Enhancing Resiliency and Reliability in Multifamily Buildings with Combined Heat and Power

June 16, 2020

CHP Technical Assistance Partnerships

In Collaboration With

IFMA™
International Facility Management Association
Empowering Facility Professionals Worldwide

ESUS
Environmental Stewardship Utilities & Sustainability Community

Download at: http://bit.ly/ClimateChangeGuide

Download at: https://bit.ly/34LiWJZ

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Agenda

- CHP Overview
- CHP and Multifamily
- Improving Resilience
- Micro CHP and Applications
- Projects Snapshots
- Tools and Resources
- Q&A

CHP Overview

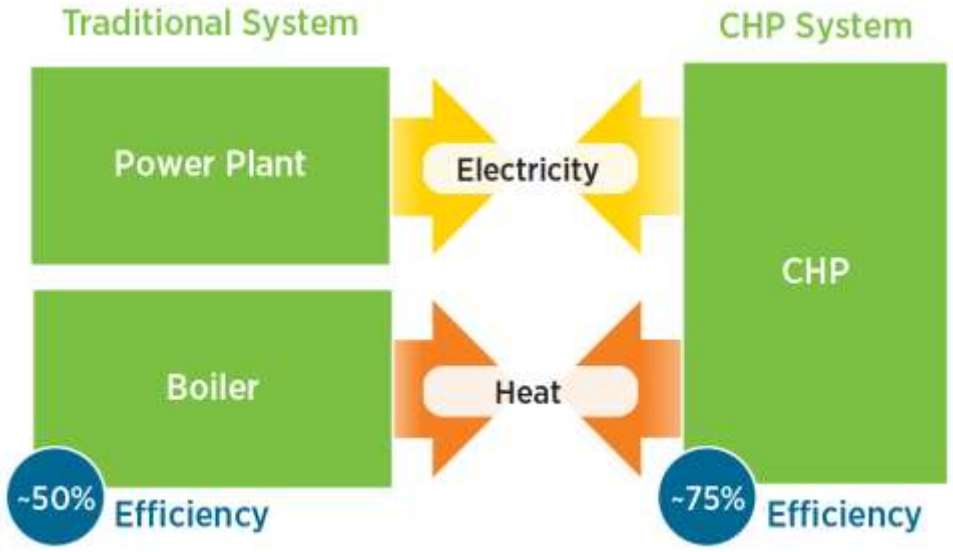
DOE CHP Technical Assistance Partnerships (CHP TAPs)

- ## 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 CHP TAPs 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

CHP: A Key Part of Our Energy Future

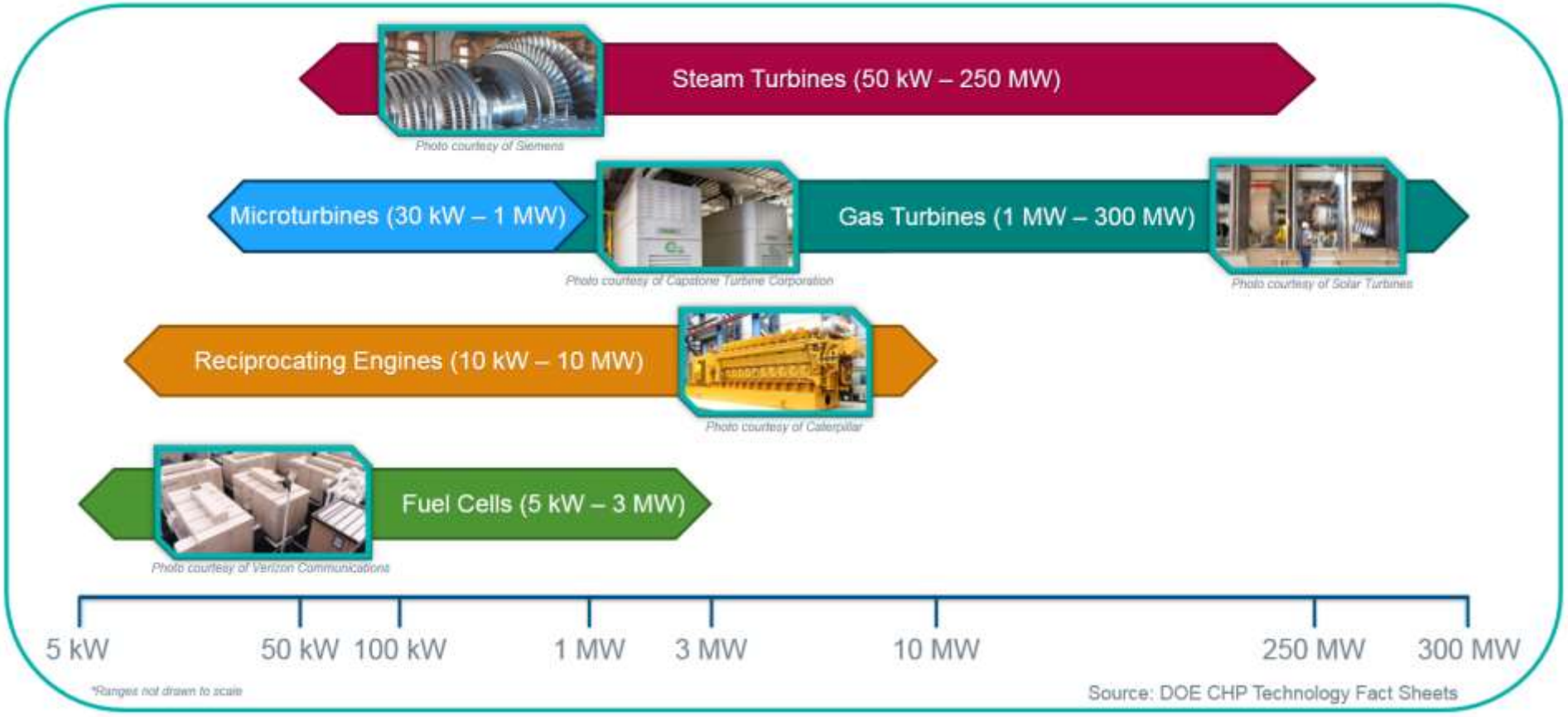
- Form of Distributed Generation (DG)
- An integrated system
- Located at or near a building / facility
- Provides at least a portion of the electrical load and
- Uses thermal energy for:
  - Space Heating / Cooling
  - Process Heating / Cooling
  - Dehumidification



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

Source: www.energy.gov/chp

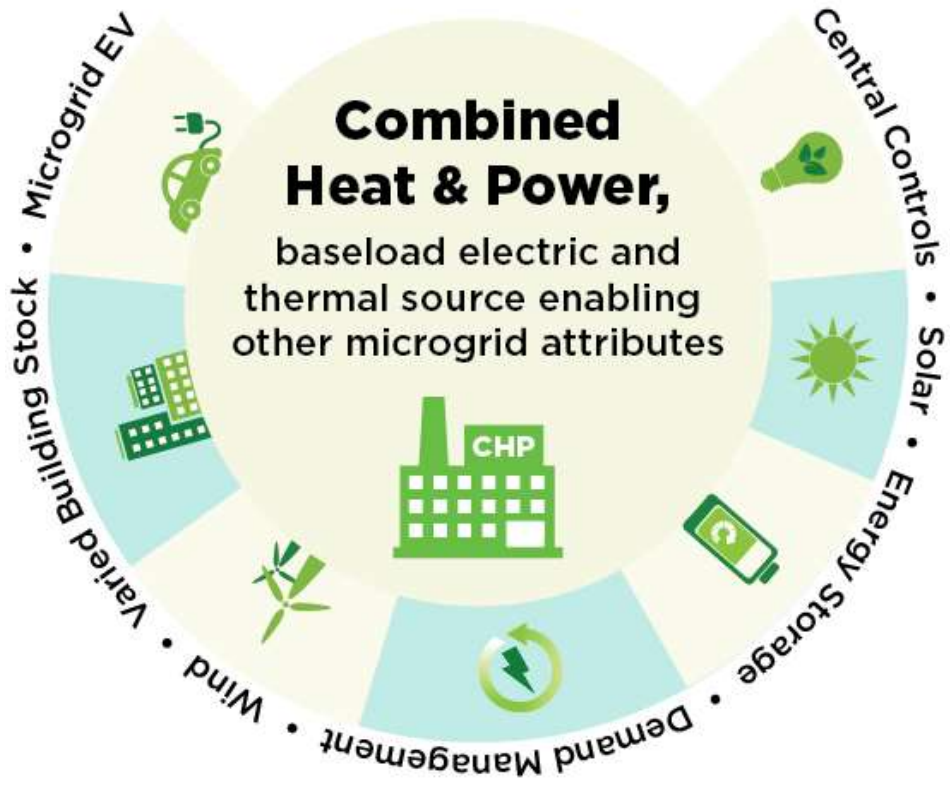
Common CHP Technologies and Capacity Ranges



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 resiliency** and enhance power quality
- On-site electric generation can **reduce grid congestion** and avoid distribution costs.

