

The Benefits of CHP And WHP at Industrial Facilities

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CHP Technical Assistance Partnerships
SOUTHCENTRAL

DOE CHP Technical Assistance Partnerships (CHP TAPs)

- **End User Engagement**

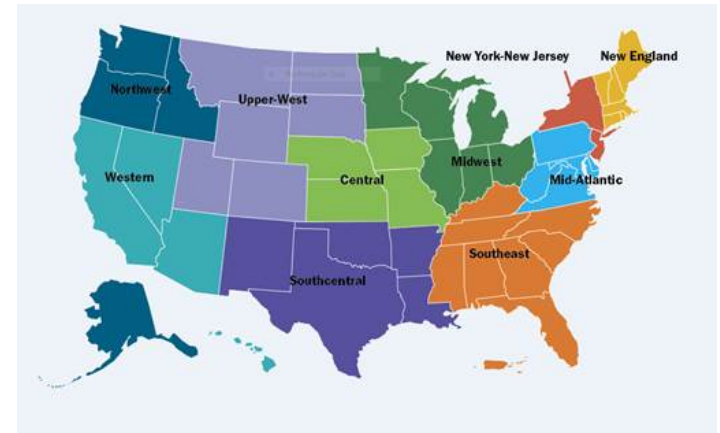
Partner with strategic End Users to advance technical solutions using CHP as a cost effective and resilient way to ensure American competitiveness, utilize local fuels and enhance energy security. CHP TAPs offer fact-based, non-biased engineering support to manufacturing, commercial, institutional and 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.

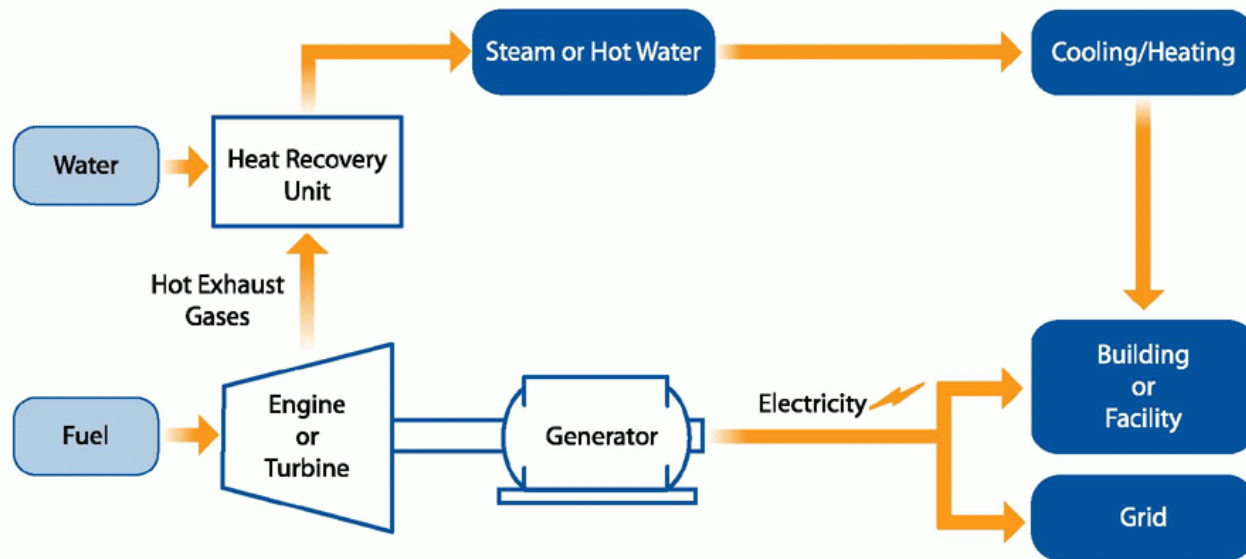


www.energy.gov/chp

CHP Overview

Reciprocating Engine or Turbine with Heat Recovery

- Gas or liquid fuel is combusted in a prime mover, such as a reciprocating engine, microturbine, or gas turbine
- The prime mover is connected to a generator that produces electricity
- Energy normally lost in the prime mover's hot exhaust and cooling system is recovered to provide useful thermal energy for the site



