CHP
EPA COMBINED HEAT AND POWER PARTNERSHIP

Packaged CHP Systems

June 28, 2018

Housekeeping

- Audio is available for this presentation through your computer's mic and speakers or by telephone. Your call-in number and access code are in the control panel box on the right-hand side of your screen.
- 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

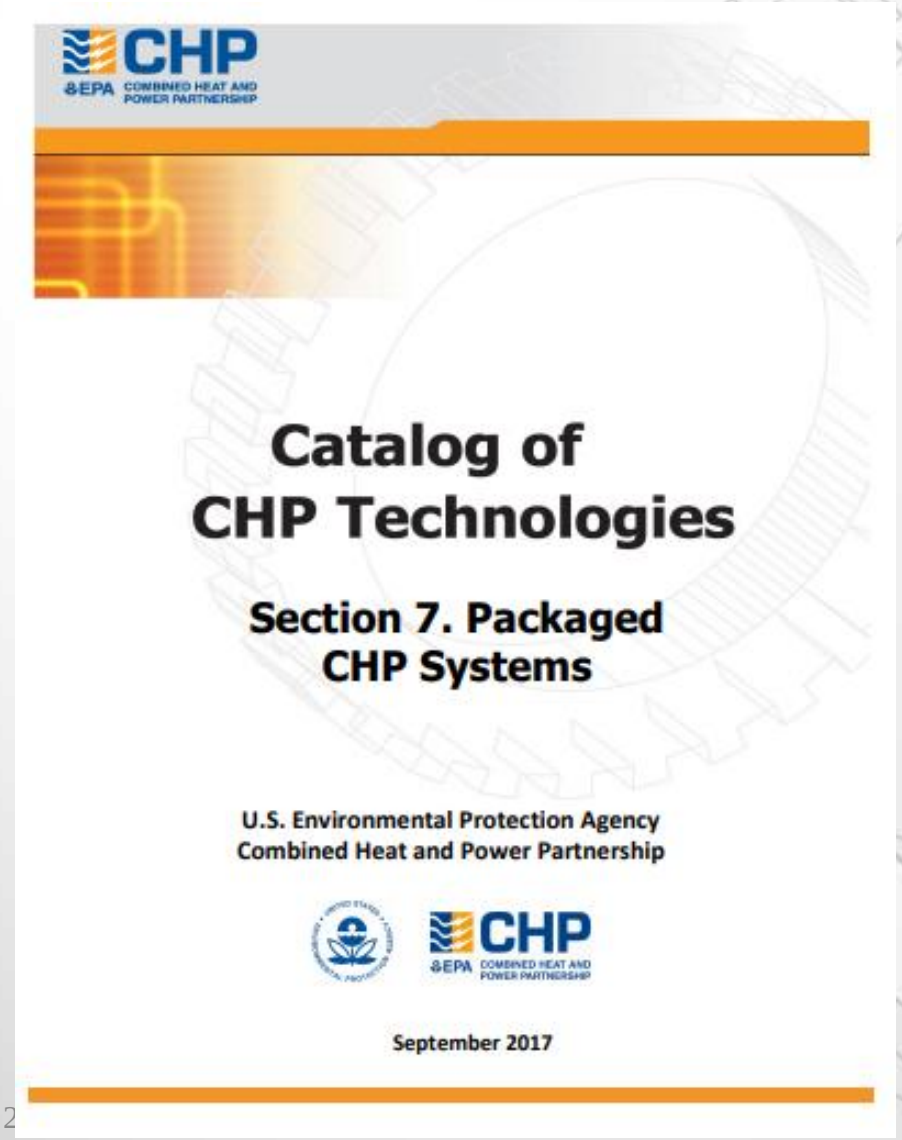
More than 400 Partners

- 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



Available at:

https://www.epa.gov/chp/catalog-chp-technologies

CHP
EPA COMBINED HEAT AND POWER PARTNERSHIP

Packaged CHP Case Study: Interfaith Medical Center

Interfaith Medical Center

EPA CHP PARTNERSHIP WEBINAR
BENJAMIN LOCKE, CEO
JUNE 28, 2018

Tecogen®
Advanced Modular CHP Systems

WHAT IS CHP?

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

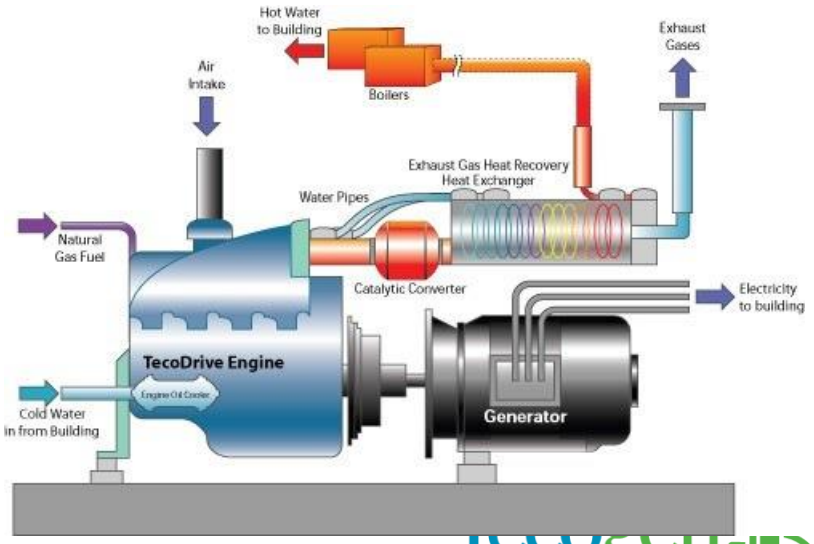
The simultaneous production of two useful outputs from a single fuel source

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.