CHP Can Enable Other Microgrid Technologies



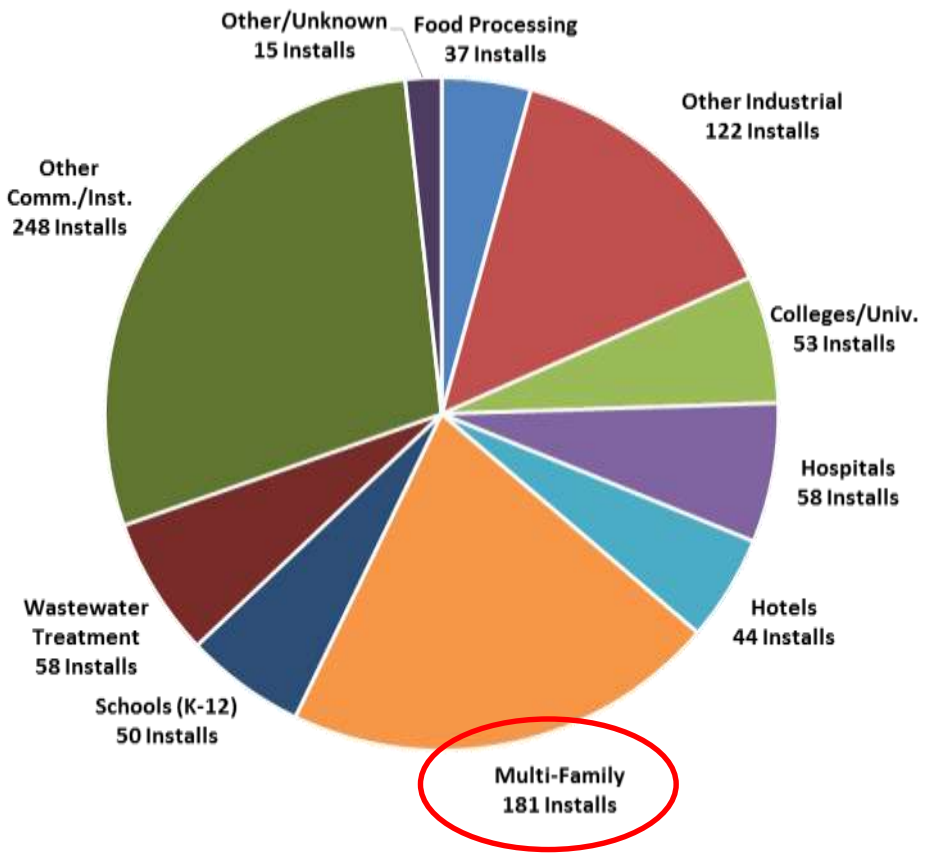
- With a CHP system providing baseload electric and thermal energy, microgrids can add:
  - Solar and wind resources
  - Energy storage
  - Demand management
  - Central controls
  - Electric vehicle charging
- Flexible CHP systems can ramp up and down as needed to balance renewable loads and provide grid services

How does CHP fit into a low carbon energy future?

- **CHP is the most efficient way to use a fossil fuel**
- **Many CHP systems use renewable or waste fuels**
- **Distributed CHP on the grid can help support greater renewable integration**

CHP Today in the United States

By Installations – 866 Installs
2014-2018

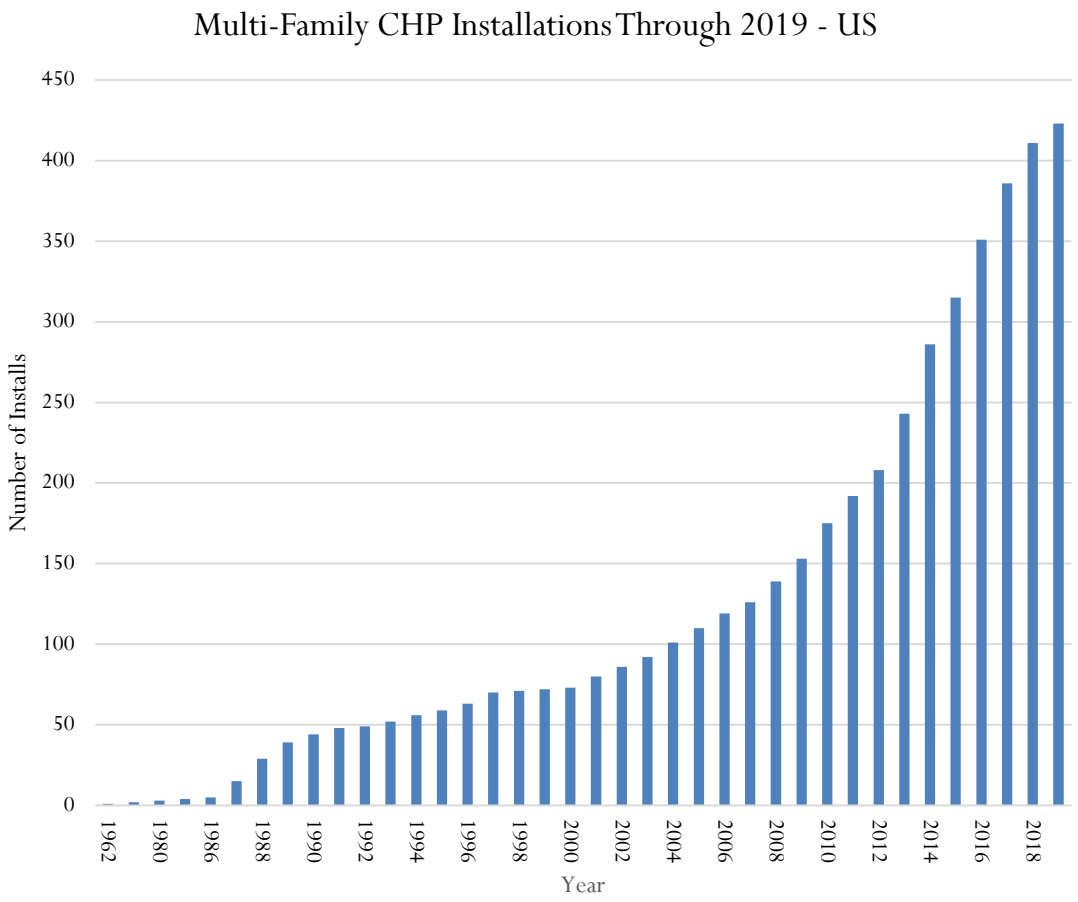


- **81.1 GW** of installed CHP at more than 4,500 industrial and commercial facilities
- 8% of U.S. Electric Generating Capacity; 14% of Manufacturing
- Avoids more than **1.8 quadrillion Btus** of fuel consumption annually
- Avoids **241 million metric tons of CO_2** compared to separate production