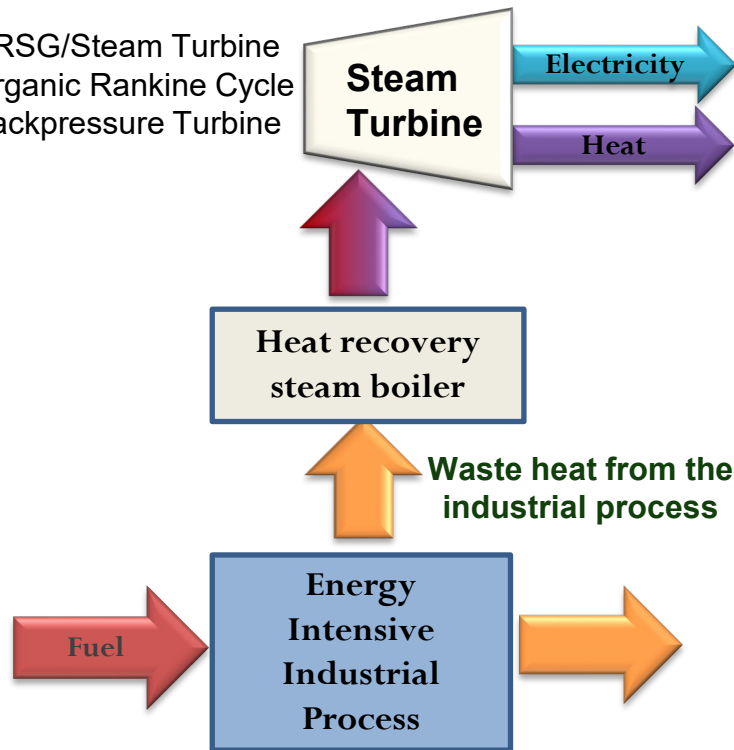
Defining Combined Heat & Power (CHP)

The on-site simultaneous generation of two forms of energy (heat and electricity) from a single fuel/energy source

Waste Heat to Power CHP

(also referred to as Bottoming Cycle CHP or Indirect Fired CHP)

- HRSG/Steam Turbine
- Organic Rankine Cycle
- Backpressure Turbine



- Fuel first applied to produce useful thermal energy for the process
- Waste heat is utilized to produce electricity and possibly additional thermal energy for the process
- Simultaneous generation of heat and electricity
- No additional fossil fuel combustion (*no incremental emissions*)
- Normally produces larger amounts electric generation (*often exports electricity to the grid; base load electric power*)



