Practical Approaches to Keeping the Lights On with CHP Microgrids

U.S. DOE CHP Deployment Program
CHP Technical Assistance Partnerships
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Director Southcentral CHP TAP
August 28, 2019

Outline

- CHP Overview
- The State of CHP
- Microgrids with CHP
- Need for Resilient Critical Infrastructure
- Resilience Improved with Microgrids
- Resilience Planning with DOE
- Project Snapshots
- Implementing a Project with CHP TAP

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

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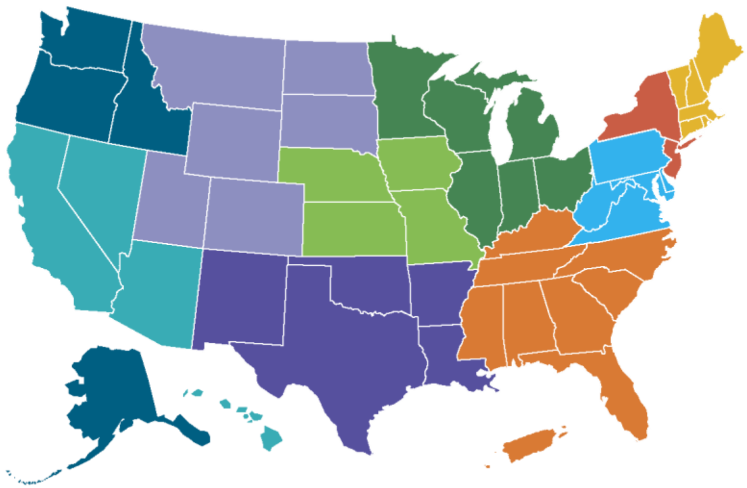

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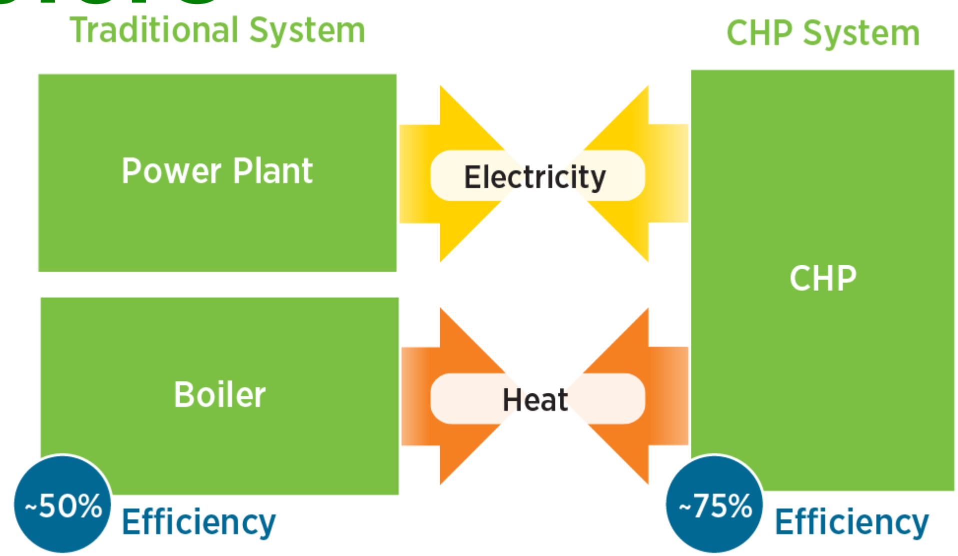
CHP Overview