Source: DOE CHP Installation Database (U.S. installations as of December 31, 2018)

CHP and Multifamily

State of Multifamily CHP

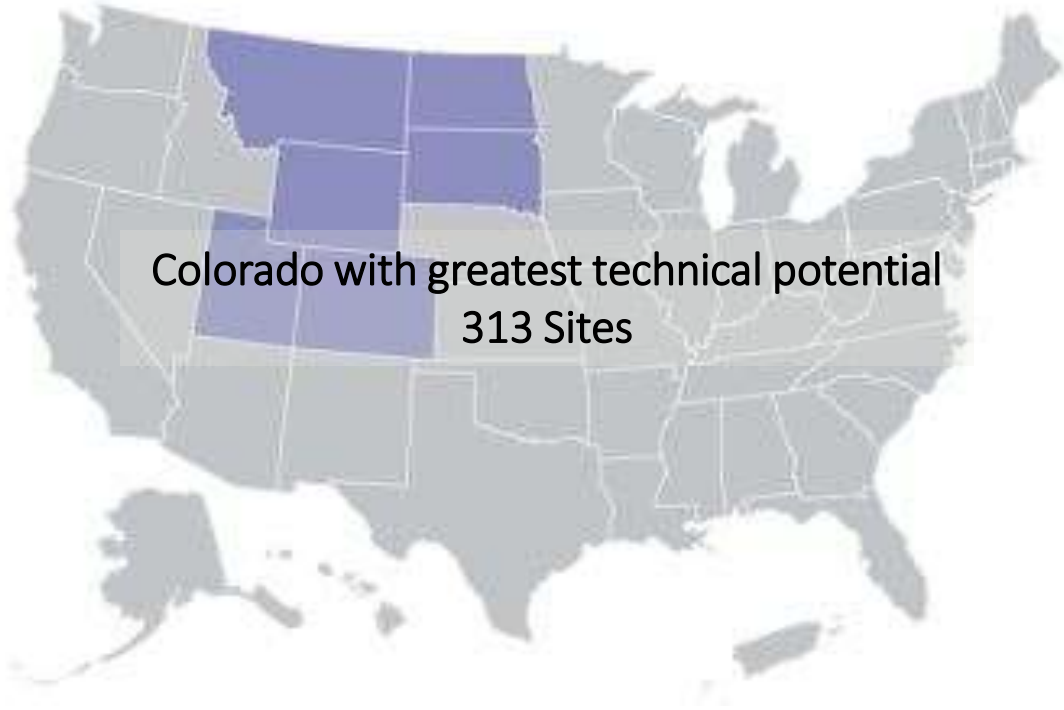


- 425 CHP Systems
- 158 MW
- Average size 371 kW
- Primary Fuel – Natural Gas
- Prime Mover – Reciprocating Engine
- Most Common Geography – New York and New Jersey

Source: DOE CHP Installation Database (U.S. installations as of December 31, 2018)

Why CHP May Work in Multifamily

- Why CHP Works in Multifamily:
  - Inherent market opportunity. Two of every 10 Americans live in a unit in a multifamily building.
  - Many of these buildings contain centralized energy systems that can incorporate CHP.
  - Multifamily buildings operate 24 hours a day, seven days a week, with a consistent need for both electricity, water heating, and space heating/cooling.
  - Benefits of resilient CHP. CHP can allow multifamily buildings to continue operation during utility grid outages, ensuring that critical loads at multifamily buildings stay operational, adding to quality of life for tenants.
  - Multifamily housing's disproportionately high energy use compared to other forms of existing residential construction. Although the dense spatial configuration of multifamily as compared with single-family housing would suggest its greater energy efficiency, the national data contradicts such an assumption. Multifamily buildings make up 18% of the total residential building stock but use 28% of the energy
  - High and stable demands for cooling. These buildings can be served using a CHP system with an absorption chiller that uses the heat from the CHP system to generate chilled water.



Source: https://www.epa.gov/sites/production/files/2019-05/documents/chp_multifamily.pdf

Deciding on CHP for Multifamily

- Is it a single building with 50 or more units? (There are examples of installations in smaller buildings.)
- Is it master metered for electricity? (If not, there is the possibility of switching to master billing from the utility with advanced sub-meters in the apartments that display the varying electricity rates, thus enabling occupants to schedule consumption and reduce their bills).
- Is there a central domestic hot water system rather than units in each apartment?
- Is it an all-electric building? These are good prospects for installing CHP

Source: https://www.epa.gov/sites/production/files/2019-05/documents/chp_multifamily.pdf

Sizing CHP Correctly

- **Sizing to average DHW loads enables efficient utilization of electricity and thermal energy.**
  - This strategy results in a relatively small CHP system, but can be applied to both master metered and direct-metered buildings with central water heating.
- **Common area electric loads are more consistent than tenant electric loads, and sizing to common area loads is a viable strategy, especially for direct-metered buildings**
  - Sizing to the average common area electric load (including exterior lighting and building operations) would result in relatively efficient CHP system operation, with thermal energy utilized for DHW and some space heating loads.
- **Sizing to full building electric loads increases the CHP size, which can result in improved performance and lower per-kW costs, but variable loads may lead to low operational efficiency.**
  - To avoid oversizing for winter months, avoid cooling loads when sizing the CHP system.

With loads for domestic hot water and non-cooling electricity remaining relatively consistent across climate zones, general rules of thumb for CHP sizing can be developed.

Source: https://www.epa.gov/sites/production/files/2019-05/documents/chp_multifamily.pdf

Improving Resilience

How Does CHP Increase Resilience?

- For end users:
  - Provides continuous supply of electricity and thermal energy for critical loads
  - Can be configured to automatically switch to “island mode” during a utility outage, and to “black start” without grid power
  - Ability to withstand long, multiday outages
- For utilities:
  - Enhances grid stability and relieves grid congestion
  - Enables microgrid deployment for balancing renewable power and providing a diverse generation mix
- For communities:
  - Keeps critical facilities like hospitals and emergency services operating and responsive to community needs

Design is Critical for Resilient CHP Systems

- Design criteria can significantly impact the resilience of CHP systems during severe weather events
- Key design considerations include:
  - Elevation of equipment above flood and storm surge levels
  - Utilize containerized or indoor systems to protect from high winds and debris
  - Utilize shock-mount systems enclosures in earthquake-prone areas
  - Equip with fire protection systems for above-ground gas delivery systems

The Texas Medical CHP system remained operational throughout Hurricane Harvey despite significant flooding in the Brays Bayou area (https://www.energy.gov/eere/amo/articles/chp-installation-keeps-hospital-running-during-hurricane-Harvey)

CHP vs. Status Quo

CHP vs. Backup Generation

Metric	CHP	Backup Generation
System Performance	• Designed and maintained to run continuously • Improved performance and reliability	• Only used during emergencies
Fuel Supply	• Natural gas infrastructure typically not impacted by severe weather	• Limited by on-site storage – finite fuel supply
Transition from Grid Power	• May be configured for "flicker-free" transfer from grid connection to "island mode"	• Lag time may impact critical system performance
Energy Supply	• Electricity • Thermal (heating, cooling, hot/chilled water)	• Electricity
Emissions	• Typically natural gas fueled • Achieve greater system efficiencies (80%) • Lower emissions	• Commonly burn diesel fuel