Common CHP Technologies and Capacity Ranges



*Ranges not drawn to scale

Source: DOE CHP Technology Fact Sheets

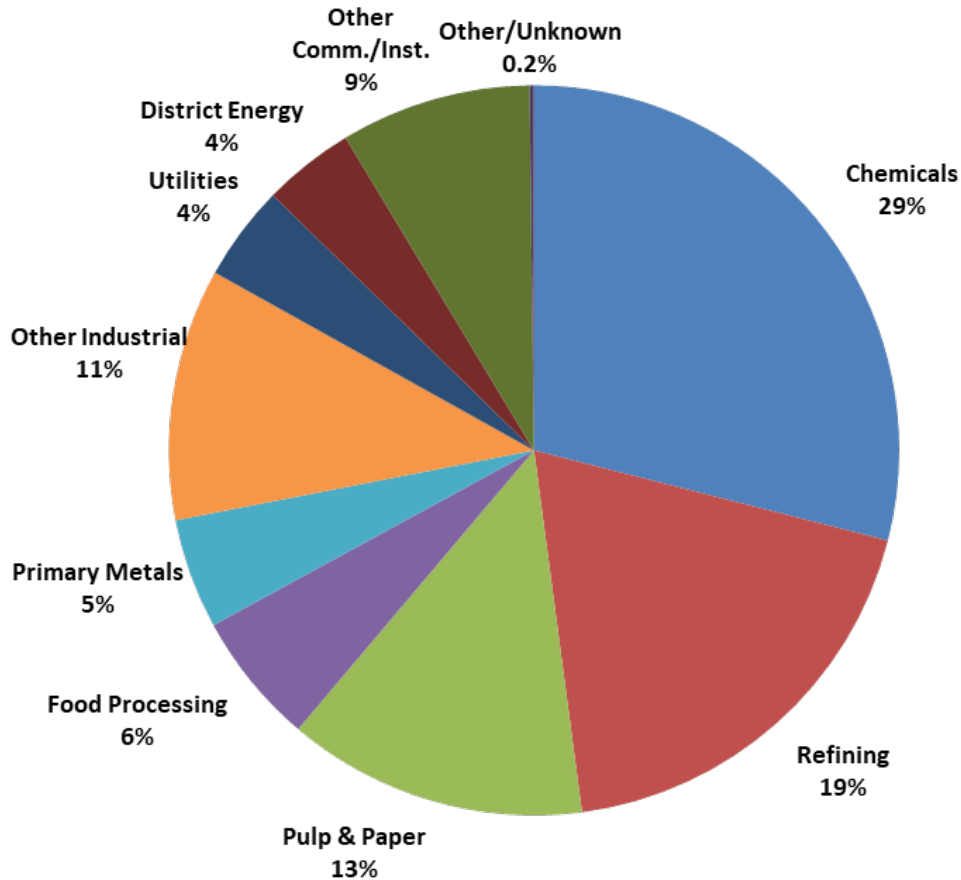
What Are the Benefits of CHP?

- 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 Today in the United States