CHP: A Key Part of Our Energy Future

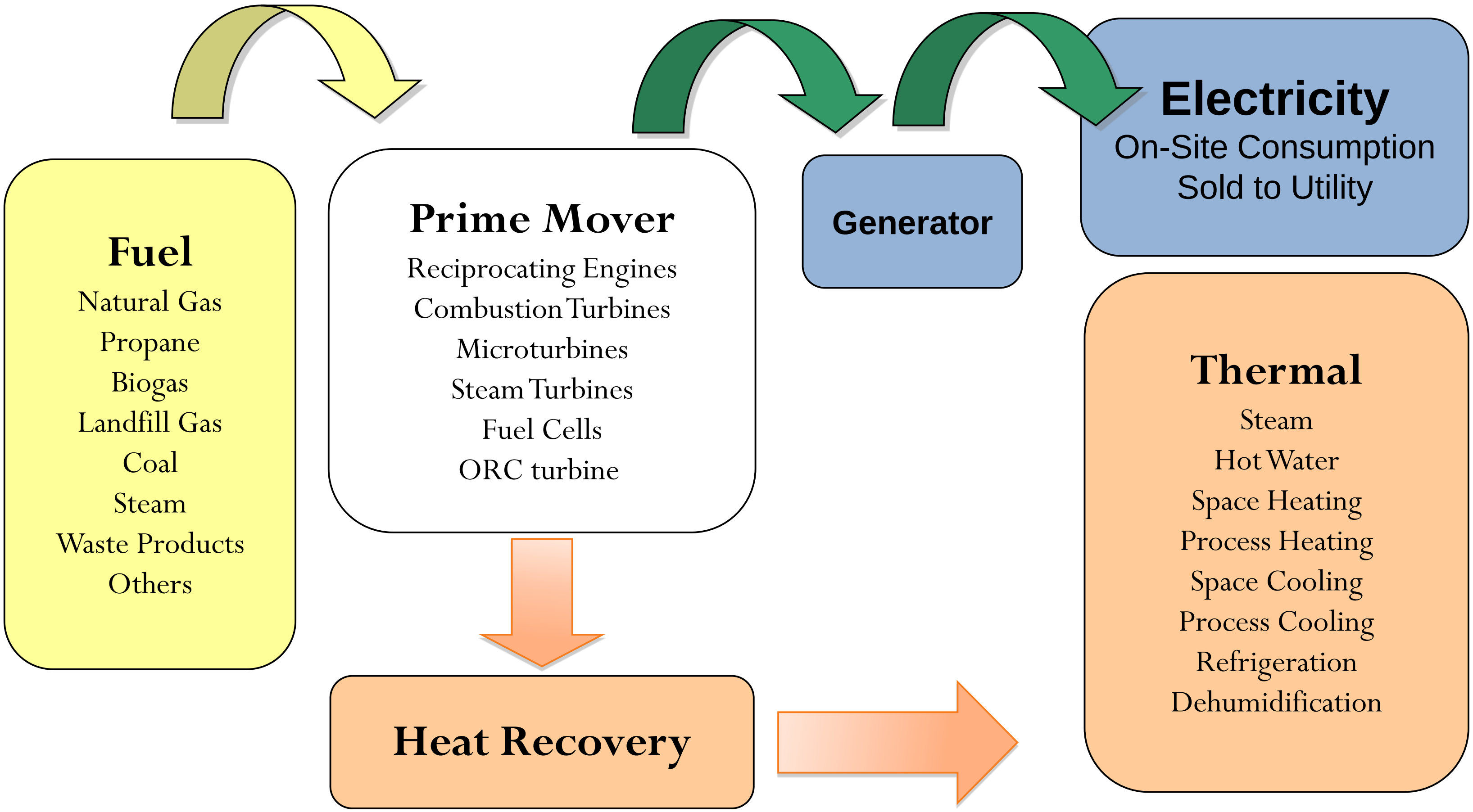
- Form of Distributed Generation (DG)
- An integrated system
- Located at or near a building / facility
- Provides at least a portion of the electrical load and
- Uses thermal energy for:
  - Space Heating / Cooling
  - Process Heating / Cooling
  - Dehumidification



