CHP and the Clean Energy Future

Presentation to the Council of Industrial Boiler Owners (CIBO)
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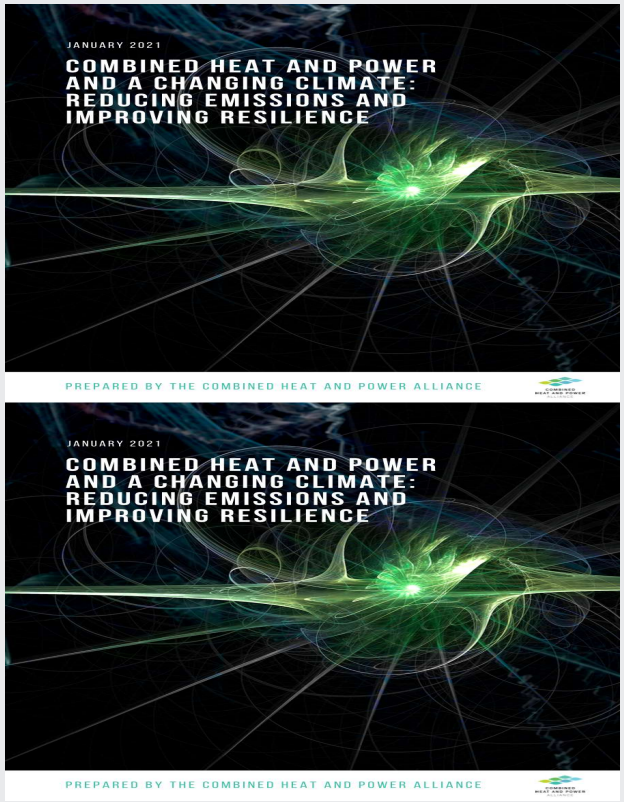
Combined Heat and Power Alliance
Deputy Director

Who We Are


2G
ABetter Way
dalkia aegis
EDF GROUP
AEP ONSITE PARTNERS
An AEP Company
AGA
American Gas Association
ALFA LAVAL
ALTURUS
APPOVIS
Baker Hughes
BGE
An Exelon Company
Blue Delta Energy
BROAD U.S.A. INC.
Capstone
Green Energy
CATERPILLAR
CEM
ENGINEERING
COGENERATION & ENERGY MANAGEMENT
Center for Sustainable Energy
CHP-Funder
Clarke Energy
A KOHLER COMPANY
Engineer · Install · Maintain
CURTIS
POWER SOLUTIONS
dbs
Power and Energy
DE
SOLUTIONS
Durawatts
Cogeneration
EC
POWER
DÜRR
UIC
UNIVERSITY OF ILLINOIS CHICAGO
Energy Resources Center
ESC
Energy Solutions Center
ENGINUITY
POWER SYSTEMS
entropy
research, llc
eSai llc
EXERGY
PARTNERS
CORPORATION
FLEXENERGY
SOLUTIONS
HARC
HERING
HFT
Integrated CHP
Systems Corp.
JENBACHER
INNIO
Kanin Energy
KELLY
KINSLEY
ENERGY SYSTEMS
KRAFT ENERGY SYSTEMS
COMBINED HEAT AND POWER
LIMA
The Right Choice
Lochinvar
MARTIN
ENERGY GROUP
NPGA
NATIONAL PROPANE GAS ASSOCIATION
NORTHEAST – WESTERN
ENERGY SYSTEMS
Power Systems Specialists
ORMAT
Pace Energy and
Climate Center
ELISABETH HAUB SCHOOL OF LAW
PennState
College of Engineering
ROLLS
ROYCE
S&C
SMACNA
SMART
SIEMENS
energy
Solar Turbines
A Caterpillar Company
Sterling Energy Group, LLC
THERMAX
VEOLIA
Washington
Gas
A WGL Company
Energy Program
WASHINGTON STATE UNIVERSITY
www.WorldCogenerationDay.org
September 4th