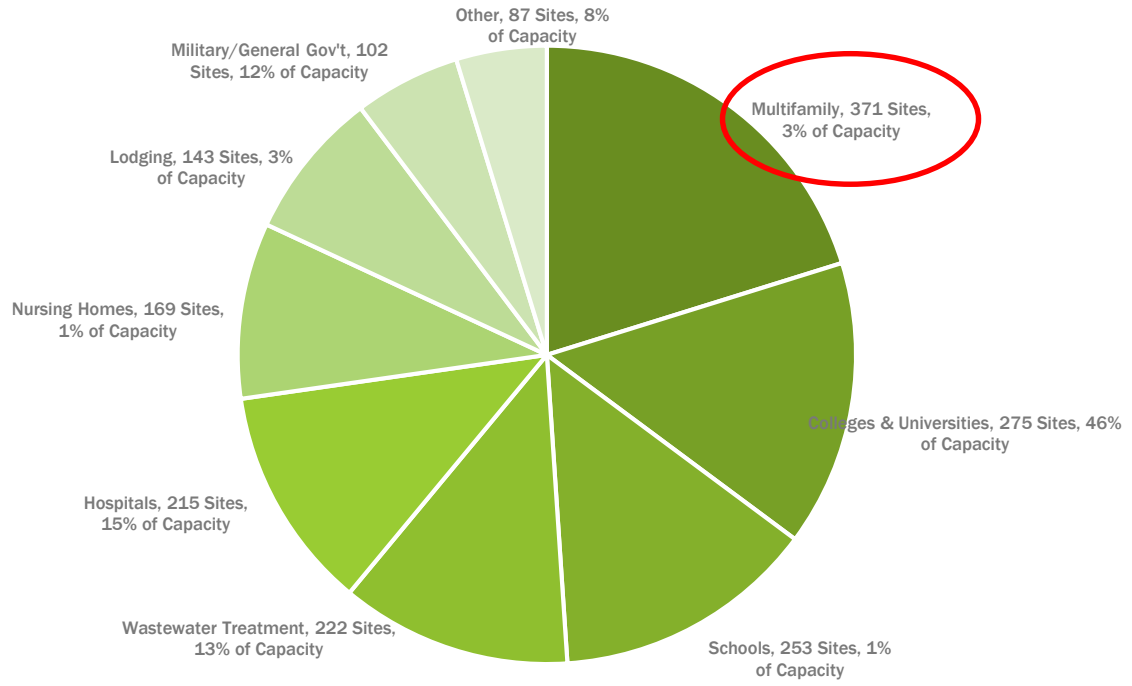
Source: DER Disaster Matrix, Issue Brief, U.S. DOE CHP for Resiliency Accelerator. 2018; Natural Gas Systems: Reliable & Resilient, The Natural Gas Council. 2017; Case Studies of Natural Gas Sector Resilience Following Four Climate-Related Disasters in 2017, ICF Prepared for SoCalGas. 2018.

What are the benefits of CHP in enhancing resilience for end users, utilities and communities?

Who Can Use CHP?

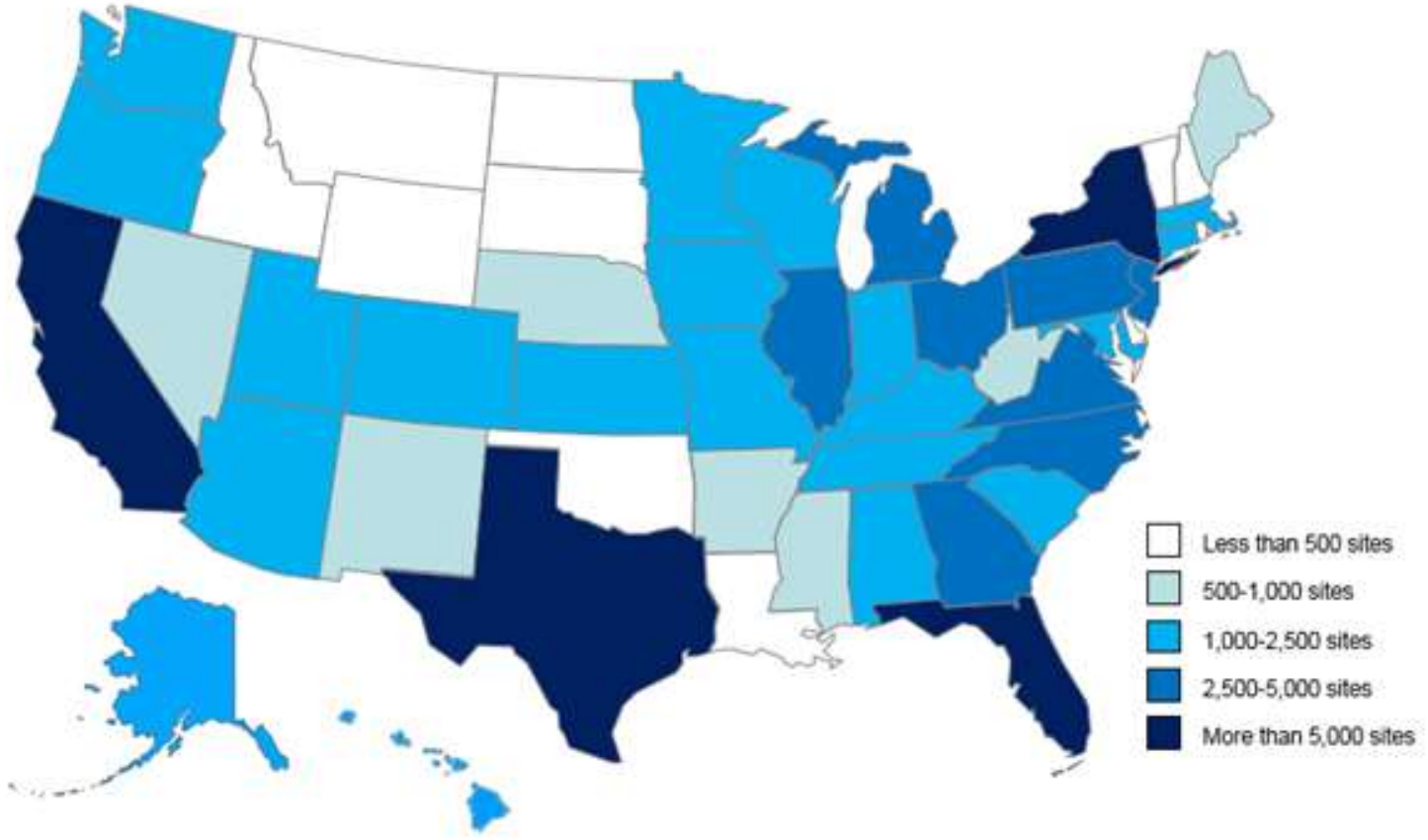
Critical infrastructure sectors conducive to CHP. Host facilities must have a consistent electric and thermal demand, and a reliable source of fuel (pipeline natural gas, anaerobic digester gas, etc.)

Airports	Chemicals & Pharmaceuticals	Colleges & Universities	Critical Manufacturing	Datacenters	Distribution Centers
Fire Stations	Fod Processing	Food Sales & Supermarkets	Government Facilities	Hospitals & Healthcare	Hotels & Lodging
Laundries	Military Bases	Multifamily	Nursing Homes	Police Stations	Prisons
		Schools	Wastewater Treatment Plants		



Critical Infrastructure CHP Installations by Subsector

Critical Infrastructure CHP Potential



Source: U.S. DOE, Combined Heat and Power Technical Potential in the United States. 2016, https://www.energy.gov/sites/prod/files/2016/04/f30/CHP%20Technical%20Potential%20Study%203-31-2016%20Final.pdf