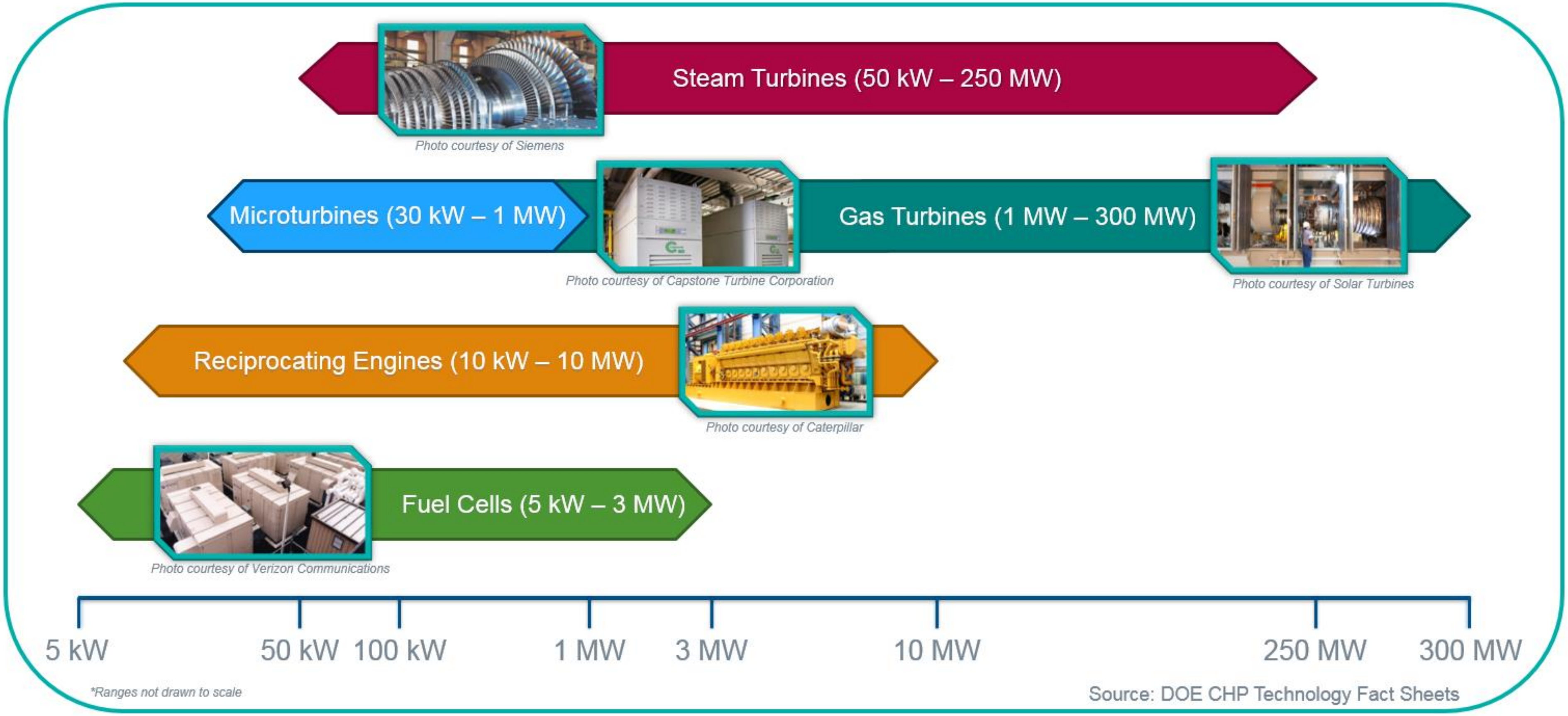
CHP provides efficient, clean, reliable, affordable energy – today and for the future.