Existing CHP Capacity

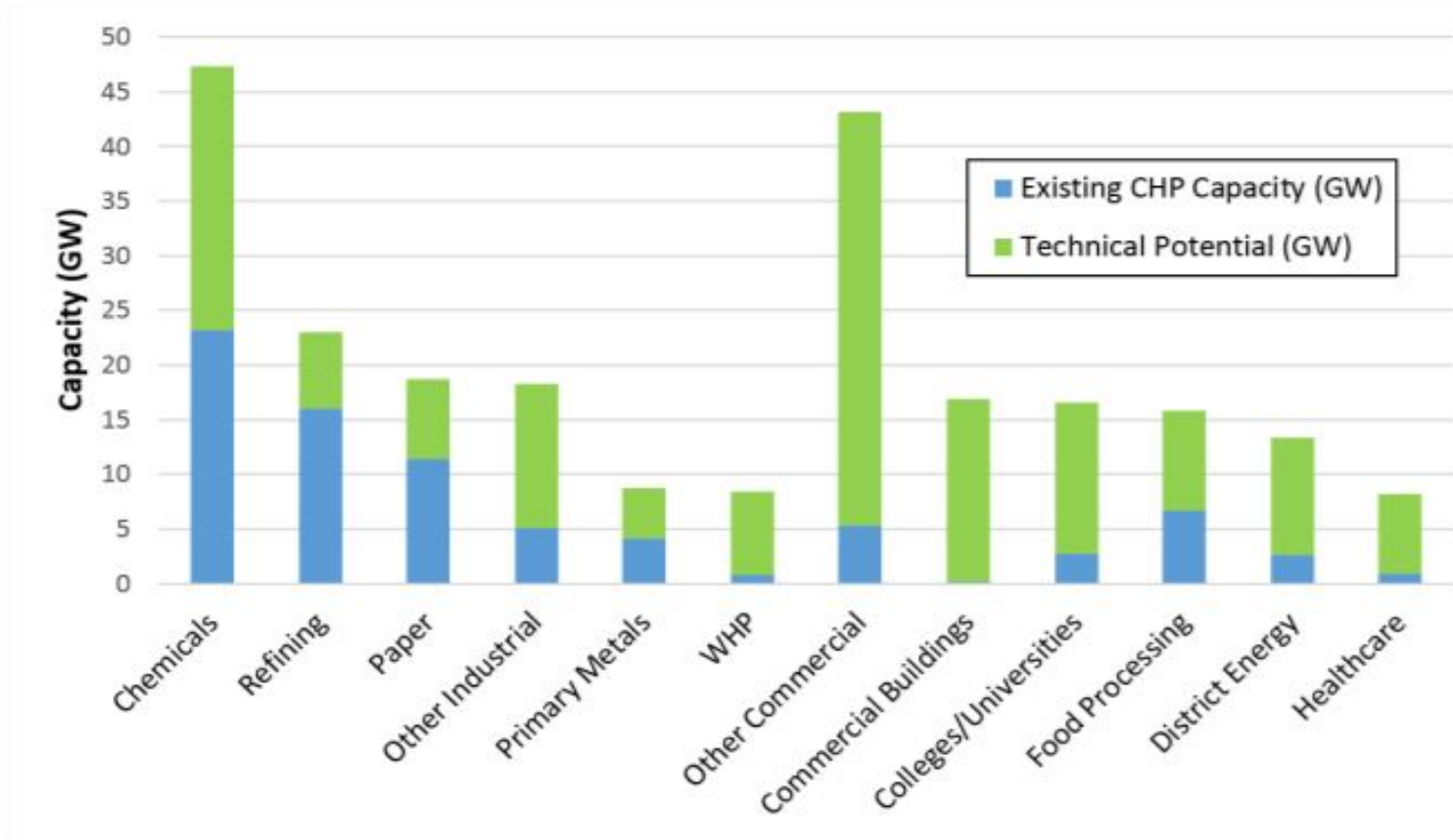


- **80.7 GW** of installed CHP at more than 4,600 industrial and commercial facilities
- 7% of U.S. Electric Generating Capacity; 13% of Industrial
- Avoids more than **1.7 quadrillion Btus** of fuel consumption annually
- Avoids **232 million metric tons of CO₂** compared to separate production

Source: DOE CHP Installation Database (U.S. installations as of December 31, 2019)

Where is the Remaining Potential for CHP?

Existing CHP Compared to On-Site Technical Potential by Sector



U.S. Dept. of Energy, "Combined Heat and Power (CHP) Technical Potential in the United States", March 2016.

WHP Technical Potential by Application

Application	# of Sites	Potential (MW)
Mining	14	23
Oil/Gas Extraction	427	538
Food Processing	19	8
Beverage and Tobacco	2	0.3
Lumber and Wood	2	1
Paper	17	5
Chemicals	64	92
Petroleum Refining	176	3,593
Stone/Clay/Glass	255	1,173
Primary Metals	116	2,186
Machinery/Computer Equip.	2	4
Transportation Equip.	1	2
Other	10	0.3
Total	1,105	7,624

Source: "Combined Heat and Power (CHP) Technical Potential in the United States", March 2016, energy.gov/chp-potential

Growing Utility Participation

Utility-Owned CHP for Grid Generation

- Build, own, and operate CHP at customer sites as part of resource planning



CHP as a Distribution System Resource

- Encourage customers to install CHP as non-wires alternative to enhance grid stability, alleviate grid congestion, or defer investments



CHP in Utility Energy Efficiency Portfolio

- Encourage customers to install CHP to gain low-cost energy savings



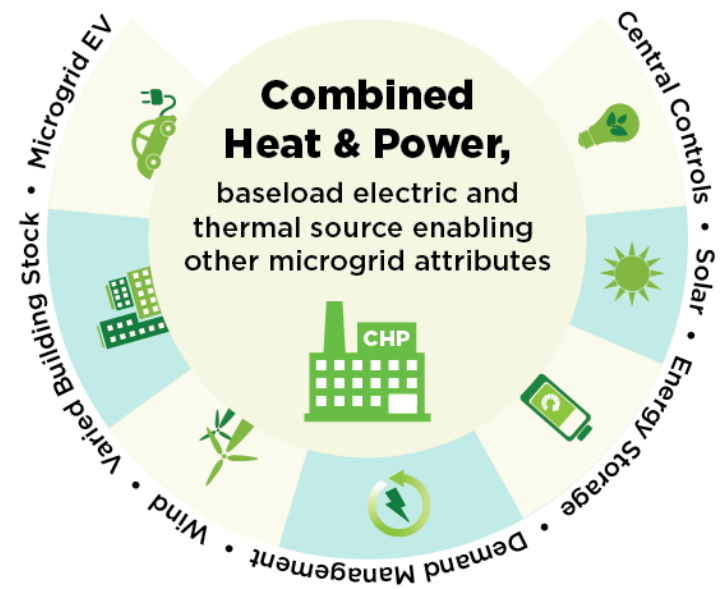
CHP and Microgrids

A microgrid is a **group of interconnected loads and distributed energy resources** within clearly defined electrical boundaries that acts as a **single controllable entity** with respect to the grid.