What We Do


JANUARY 2021
COMBINED HEAT AND POWER AND A CHANGING CLIMATE: REDUCING EMISSIONS AND IMPROVING RESILIENCE
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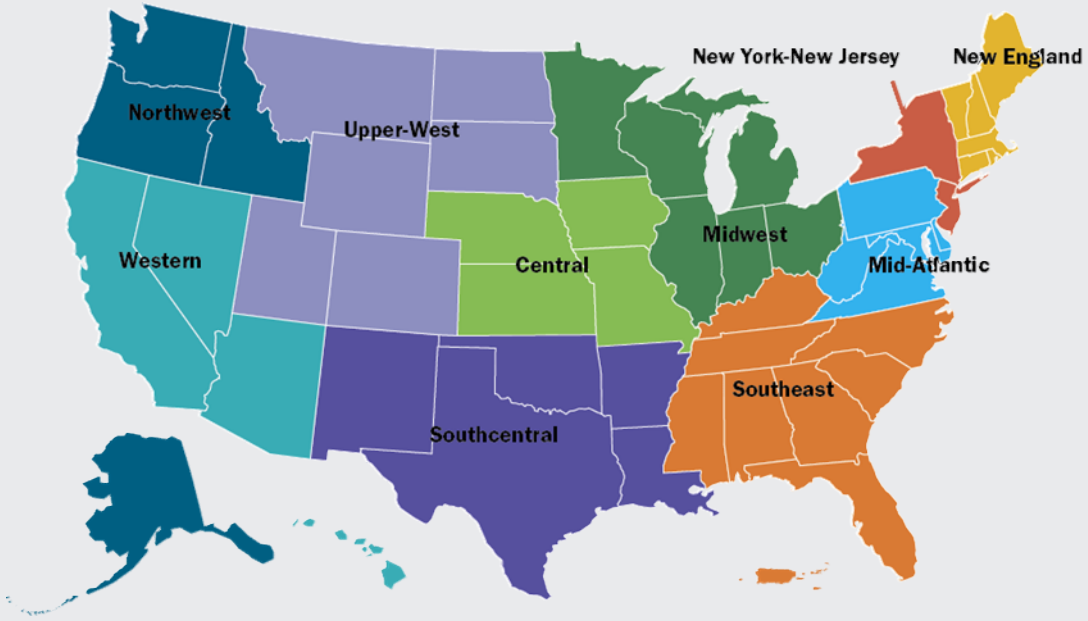
September 13-15, 2021


Combined Heat and Power Alliance Presents
THE TECHNOLOGY SERIES
Blog posts highlighting new technologies in the CHP industry.

CHP Resources

- **CHP TAPs**
  - https://betterbuildingssolutioncenter.energy.gov/chp/chp-taps
- **US DOE CHP eCatalog of packaged CHP systems**
  - https://chp.ecatalog.lbl.gov/search
- **NREL REopt Lite tool**
  - https://reopt.nrel.gov/tool
- **EPA CHP Energy and Emissions Savings Calculator**
  - https://www.epa.gov/chp/chp-energy-and-emissions-savings-calculator
- **CHP Project Profiles**
  - https://betterbuildingssolutioncenter.energy.gov/chp/chp-project-profiles-database

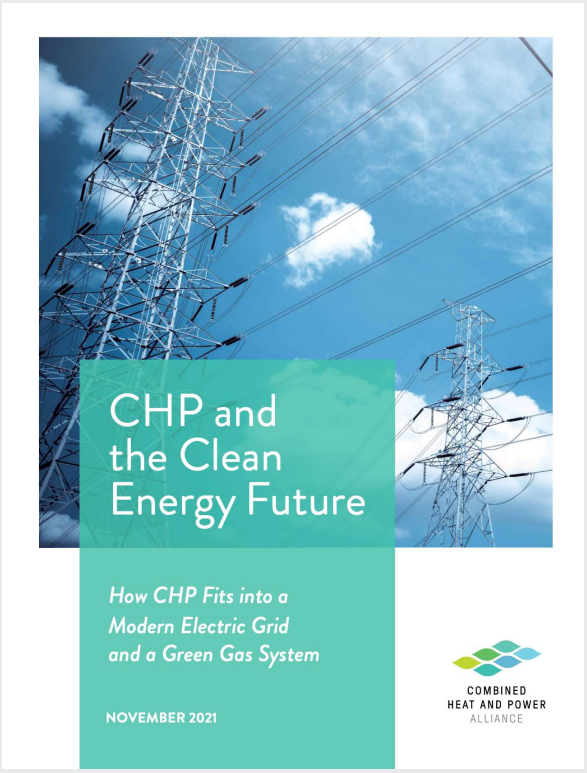
CHP TAPs Regions



https://betterbuildingssolutioncenter.energy.gov/chp/chp-taps

CHP and the Clean Energy Future

- The electric grid of the future will connect more distributed resources, will include more microgrids, and will be less carbon intensive.
- CHP systems are an integral part of the grid of the future, providing energy close to where it is consumed, enhancing resiliency, and reducing emissions.
- The gas system of the future will be greener as well, incorporating more clean fuels such as renewable natural gas (RNG) and clean hydrogen.
- CHP systems are an important part of this system too, as they can use these clean fuels efficiently, requiring less fuel inputs to achieve the same energy outputs.