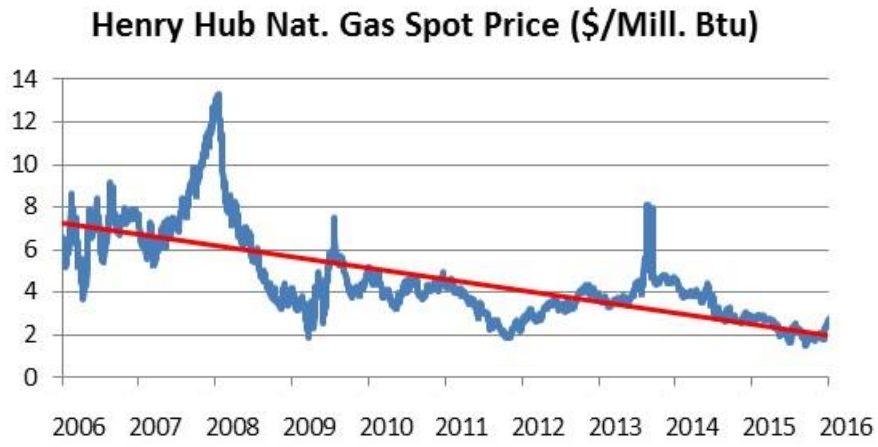
- **<u>Electrical CHP ("cogeneration")</u>**

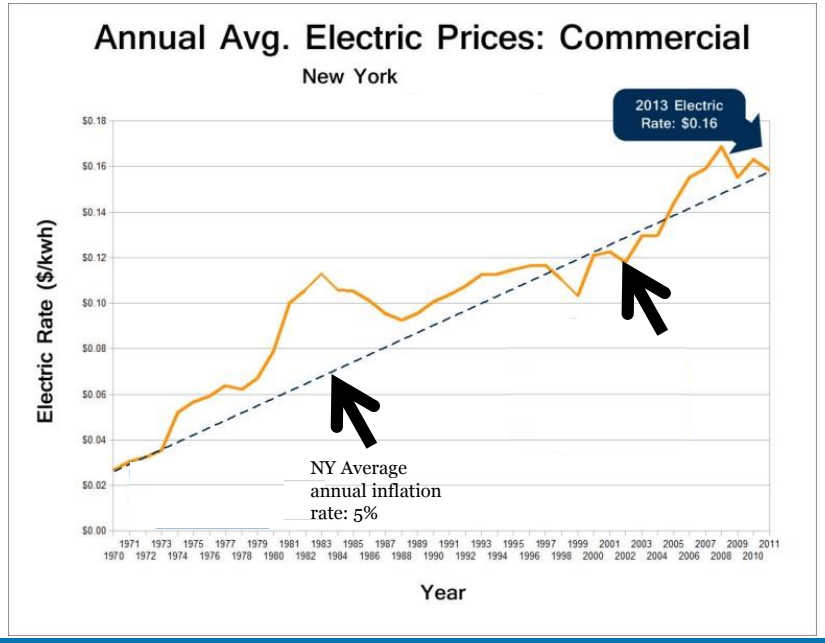
  Shaft work turns a generator to create electricity, heat is recovered from prime mover
- **<u>Mechanical CHP</u>**

  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?

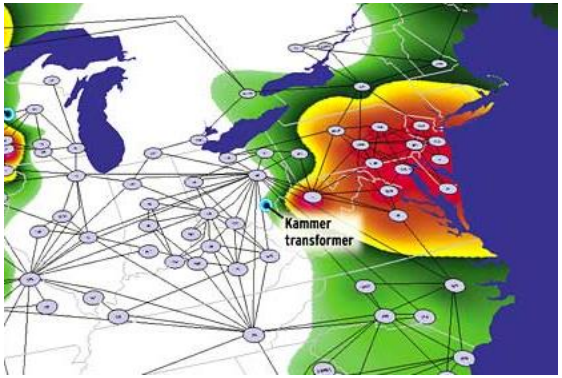




- **Stunning turnaround in natural gas price & availability**
  - Low prices likely to persist for many years
- **Electric tariffs likely to remain high and generally increasing**
  - High demand charges and Time Of Use (TOU) rates
- **Long-term pressure for infrastructure upgrades**
- **Opportunity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