A microgrid can **connect and disconnect** from the larger utility grid to enable it to operate in both **grid-connected** or **island-mode**.

Source: U.S. Department of Energy Microgrid Exchange Group

- With a CHP system providing reliable baseload electric and thermal energy, microgrids can add renewables and storage
- Increased focus on resilience for critical infrastructure
 - Universities, Hospitals, Military bases, Communities



Distributed Energy Resources Disaster Matrix

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

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						

Source:

https://betterbuildingsolutioncenter.energy.gov/sites/default/files/attachments/DER_Disaster_Impacts_Issue%20Brief.pdf



CHP vs. Status Quo

CHP vs. Backup Generation

Metric	CHP	Backup Generation
System Performance	<ul style="list-style-type: none">• Designed and maintained to run continuously• Improved performance and reliability	<ul style="list-style-type: none">• Only used during emergencies
Fuel Supply	<ul style="list-style-type: none">• Natural gas infrastructure typically not impacted by severe weather	<ul style="list-style-type: none">• Limited by on-site storage – finite fuel supply
Transition from Grid Power	<ul style="list-style-type: none">• May be configured for “flicker-free” transfer from grid connection to “island mode”	<ul style="list-style-type: none">• Lag time may impact critical system performance
Energy Supply	<ul style="list-style-type: none">• Electricity• Thermal (heating, cooling, hot/chilled water)	<ul style="list-style-type: none">• Electricity
Emissions	<ul style="list-style-type: none">• Typically natural gas fueled• Achieve greater system efficiencies (80%)• Lower emissions	<ul style="list-style-type: none">• 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.

WHP for Industry

Benefits of WHP

- Utilize heat from existing thermal processes, which would otherwise be wasted to produce electricity.
- Important resource for vastly increasing industrial energy efficiency.
- Improving the competitiveness of the U.S. industrial sector.
- Providing a source of pollution-free power.



Port Arthur Steam Energy/Oxbow Corp.

Main Sources of Waste Heat

- Waste Heat from a Thermal Process
- Waste Heat from a Mechanical Drive
- Waste heat from other systems



Port Arthur Steam Energy/Oxbow Corp, Texas



Northern Boarder Pipeline, North Dakota

Project Snapshots

Project Snapshot

Waste heat to power and process heat, Port Arthur, TX

Application/Industry: Petroleum Refining

Capacity: 5 MW

Equipment: Waste heat recovery boilers; back pressure steam turbine

Fuel Type: Waste heat

Thermal Use: Steam and electricity generation

Installation Year: 2005

Environmental Benefits: CO₂ emissions reduced by 159,000 tons/year

Testimonial: “Through the recovery of otherwise-wasted heat to produce high pressure steam for crude oil processing, Port Arthur Steam Energy LLP has demonstrated exceptional leadership in energy use and management.”

- U.S. Environmental Protection Agency, in giving the 2010 Energy Star Award

https://chptap.lbl.gov/profile/186/Port_Arthur_Steam-Project_Profile.pdf



Project Snapshot:

Power Reliability

Evonik Industries
Garyville, LA

Application/Industry: Chemicals

Capacity: 5 MW

Prime Mover: Gas turbine

Fuel Type: Natural gas

Thermal Use: Process steam

Installation Year: 2012

Highlights: Evonik decided to invest in a CHP system to improve both their electric power and steam reliability. The system provides 100% of the facility's electric needs for most of the year and eliminated Evonik's dependency on their previous steam supplier, minimizing disruptions that were out of their control.