CHP and the Clean Energy Future: Key Aspects of CHP

- Highly efficient
- Less fuel inputs for same energy outputs, reduces emissions
- Integration with other energy resources, including wind and solar
- Backbone of many microgrids
- Provide generating capacity to the utility grid
- Can use renewable and lower-carbon fuels
- Highly resilient


REPORT IN BRIEF

CHP AND THE CLEAN ENERGY FUTURE

How CHP Fits into a Modern Electric Grid and a Green Gas System

Combined heat and power (CHP) systems are an important part of our nation's energy future as we collectively seek energy resources that are cleaner, reliable, and more resilient.

The electric grid of the future will connect more distributed resources, will include more microgrids, and will be less carbon intensive. CHP systems are an integral part of the grid of the future, providing energy close to where it is consumed, enhancing resiliency, and reducing emissions.

The gas system of the future will be greener as well, incorporating more clean fuels such as renewable natural gas (RNG) and clean hydrogen. CHP systems are an important part of this system too, as they can use these clean fuels efficiently, requiring less fuel inputs to achieve the same energy outputs.

The grid of the future will connect more distributed resources, include more microgrids, and be less carbon intensive. CHP systems are an integral part of this future grid.

CHP is an integral component of both the electric grid of the future and a future greener gas system. CHP is a clean, reliable, and resilient energy resource that can help governments, utilities, businesses, institutions, and communities meet their energy system goals, including reducing emissions, saving money, maintain energy reliability, and improving resiliency in the face of a changing climate.

Attributes of CHP systems make this technology uniquely qualified to provide cleaner, reliable, and more resilient electric and thermal energy resources, including:

- In almost all regions of the U.S., CHP systems installed through 2035 and operating through 2050 are expected to cause a net reduction in carbon emissions over their system life.

The gas system of the future has the potential to be less carbon-intensive.

systems are an important part of this system too, as they can use these clean fuels efficiently, requiring less fuel inputs to achieve the same energy outputs.

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The gas system of the future has the potential to be less carbon-intensive.

- Properly designed CHP systems typically operate with an overall efficiency of 65-85 percent.
- CHP systems require less fuel inputs for the same energy outputs, saving money and reducing emissions.
- CHP can be integrated with other clean resources, including as part of a net-zero energy facility.
- CHP is the backbone of many microgrids, and used in 67% of continuously operating microgrids in the U.S.
- Flexible CHP systems can provide generating capacity to the utility electric grid when demand increases or intermittent renewable resources are not available.
- Renewable and lower-carbon fuel technologies such as RNG and hydrogen can serve as the primary fuel source for CHP systems.

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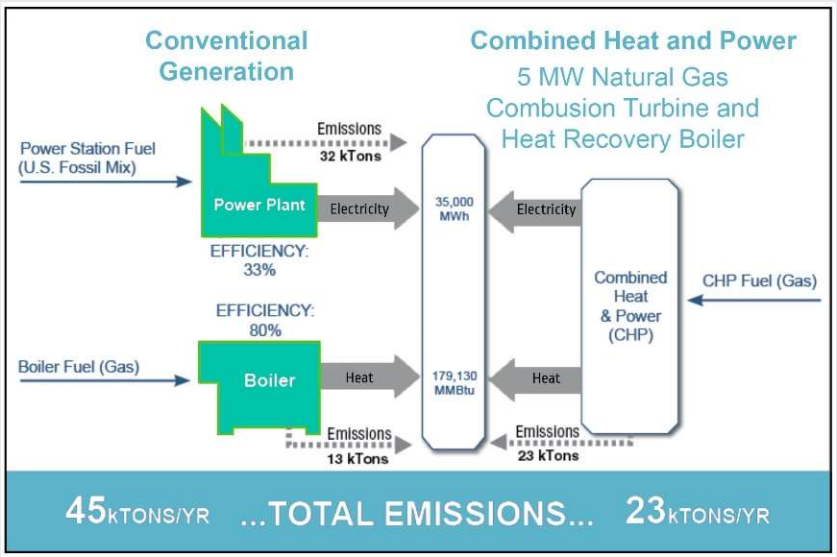
CHP and Emissions

- CHP uses a single fuel source to generate both heat and electricity. CHP's key advantage is efficiency – more than twice the energy efficiency of the average power plant.
- CHP uses less fuel to provide the same energy services, so it can reduce all emissions including criteria pollutants and GHG emissions.