Other CHP Drivers

- Resiliance 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



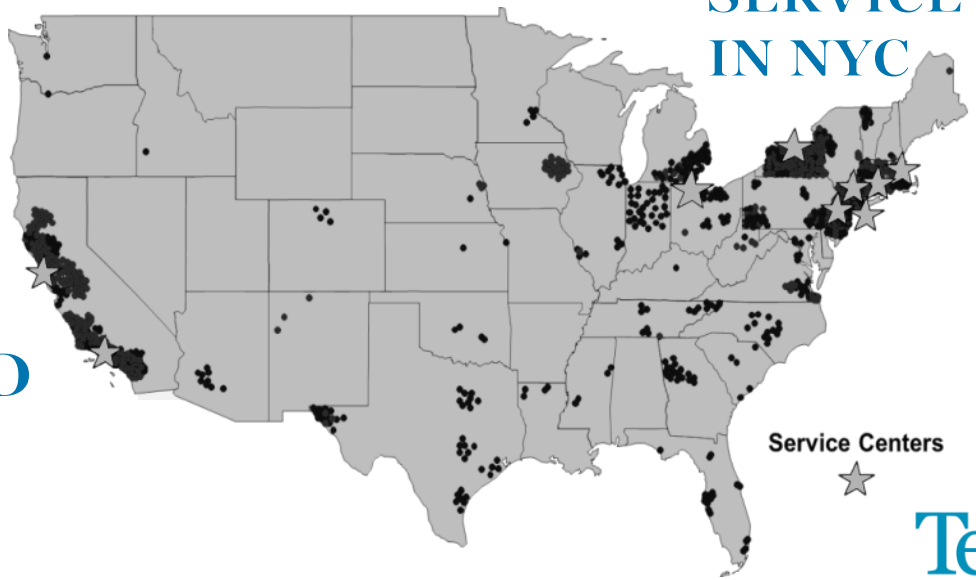
TECOGEN COMPANY OVERVIEW

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

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

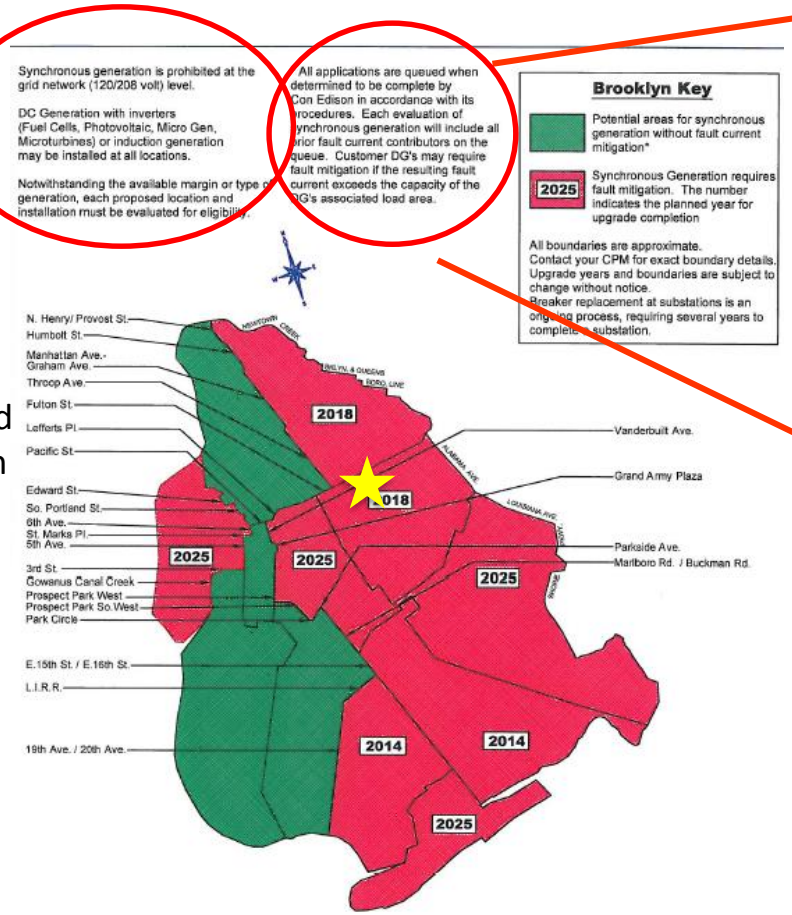
UL 2200 Certified & TYPE 10 EPSS Rated for Emergency Power