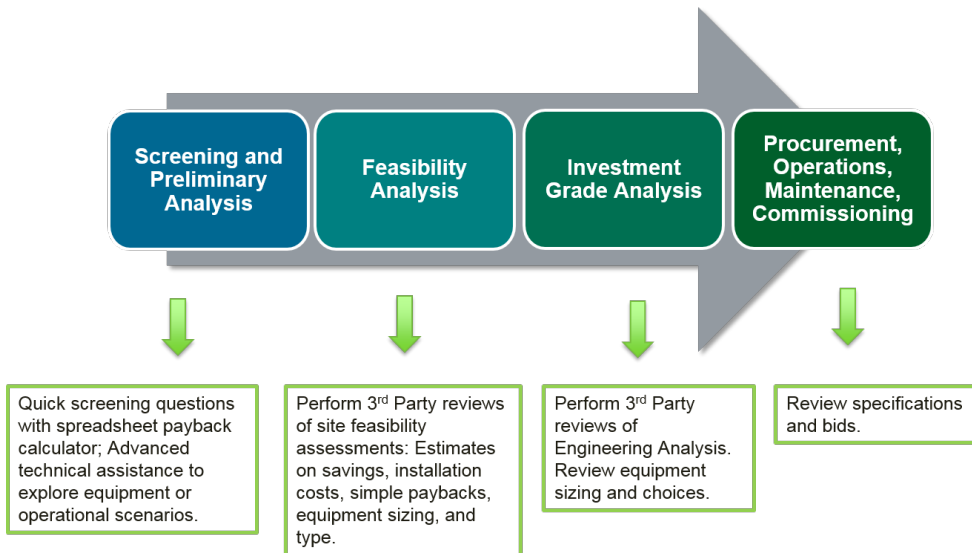
Source: Evonik, Garyville, LA
<http://corporate.evonik.com/en/Pages/default.aspx>

How to Implement a WHP Project with the Help of CHP TAP

CHP TAP Approach

Ten CHP TAPs are comprised of regional CHP experts who provide fact based, unbiased information on CHP, including technologies, project development, project financing, local electric and natural gas utility interfaces, and related state/local best practice policies. They are vendor, fuel, and technology neutral.

CHPTAP Role for Technical Assistance:



- **End-User & Stakeholder Engagements**
 - **Workshops**
 - **Webinars**
 - **One-on-one Meetings**
 - **Presentations**
 - **Booths at Conferences**
 - **Project or Policy/Program Profiles**
 - **Education – NOT Advocacy**
- **Technical Services**
 - **Screening Technical Assistance**
 - **Advanced Technical Assistance**
 - **Portfolio Reviews**



CHP Deployment Support Resources

Objective:

- Resources, tools, analyses and technical materials to support CHP TAP mission;
- Educate state and local policy makers, regulators, end users, trade associations, and CHP stakeholders;
- Inform DOE Deployment and R&D program planning
- energy.gov/chp

Materials include:

- CHP installation database
- Market analysis and tracking
- CHP regulatory and policy trends
- Technology information and industry trends
- Screening/evaluation tools
- Case studies and project profiles
- Fact Sheets
- Specific issue research and reports
- Program metrics and evaluation

The collage features several documents from the 'Combined Heat and Power Technology Fact Sheet Series' by the U.S. Department of Energy. Key elements include:

- Microgrids Fact Sheet:** Defines microgrids as interconnected loads and distributed energy resources (DERs) within a clearly defined electrical boundary. It notes that approximately 237 microgrids are currently in operation, with over 150 more planned. It also lists applications for improved electricity resiliency and cost savings.
- Microgrid Database:** A bar chart comparing CHP capacity across various states, showing that CHP has the most capacity in most states.
- Microgrid Database, February 2020:** A report detailing the capacity of CHP technologies used in microgrids.
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Next Steps

Resources are available to assist in developing CHP Projects.

Contact the Southcentral CHP TAP to:

- Perform CHP and WHP Qualification Screening for a particular facility
- Advanced Technical Assistance
- Identify existing CHP sites for Project Profiles



Thank You

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