35% Reduction of CO_2 Emissions

CO_2 Emissions – 5 MW CHP Versus 5 MW of Separate Heat and Power Production

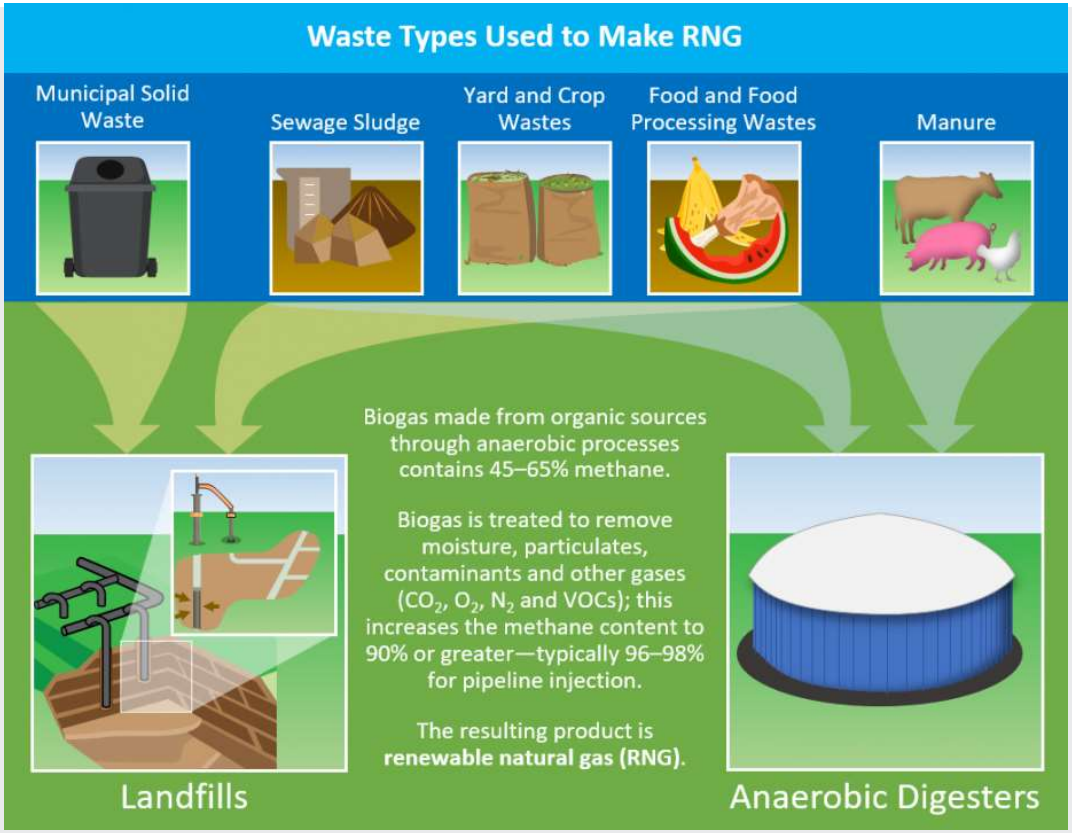


Source: U.S. EPA, 2015, https://bit.ly/2E2lByK.