Interfaith Medical/ConEd Restrictions

Brooklyn

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

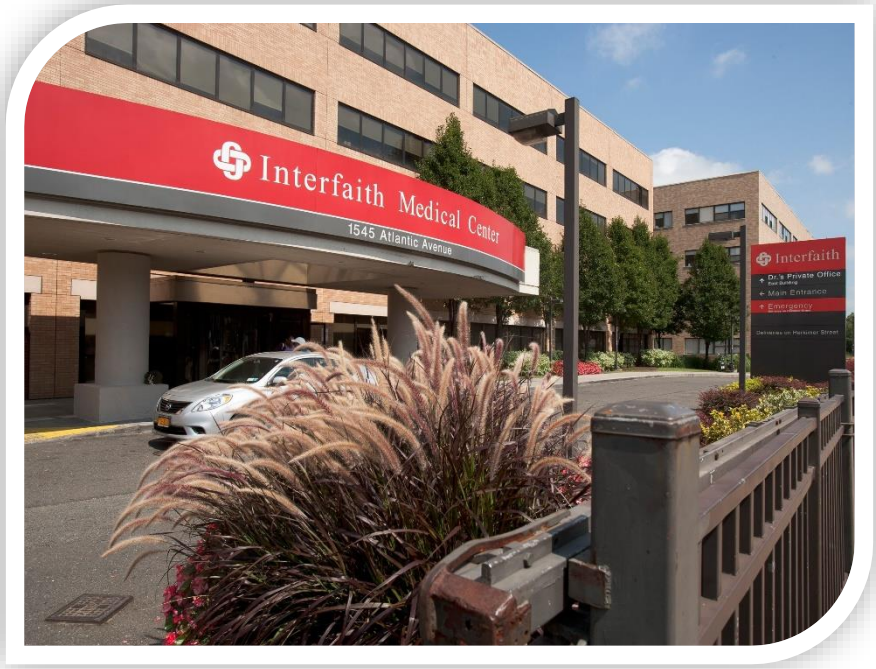
"All applications are queued when determined to be complete by Con Edison in accordance with its procedures. Each evaluation of synchronous generation will included all prior fault current contributors on the queue. Customer DG's may require fault mitigation if the resulting fault current exceeds the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