Micro CHP and Applications

Micro CHP

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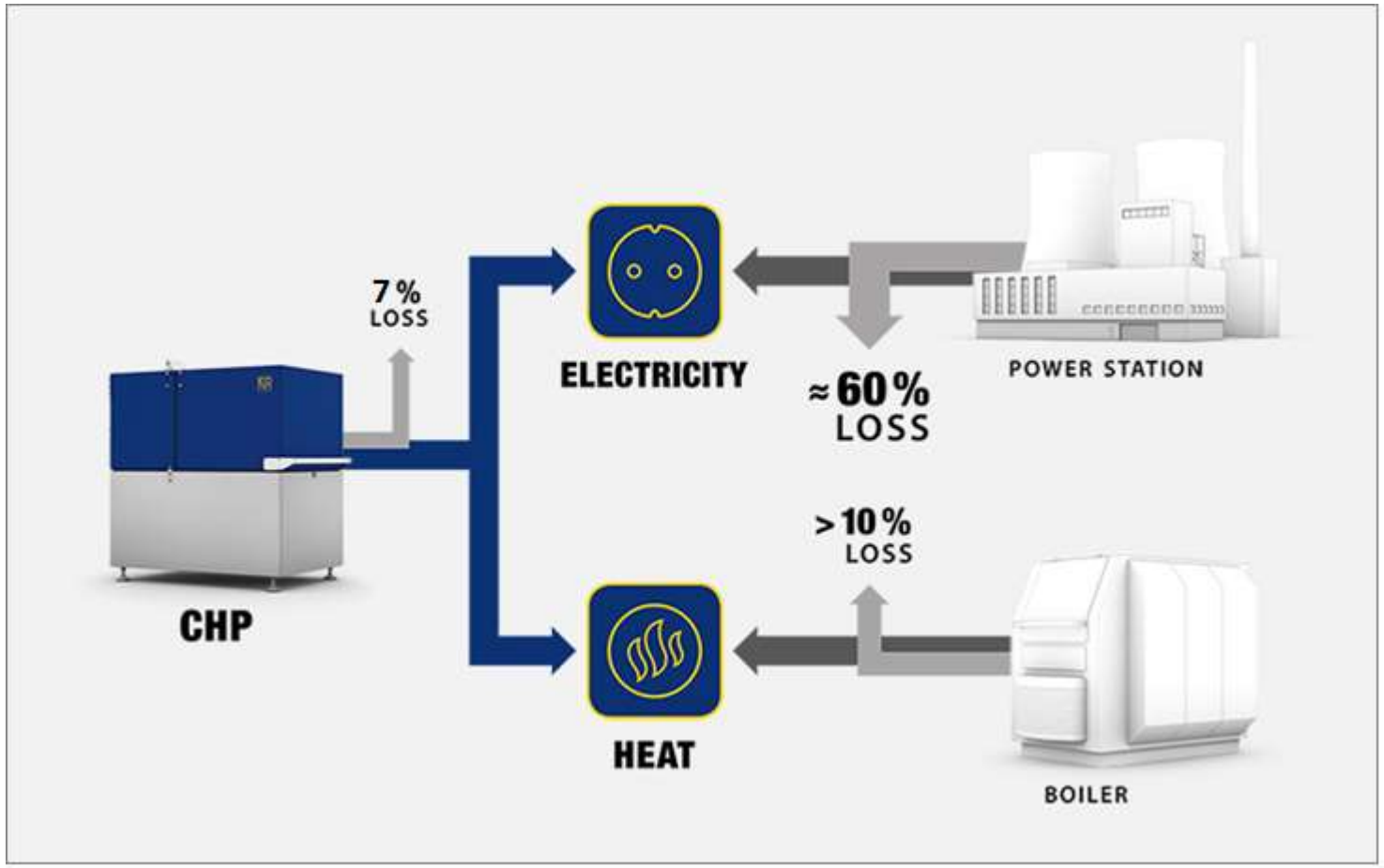
What is μ CHP?

- **CHP is the ability to produce heat *and* power from a single fuel source**

- **μ = Micro (<50kW)**
- **C = Combined**
- **H = Heat**
- **P = Power**



Why Lochinvar CHP?

- Electric production efficiency: 31%
  - No transmission losses
  - Power produced on-site
- Heat production efficiency: 62%
  - Heat is utilized for producing hot water
- Total efficiency: 93% (LHV)
- Reduce Demand Charges
  - Electricity produced at low NG rate
- Reduced greenhouse emissions
  - Clean burning NG with stoichiometric combustion

Why CHP?

- **Demand Charges**
  - The hidden cost in commercial power bills
- Typically based on 15 minute intervals
- Can account for up to 50% of a facilities power expenditures

ABC Utility Company
100 Electricity Circle
Anycity, Anystate 23456

Your Local Company
123 Sunshine Way
Anycity, Anystate 23456

Billing Date:	January 15, 2017
Account Number:	1235678912
Date Due:	**February 15, 2017**
Amount Due:	**$8,312.73**

Your Balance with Us	
Previous Balance	$7,956.89
Payments/Credits	$7,956.89
New Charges	$8,312.73

Payments Received		
Date	Description	Amount
12/15/2017	Payment Received	$7,956.89

Meter Number	Service Period	Elapsed Days	Meter Readings *Previous*	*Current*	Amount Used This Month
3456789	12/15/16- 1/15/17	31	70927	94172	43,256 kWh
3456789	Demand				
	On-peak Demand				500 kW
	Off-peak Demand				150 kW

New Charges	Units		Cost Per Unit	Charge
Basic Charge (fixed fee)				$23.00
Electricity Consumption	23,245	kWh	$0.16253	$3,778.01
Demand Charge - 15 min kW			*Total Demand Charges:*	$4,306
On-peak	500	kW	$7.13	$3,565
Off-peak	150	kW	$4.94	$741
Delivery Charge	23,245	kWh	$0.00619	$143.89
Transmission Charge	23,245	kWh	$0.00266	$61.83
Total Due				**$8,312.73**

Lochinvar XRGI 25 Power Unit

- Efficiency @ 100% Load
  - Electrical 31%
  - Heat 62%
  - Total 93% (LHV)
- Basic Specifications
  - 24kW (81,891 Btu) – 480V 3ph
  - 163,000 Btu Heating Output
  - 262,000 Btu Fuel Input
- Asynchronous generator
    - Requires grid power
- Toyota 4Y NG industrial engine
- Quiet operation 45-50dba **Silence**Plus 46 dBA

Intertek

An **asynchronous generator** or **induction generator** is a type of alternating current (AC) electrical **generator** that uses the principles of **induction** motors to produce power. **Induction generators** operate by mechanically turning their rotors faster than synchronous speed.

Lochinvar

- Multi-Family, Massachusetts

  Pope Tower

  - Installed 2020
  - 25kW-163,000Btu
  - DHW

- Multi-Family, Rhode Island

  Kilmartin Plaza

  - Installed 2020
  - 25kW-163,000Btu
  - DHW

- Multi-Family, Rhode Island

  Valley Apartments

  - Installed 2019
  - 25kW-163,000Btu
  - DHW

- Multi-Family, Rhode Island
  - Spring Villa Apartments
  - Installed 2019
  - 25kW-163,000Btu
  - DHW

Maintenance

- Every 4K-6K hours of operation
- Estimated labor: 2-3 hours
- What's Included:

  13 Gallons Oil, Oil Filter

  Spark Plugs

  Air filter

  O2 Sensor

+

Market Potential

Lochinvar®

Carbon Footprint Reduction

NOx <0.0117 lbs/MMBTU
CO <0.0117 lbs/MMBTU
VOC <0.0059 lbs/MMBTU

Calculation based on EPA CHP Energy & Emissions Savings Calculator

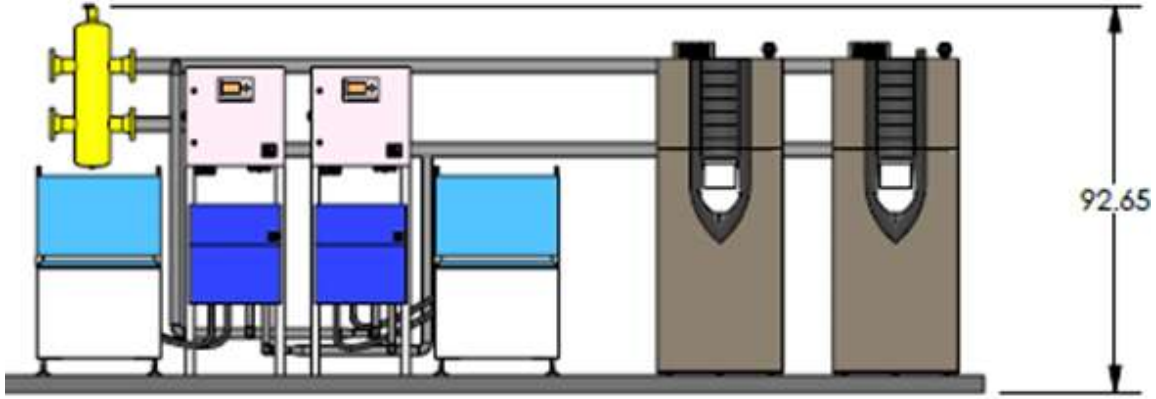
Equal to the annual greenhouse gas emissions from 14 passenger vehicles.