Source: www.energy.gov/chp

CHP System Schematic



Common CHP Technologies and Capacity Ranges



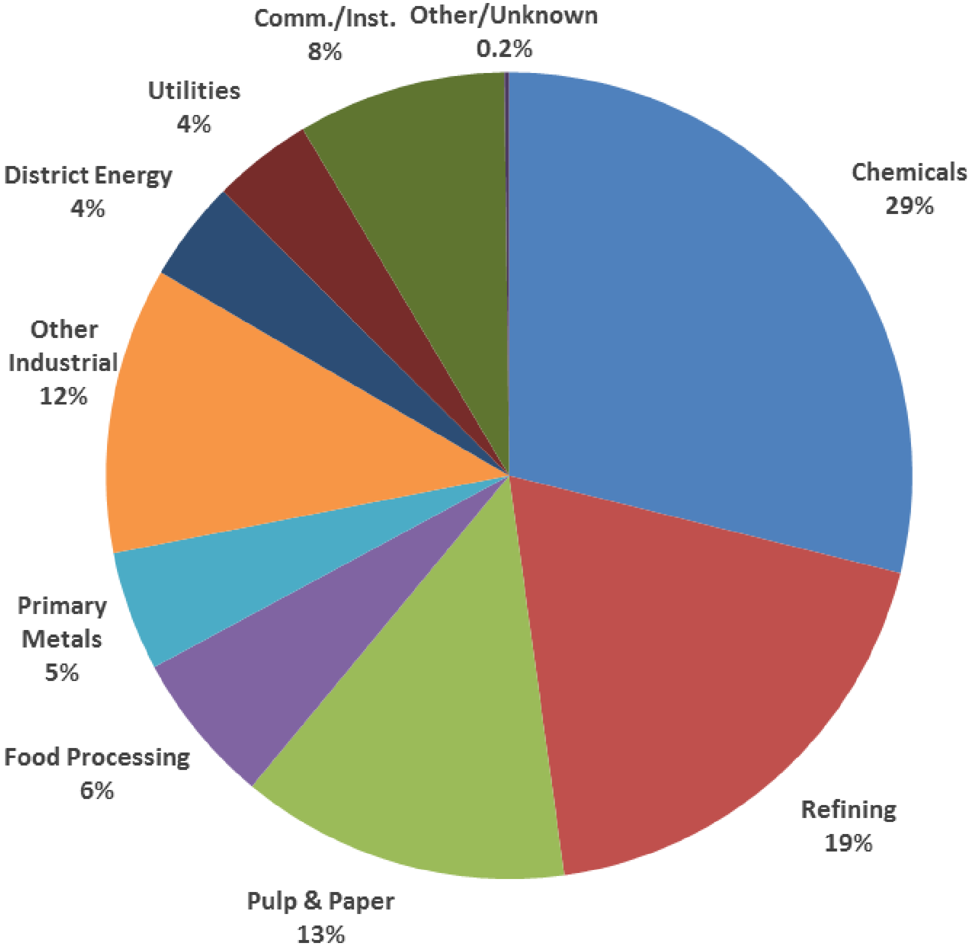
What Are the Benefits of CHP?

- 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.

The State of CHP

CHP Today in the United States

Existing CHP Capacity

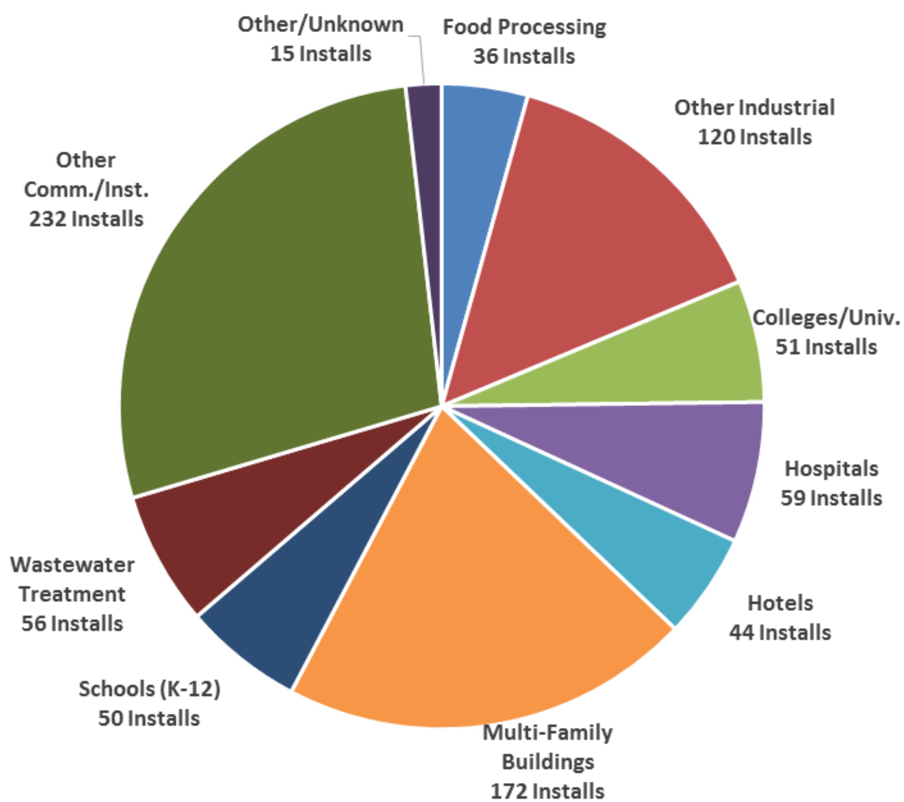


Source: DOE CHP Installation Database (U.S. installations as of Dec. 31, 2018)