CHP and Emissions

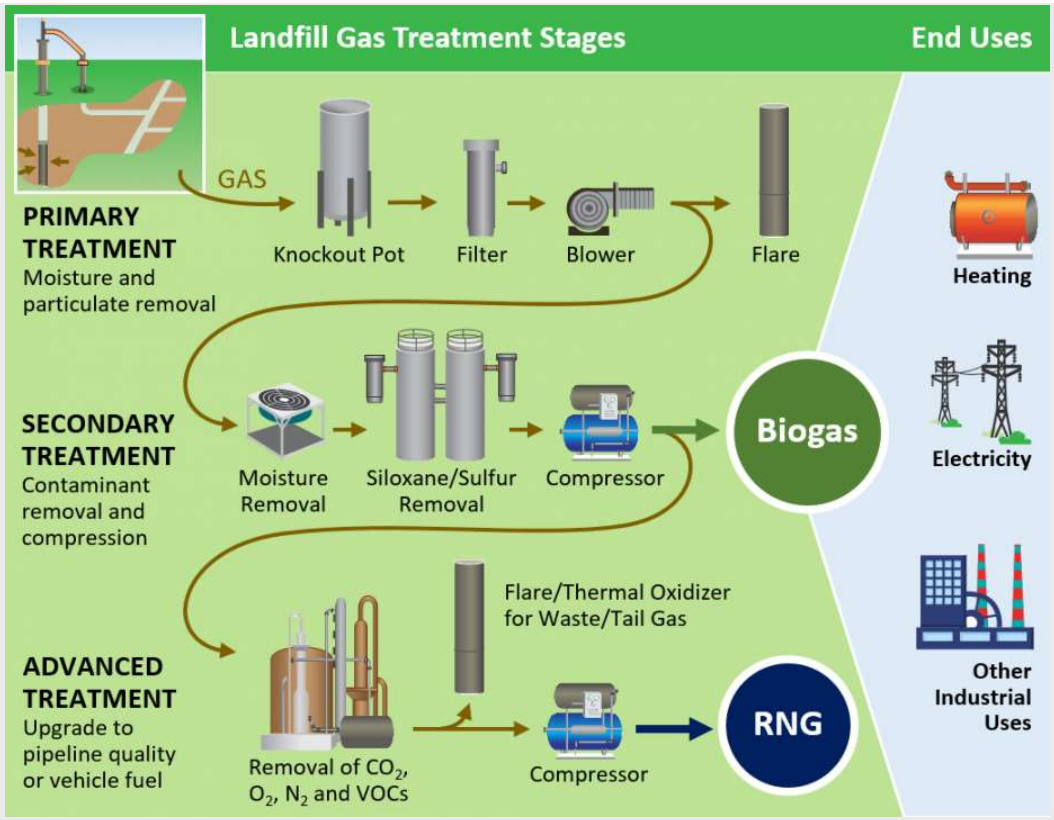
- CHP systems reduce emissions because they:
  - Are highly efficient
  - Displace higher-emitting marginal grid resources
  - Have a high capacity factor
  - Enable intermittent renewable resources
  - Can use lower-carbon fuels
  - Can be paired with carbon capture

Lower-Carbon Fuels: Biogas and RNG



Source: U.S. EPA, https://www.epa.gov/lmop/renewable-natural-gas.

Lower-Carbon Fuels: Biogas and RNG



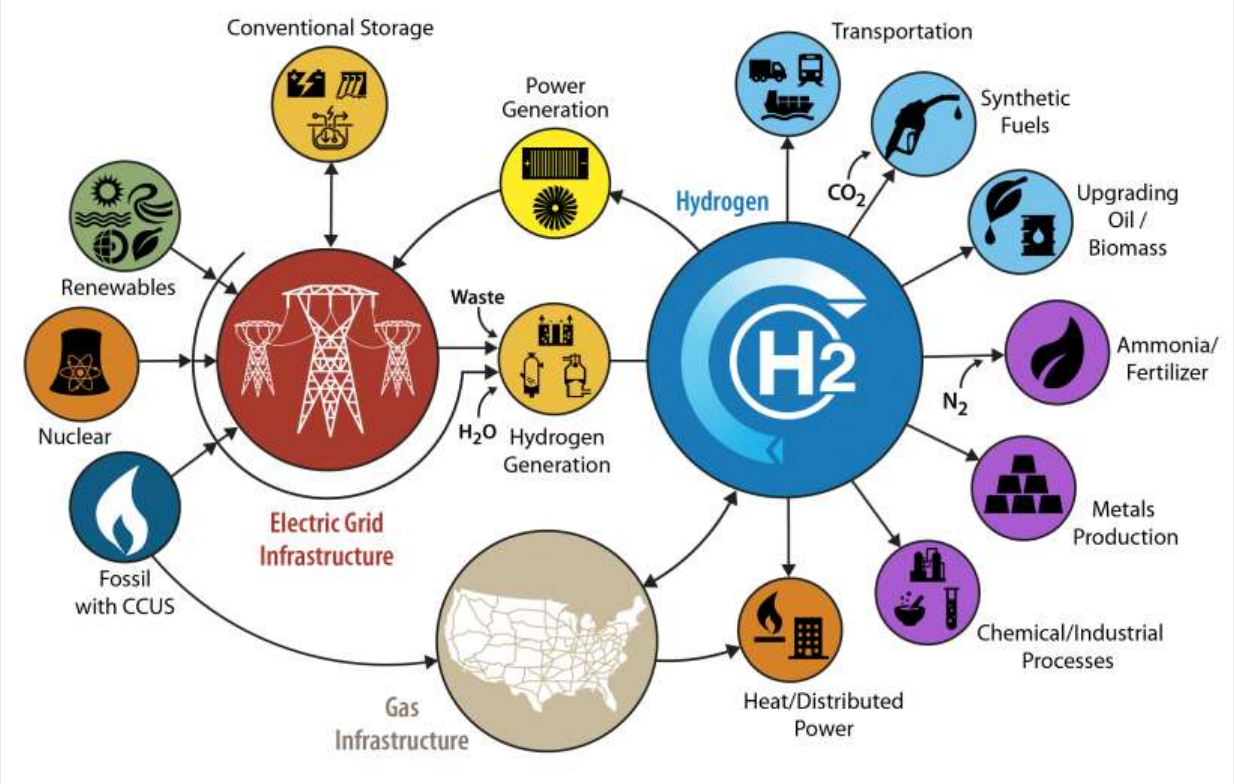
Source: U.S. EPA, https://www.epa.gov/lmop/renewable-natural-gas.