Equal to the annual greenhouse gas emissions from the generation of electricity used by 10 homes.

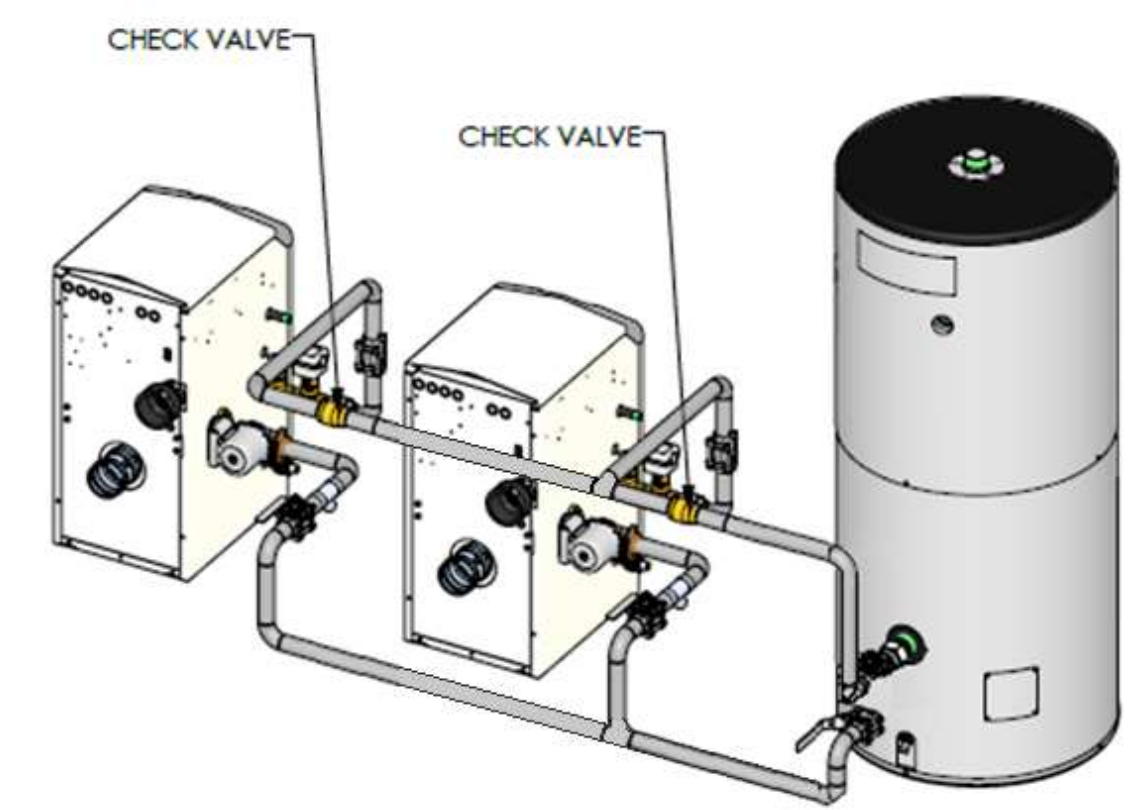
Micro CHP Integration

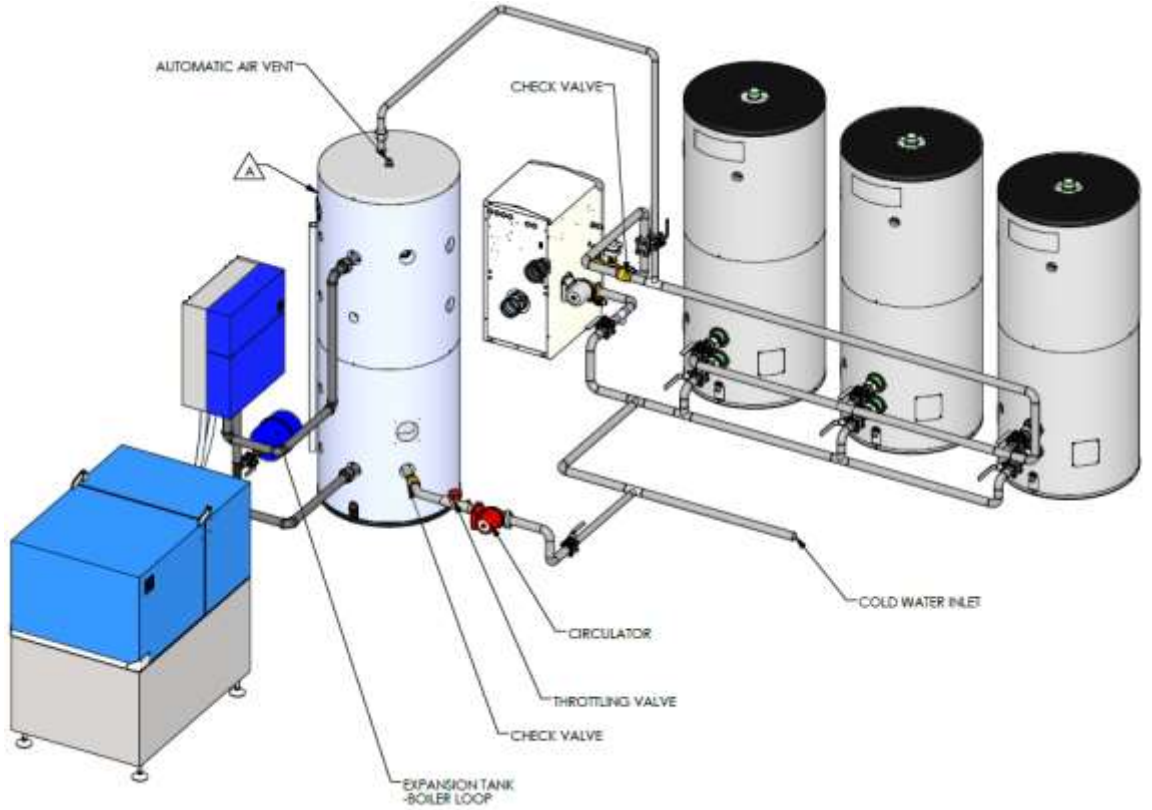
1 - 6 MMBtu 60% Eff

2 – 2.5 MMBtu, 2 – 163K BTU’s, 48KW Elec



Micro CHP Integration



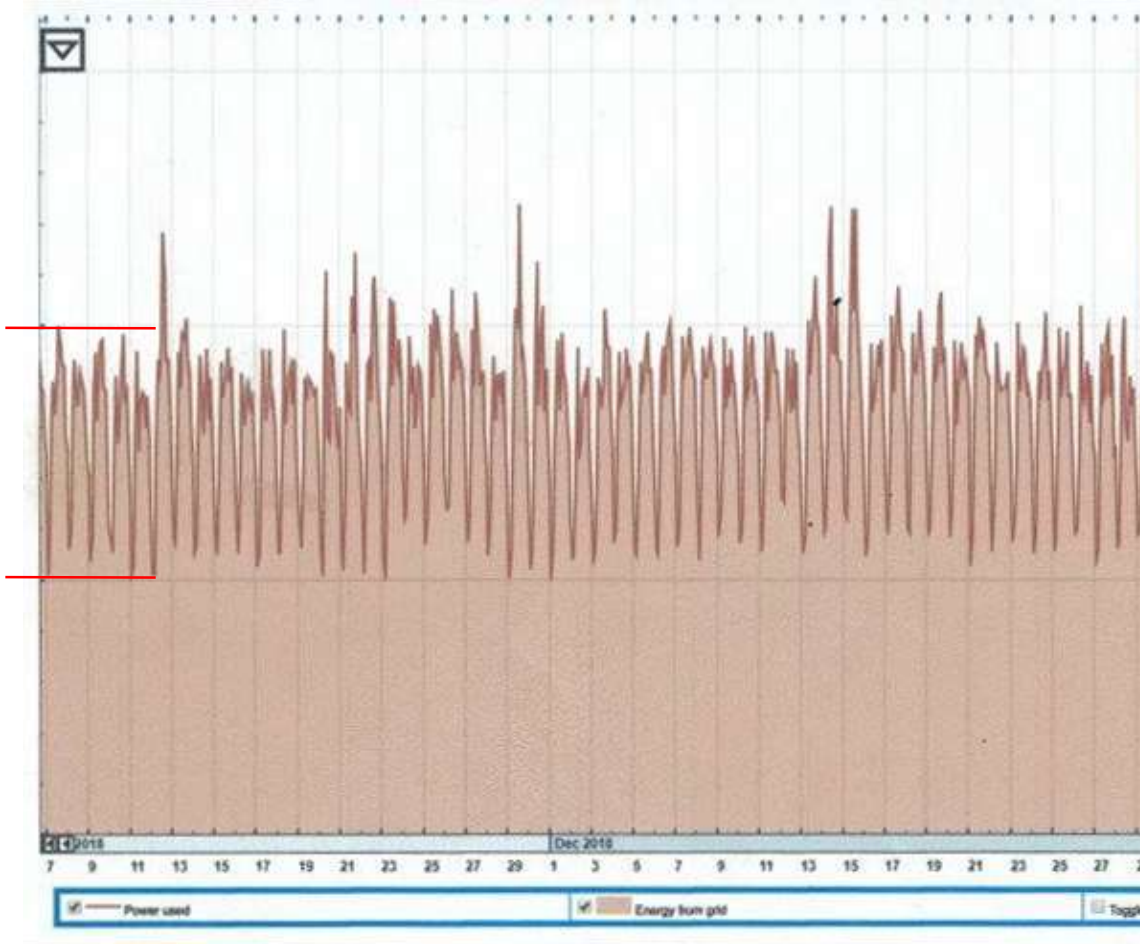


Real Results!

Electrical Grid Demand kW

30kW

10kW



Project Snapshot

Project Snapshot:

Microturbine Application in Apartments