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

★ Interfaith Medical 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

Tecogen®
Advanced Modular CHP Systems

SCOPE OF WORK – Site Layout

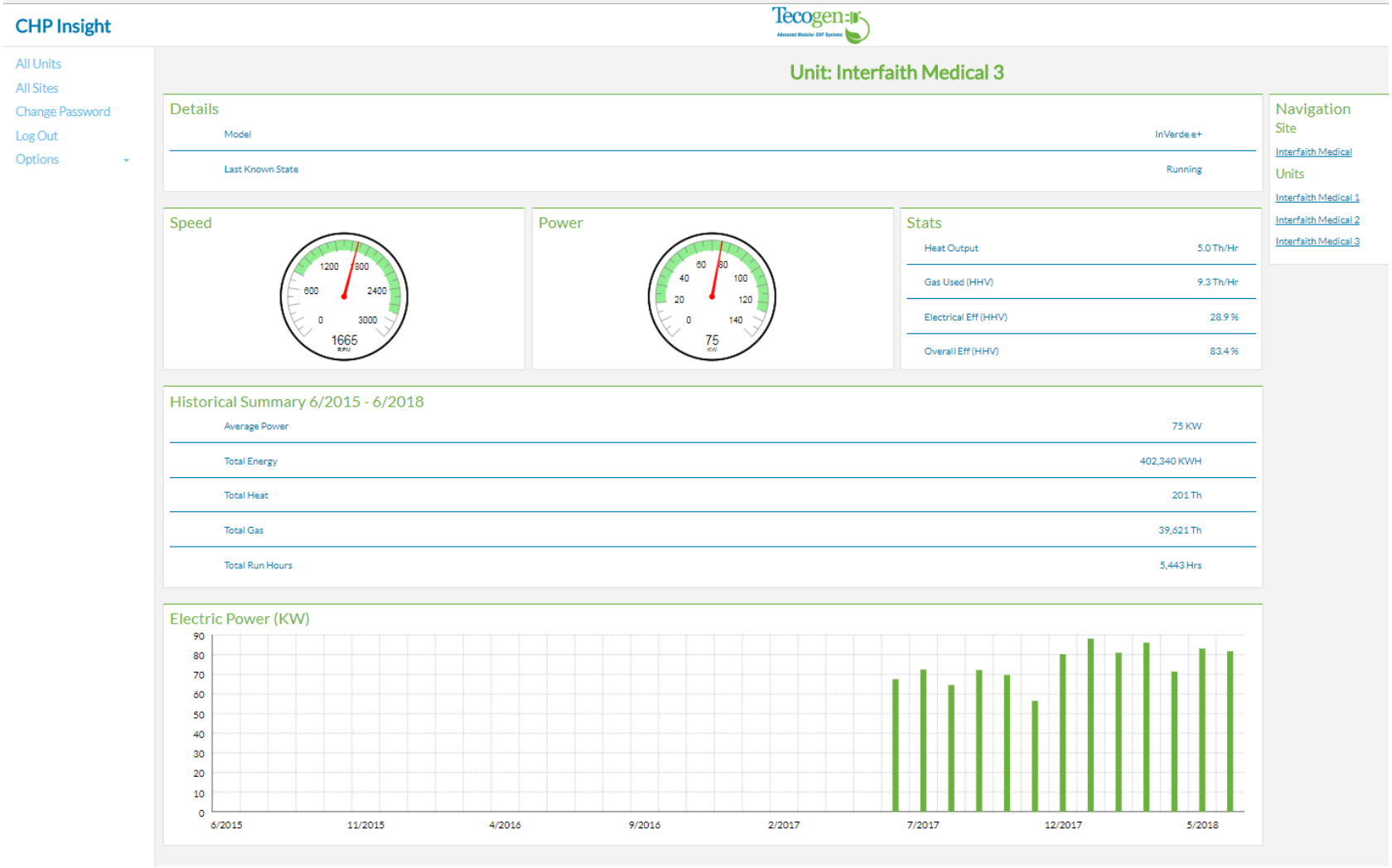
ECONOMIC ANALYSIS BACK UP

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



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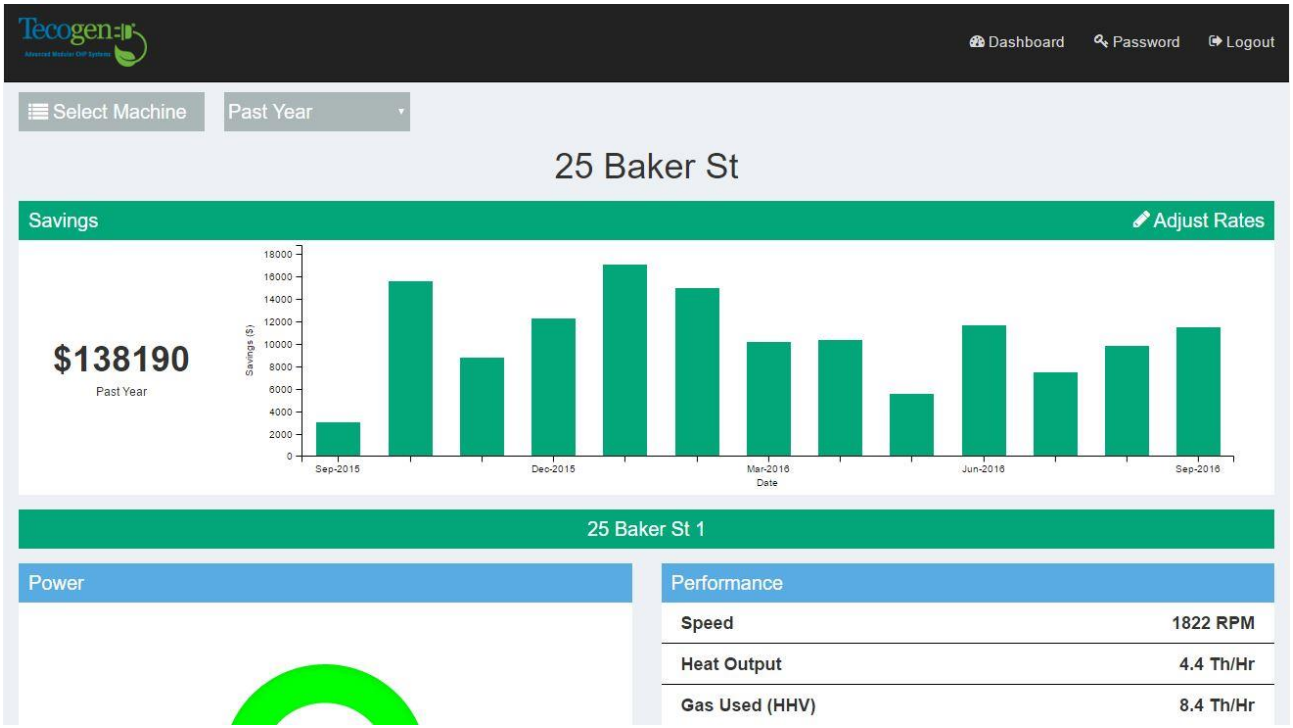
Cloud Based Monitoring Capability