Lower-Carbon Fuels: Hydrogen

Types of Hydrogen		
green	**blue**	**grey**
produced using renewable electricity	produced using natural gas, carbon emissions captured and stored	produced using natural gas

Lower-Carbon Fuels: Hydrogen

H2@Scale



Source: U.S. DOE Hydrogen and Fuel Cell Technologies Office, https://www.energy.gov/eere/fuelcells/h2scale.

CHP and Resilience

- Increased reliance on the electric grid increases the impact grid disruptions have on businesses, industry, and communities.
- CHP can reliably deliver power and thermal energy locally for critical infrastructure.
- CHP systems can support industrial and manufacturing facilities that are essential to the reliable supply of food and health and safety products.

Matrix of DER Vulnerability to Weather Events

Natural Disaster or Storm Events	Flooding	High Winds	Earthquakes	Wildfires	Snow/Ice	Extreme Temperature
Battery Storage	◒	○	◒	●	○	◒
Biomass/Biogas CHP	◒	◒	◒	●	○	○
Distributed Solar	○	◒	◒	●	◒	◒
Distributed Wind	○	◒	◒	◒	◒	◒
Natural Gas CHP	○	○	◒	◒	○	○
Standby Generators	◒	○	◒	●	◒	○

Ranking Criteria

Four basic criteria were used to estimate the vulnerability of a resource during each type of disaster event. They include the likelihood of experiencing:

1. *a fuel supply interruption,*
2. *damage to equipment,*
3. *performance limitations, or*
4. *a planned or forced shutdown*

