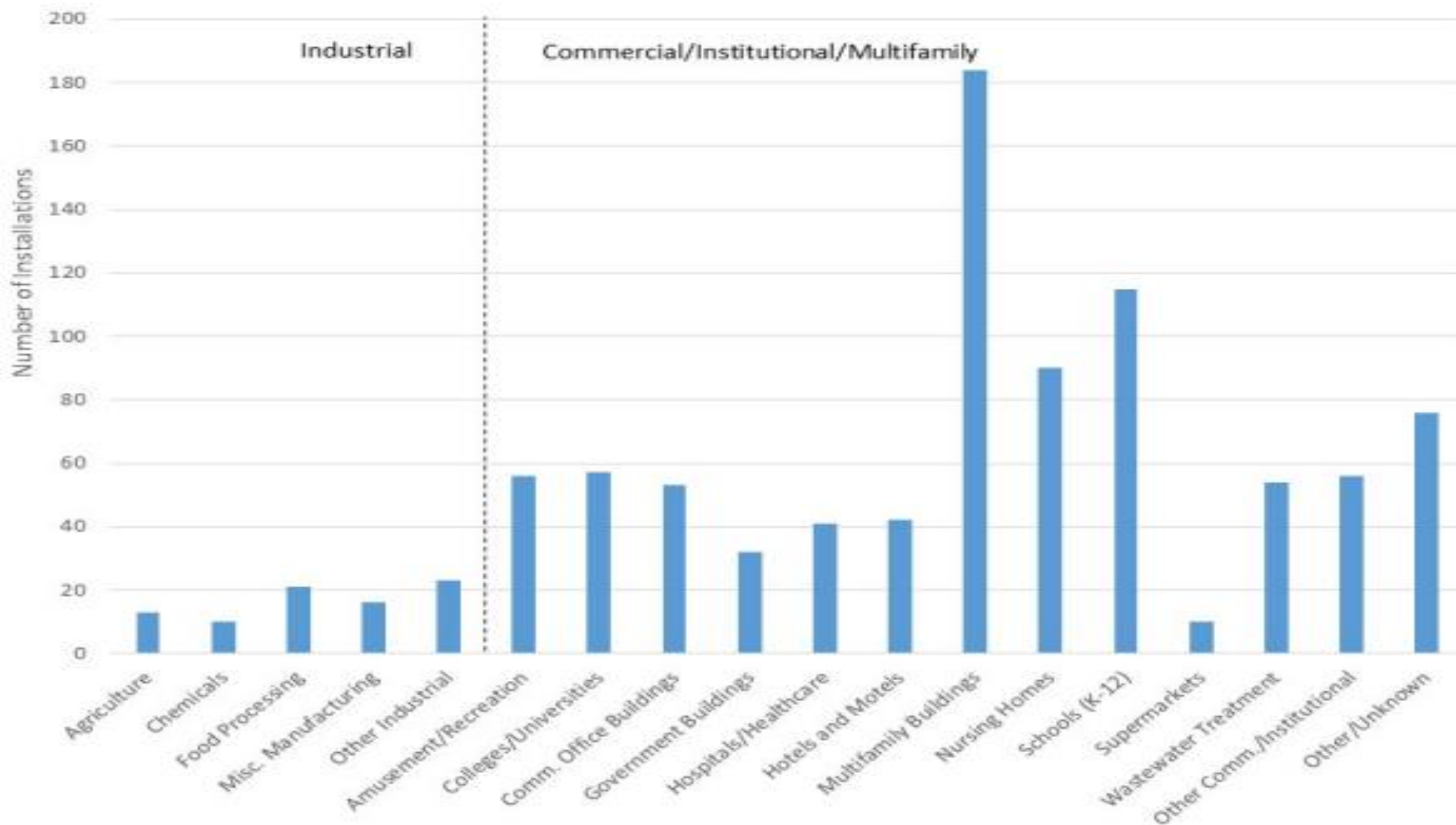
jbeiter@e-finity.com • www.e-finity.com

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.icfwebervices.com/chpdb/>

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