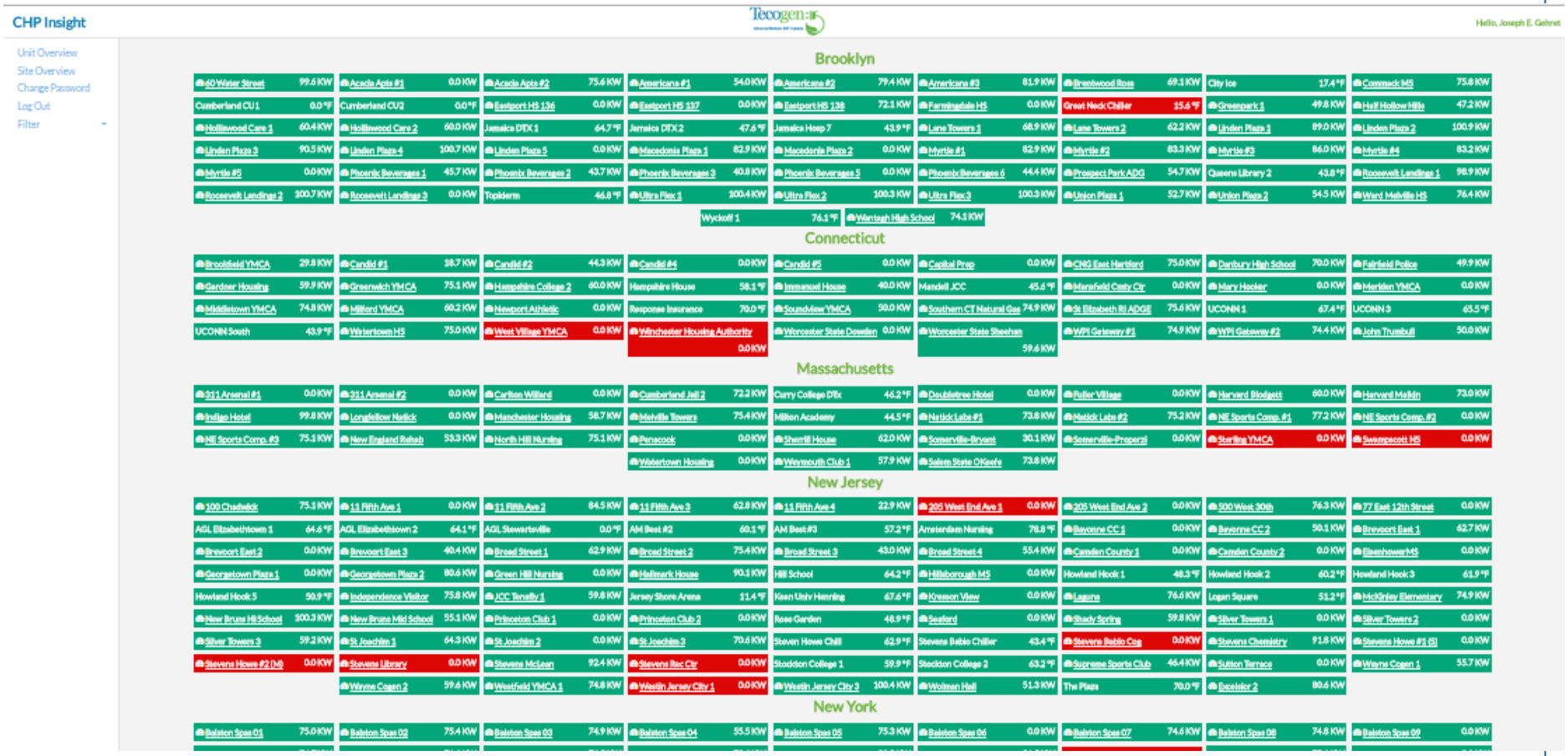
Instant access to any machine anywhere

-Access customizable so owners and energy managers can only see their equipment

-Service tech's utilize same service for dispatching



Fleet Monitoring Capability



Tecogen

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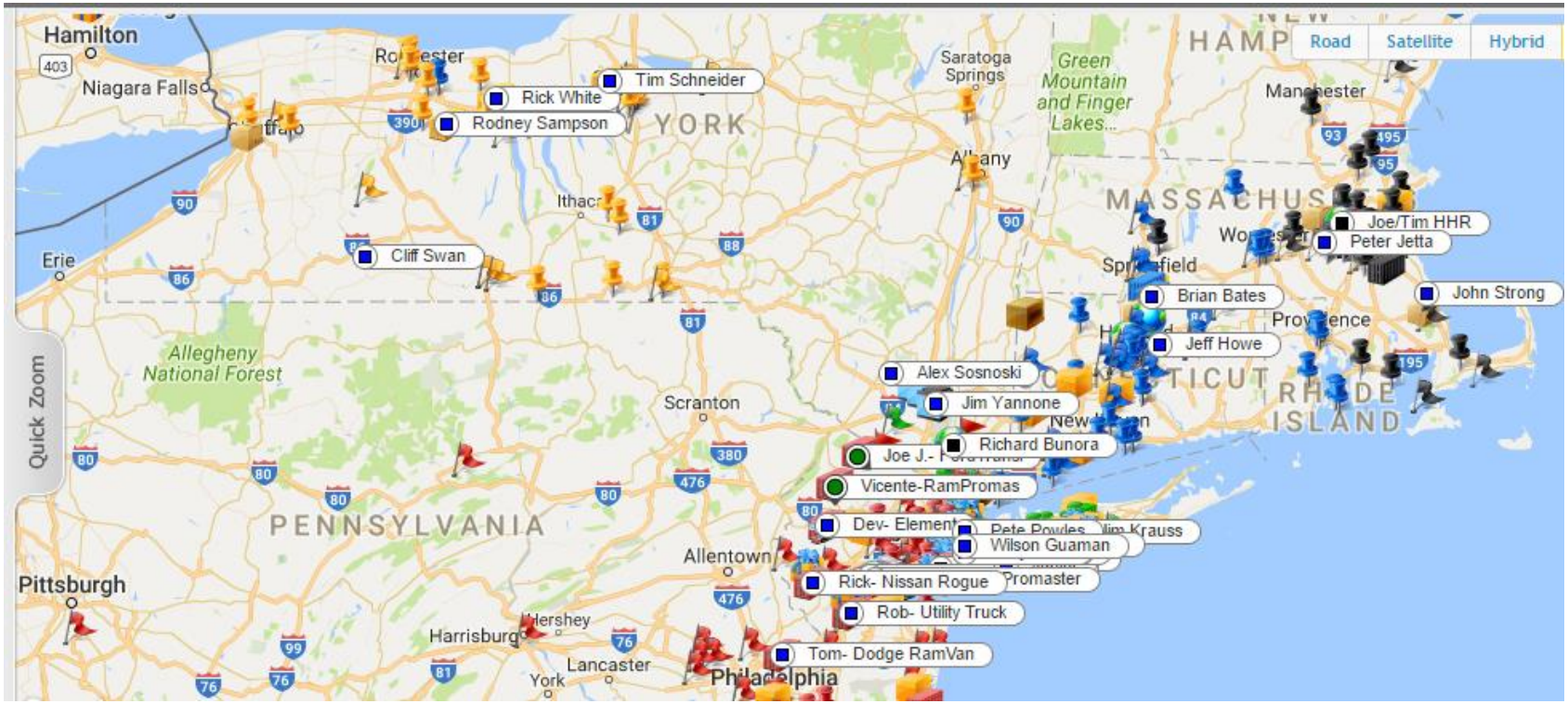
Technician Dispatching