○ *indicates the resource is unlikely to experience any impacts*

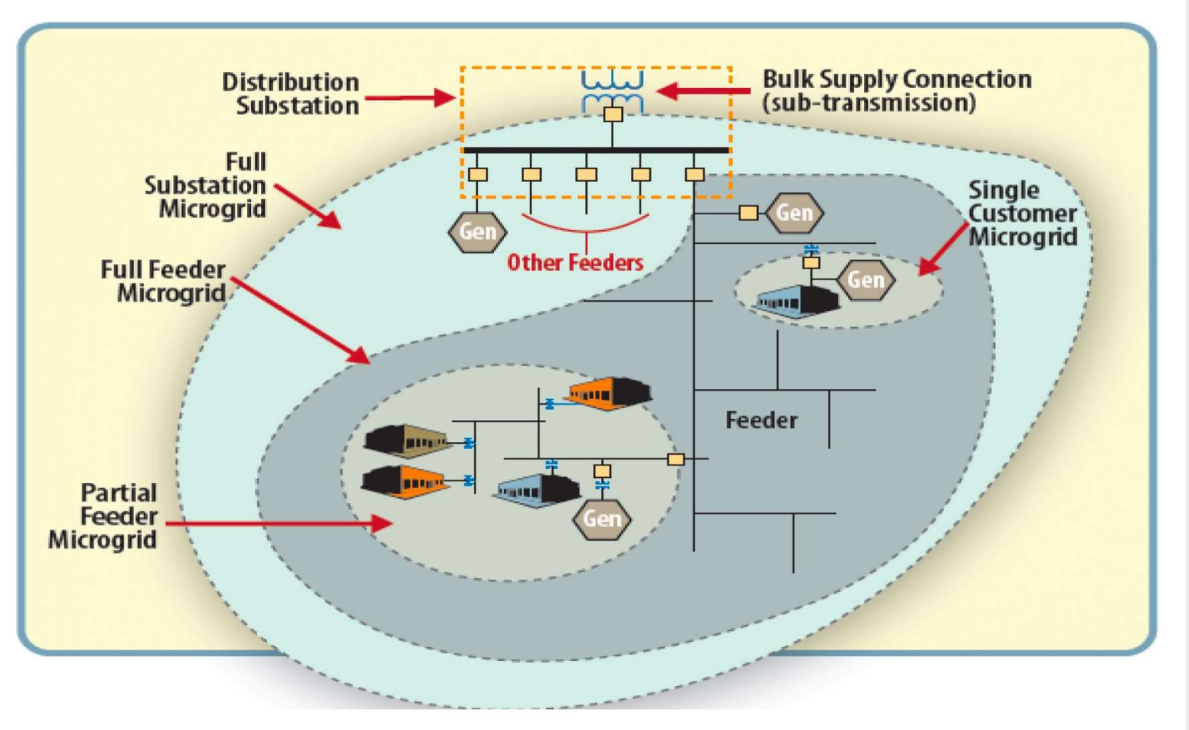
◒ *indicates the resource is likely to experience one, two, or three impacts*

● *indicates the resource is likely to experience all four impacts*

Better Buildings: U.S. Department of Energy. "Issue Brief: Distributed Energy Resources Disaster Matrix." https://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/DER_Disaster_Impacts_Issue%20Brief.pdf