Schmidt Artists Lofts
(revamped Schmidt Brewery)
St. Paul, MN

Application/Industry: Multifamily

Capacity: 65 kW

Prime Mover: Microturbine

Fuel Type: Natural gas

Thermal Use: Heating

Installation Year: 2014

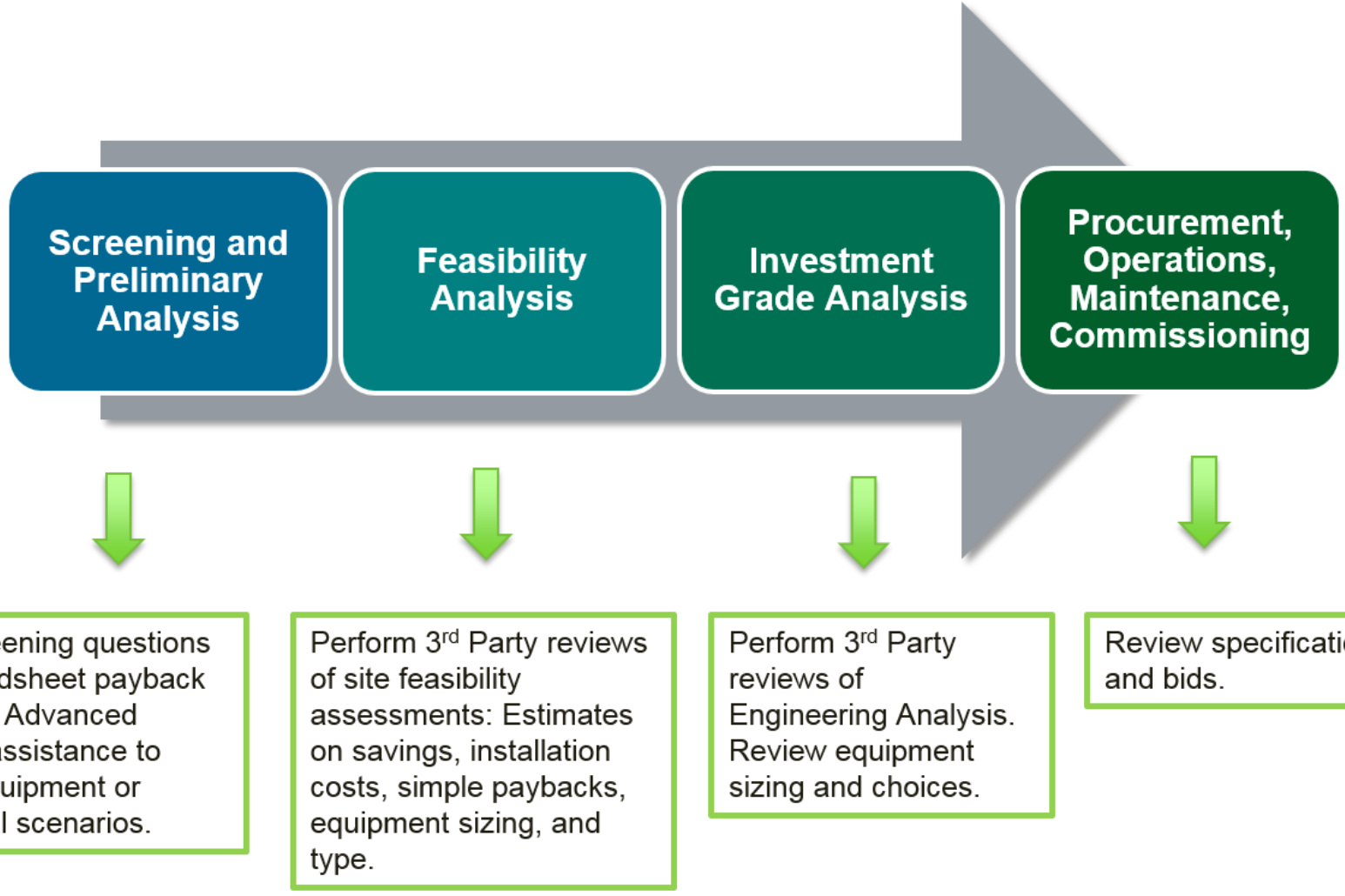
Energy Savings: Unknown

Highlights: The 65 kW "jet engine" produces electricity and thermal energy around the clock. Vergent Power's "Factory Protection Plan" is providing full maintenance coverage through 2024.