Tecogen

Advanced Modular CHP Systems

Questions?

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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

Capstone Turbine Corporation
AUTHORIZED SALES

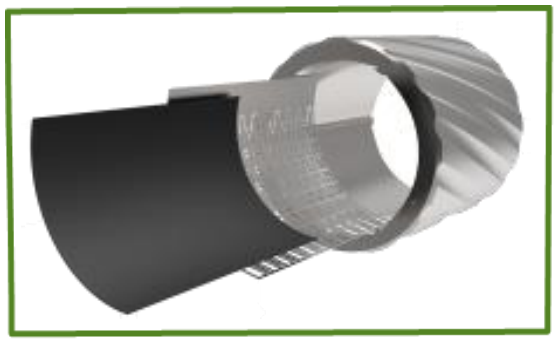
About E-Finity

E-Finity Distributed Generation
Exclusive Capstone Distributor Since 2007

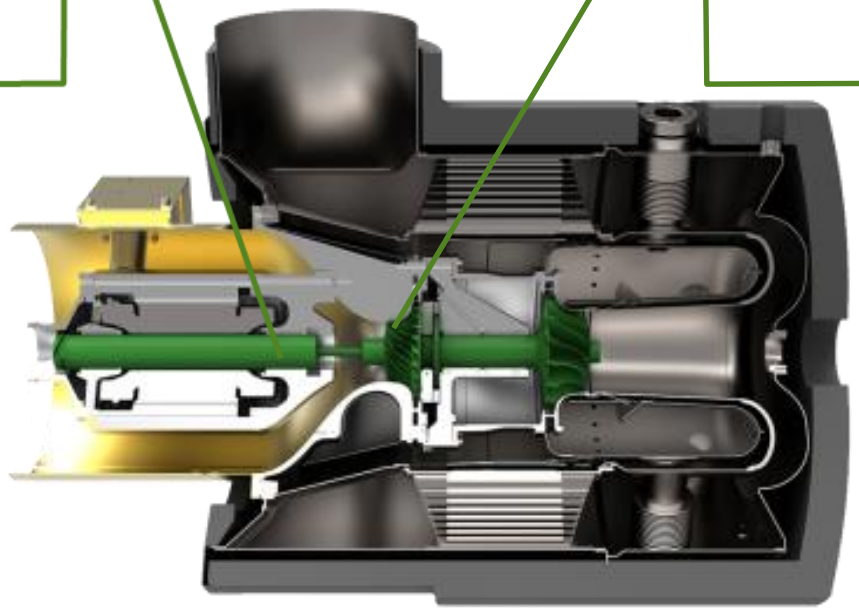
- E-Finity has deployed and operates a fleet approaching 600 microturbines
- More than 150 microturbines are used in CHP or CCHP application
- 98% operate 24x7
- Nearly 75% of the turbine fleet is "Island Capable"

Capstone Turbine Corporation AUTHORIZED SALES

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

Capstone® Turbine Corporation AUTHORIZED SALES

Resiliency (N+ Redundancy)

C600 Power Package

C800 Power Package

C1000 Power Package

Capstone Turbine Corporation
AUTHORIZED SALES

Turbine Array Reaches 16 Years Continuous Operation

Masonic Village – Elizabethtown, Pennsylvania

Capstone® Turbine Corporation

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

Capstone Turbine Corporation
AUTHORIZED SALES

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

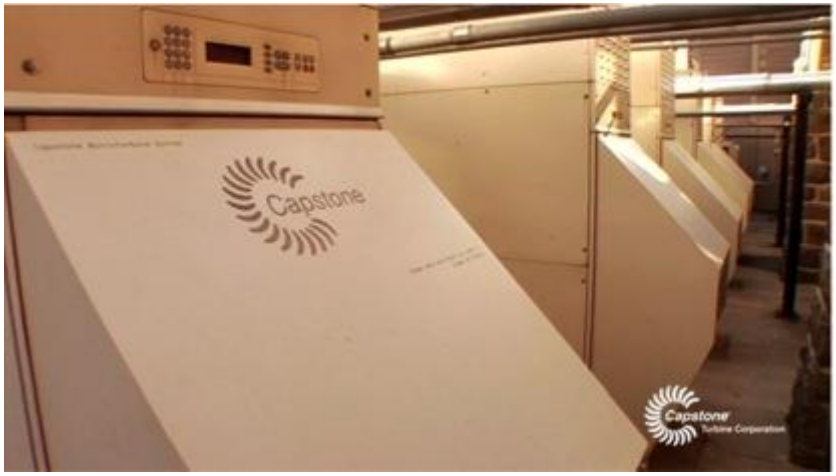
Masonic Village

- 2001 – officials at Masonic Village knew if 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