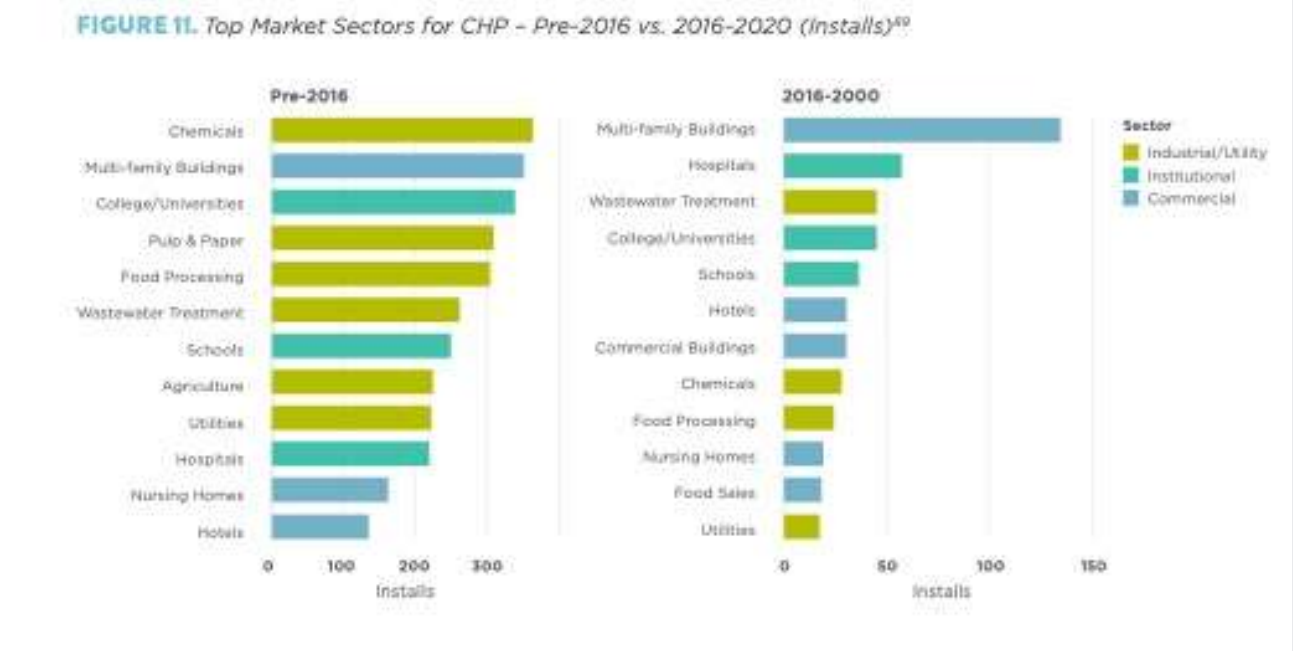
CHP and Microgrids

The Role of Microgrids in Helping to Advance the Nation's Energy System



Source: U.S. Department of Energy Office of Electricity, https://www.energy.gov/oe/activities/technology-development/grid-modernization-and-smart-grid/role-microgrids-helping.

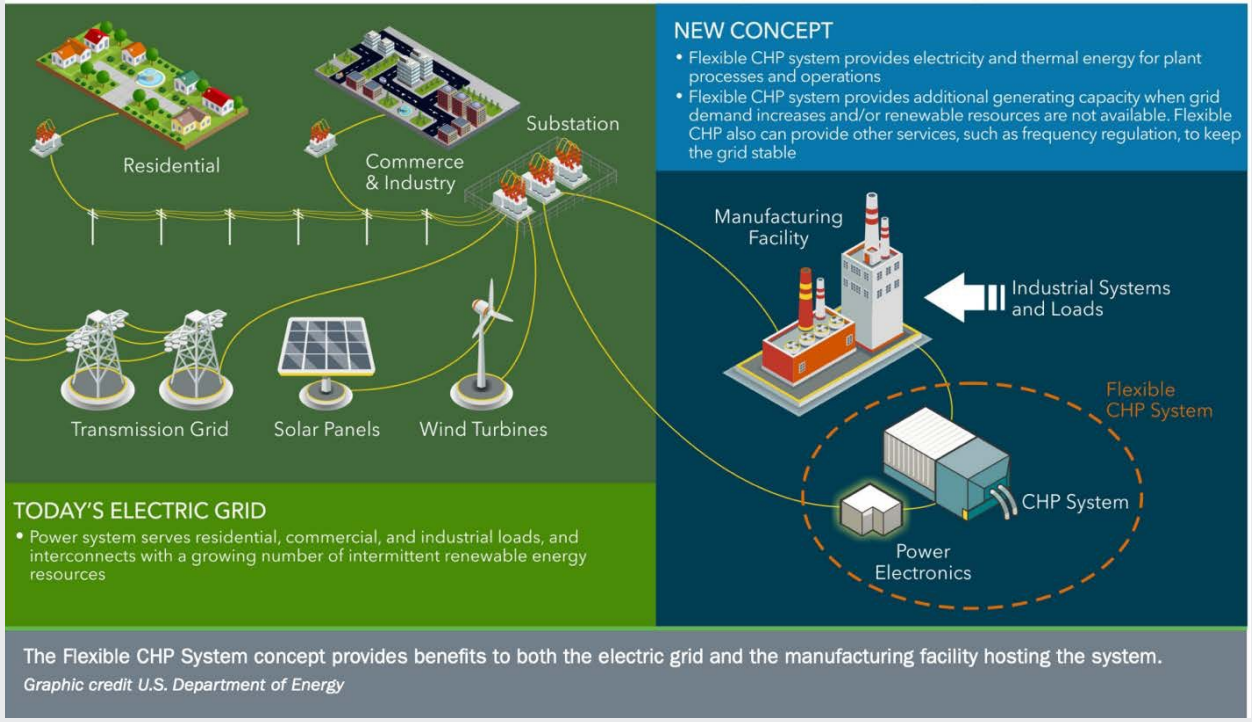
CHP Trends



Source: David Jones, ICF, "CHP State of the Market," National Summit on CHP, State of the Market panel, September 13, 2021.

CHP Trends

FIGURE 10. *Flexible Combined Heat and Power Systems — The Concept*[76]



Source: "Flexible Combined Heat and Power (CHP) Systems," U.S. Department of Energy Office of Energy Efficiency and Renewable Energy, January 2018, https://www.energy.gov/sites/prod/files/2018/01/f47/Flexible%20CHP%20Comms_01.18.18_compliant.pdf.

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HEAT AND POWER
ALLIANCE

Thank you!

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