Source: www.vergentpower.com; http://www.dominiumapartments.com/

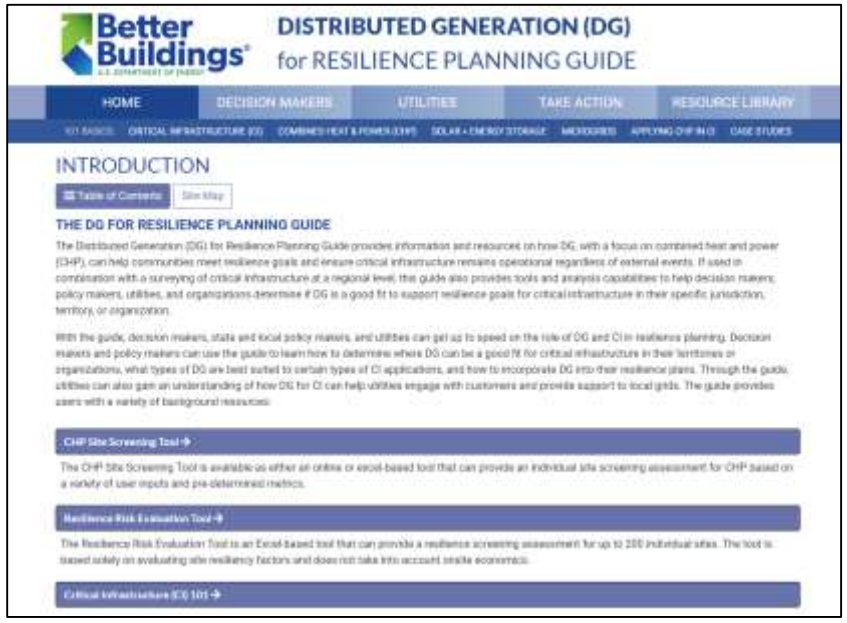
Tools and Resources

CHP TAP Role: Technical Assistance



CHP in Resilience Resources

DG for Resilience Planning Guide



https://dg.resilienceguide.lbl.gov/

CHP: Enabling Resilient Infrastructure for Critical Facilities

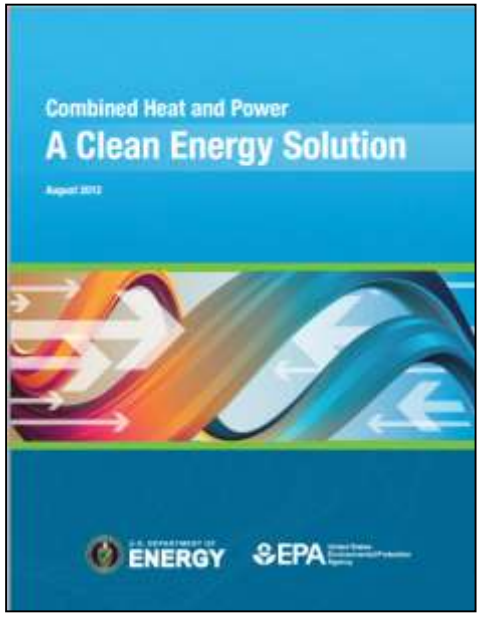
https://www.energy.gov/sites/prod/files/2013/11/f4/chp_critical_facilities.pdf

CHP Resources

CHP Issue Brief Series

https://betterbuildingssolutioncenter.energy.gov/chp/resources-publications

Good Primer Report



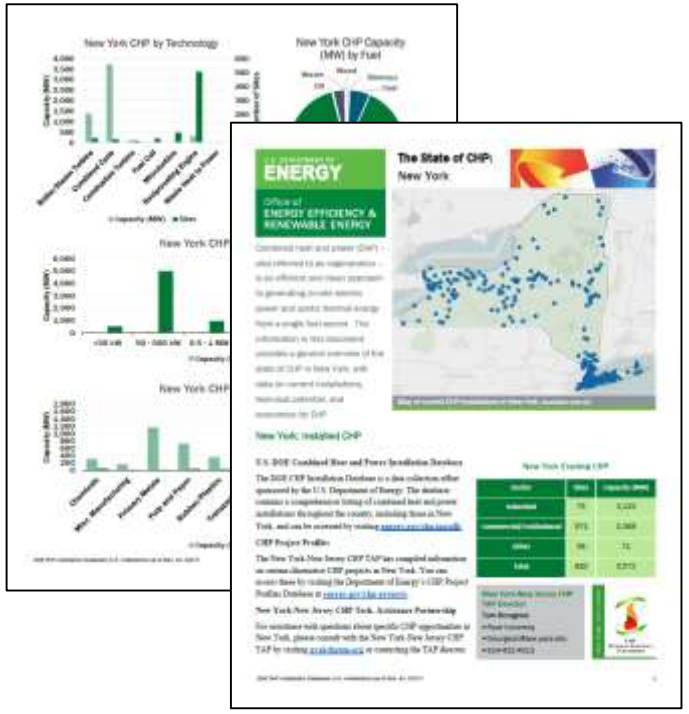
https://www.energy.gov/eere/amo/downloads/chp-clean-energy-solution-august-2012

CHP Resources

DOE CHP Technologies Fact Sheet Series

www.energy.gov/chp-technologies

State of CHP Pages



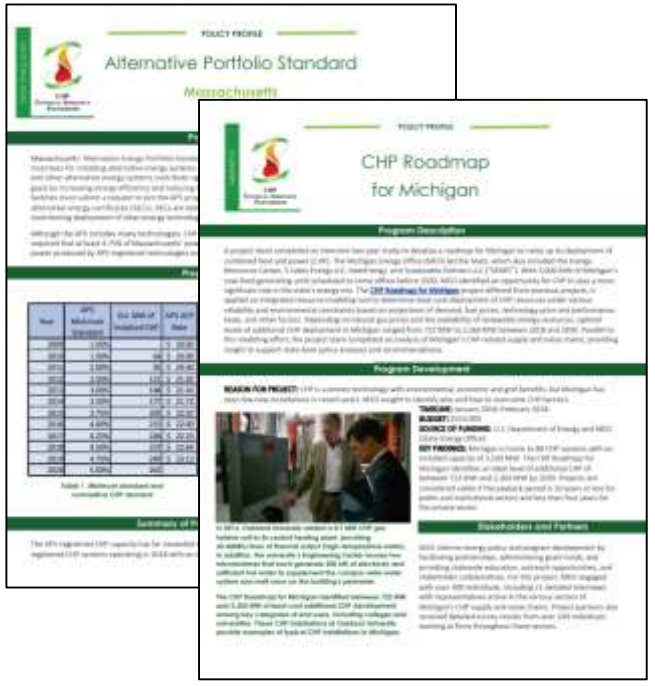
https://www.energy.gov/eere/amo/state-chp-all-50-states-fact-sheet-series

CHP Project Resources

DOE Project Profile Database

energy.gov/chp-projects

DOE Policy/Program Profiles



energy.gov/chptap

CHP Databases

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

energy.gov/chp-installs

EPA dCHPP (CHP Policies and Incentives Database

www.epa.gov/chpdchpp-chp-policies-and-incentives-database

DOE CHP Technical Assistance Partnerships (CHP TAPs)

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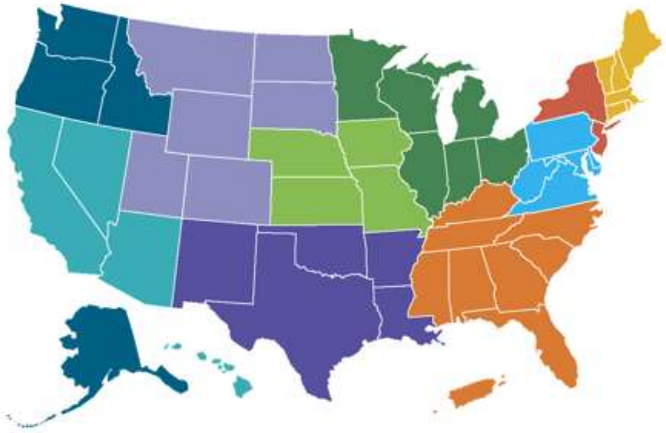

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Summary

- CHP enables
  - Higher overall utilization efficiencies
  - Reduced environmental footprint
  - **Reduced operating costs**
- CHP can be used in different strategies, including **critical infrastructure resiliency**
- **Proven technologies** are commercially available and cover a full range of sizes and applications

Questions?

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Thank You!

IFMA™

International Facility Management Association

Empowering Facility Professionals Worldwide

ESUS

Environmental Stewardship Utilities & Sustainability Community