Capstone Turbine Corporation AUTHORIZED SALES

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



Capstone Turbine Corporation
AUTHORIZED SALES

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

Capstone Turbine Corporation
AUTHORIZED SALES

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

Capstone Turbine Corporation
AUTHORIZED SALES

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

Capstone Turbine Corporation AUTHORIZED SALES

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

Capstone Turbine Corporation AUTHORIZED SALES

For Further Information

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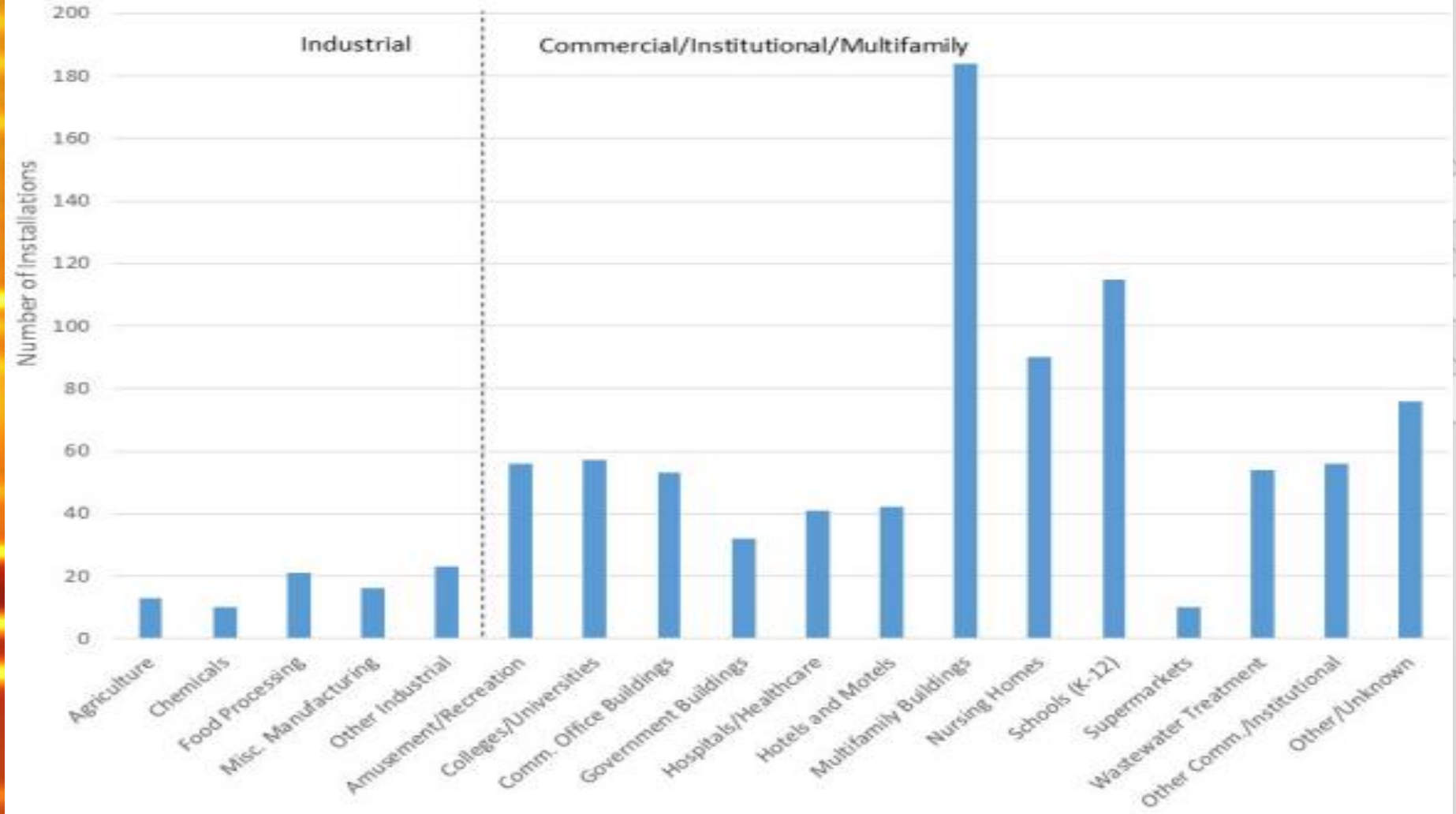
Power to be Independent

Capstone Turbine Corporation AUTHORIZED SALES

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/.

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