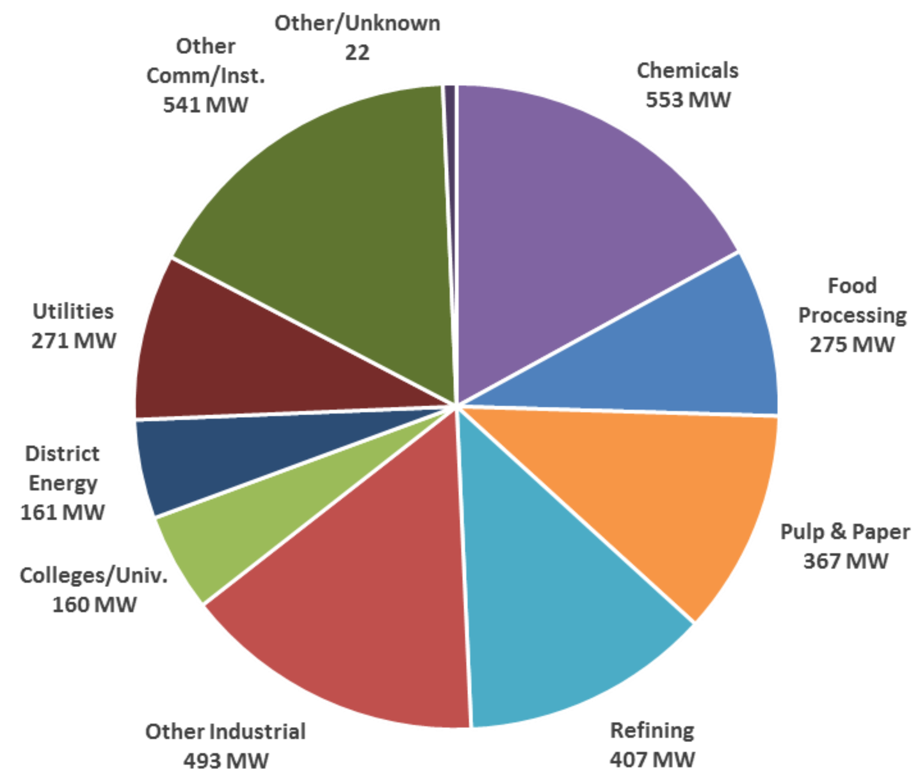
- **80.7 GW** of installed CHP at more than 4,500 industrial and commercial facilities
- 8% of U.S. Electric Generating Capacity; 14% of Manufacturing
- Avoids more than **1.8 quadrillion Btus** of fuel consumption annually
- Avoids **241 million metric tons of CO_2** compared to separate production

CHP Additions by Application (2014-2018)

By Installations – 835 Installs



By Capacity – 3.3 GW

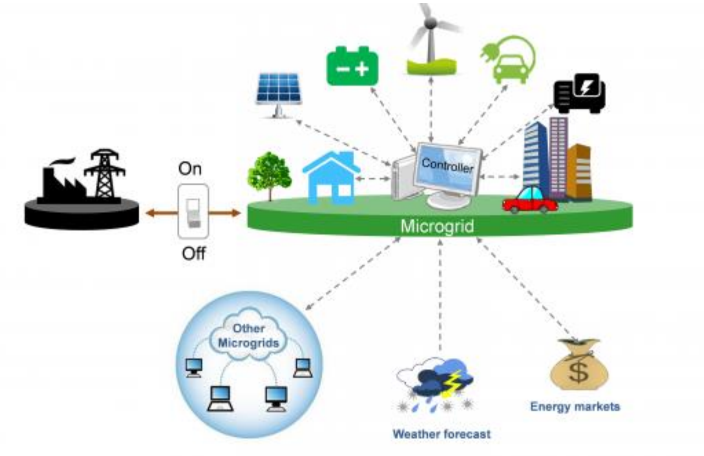


Source: DOE CHP Installation Database (U.S. installations as of Dec. 31, 2018)

Microgrids with CHP

Microgrid Definition

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.



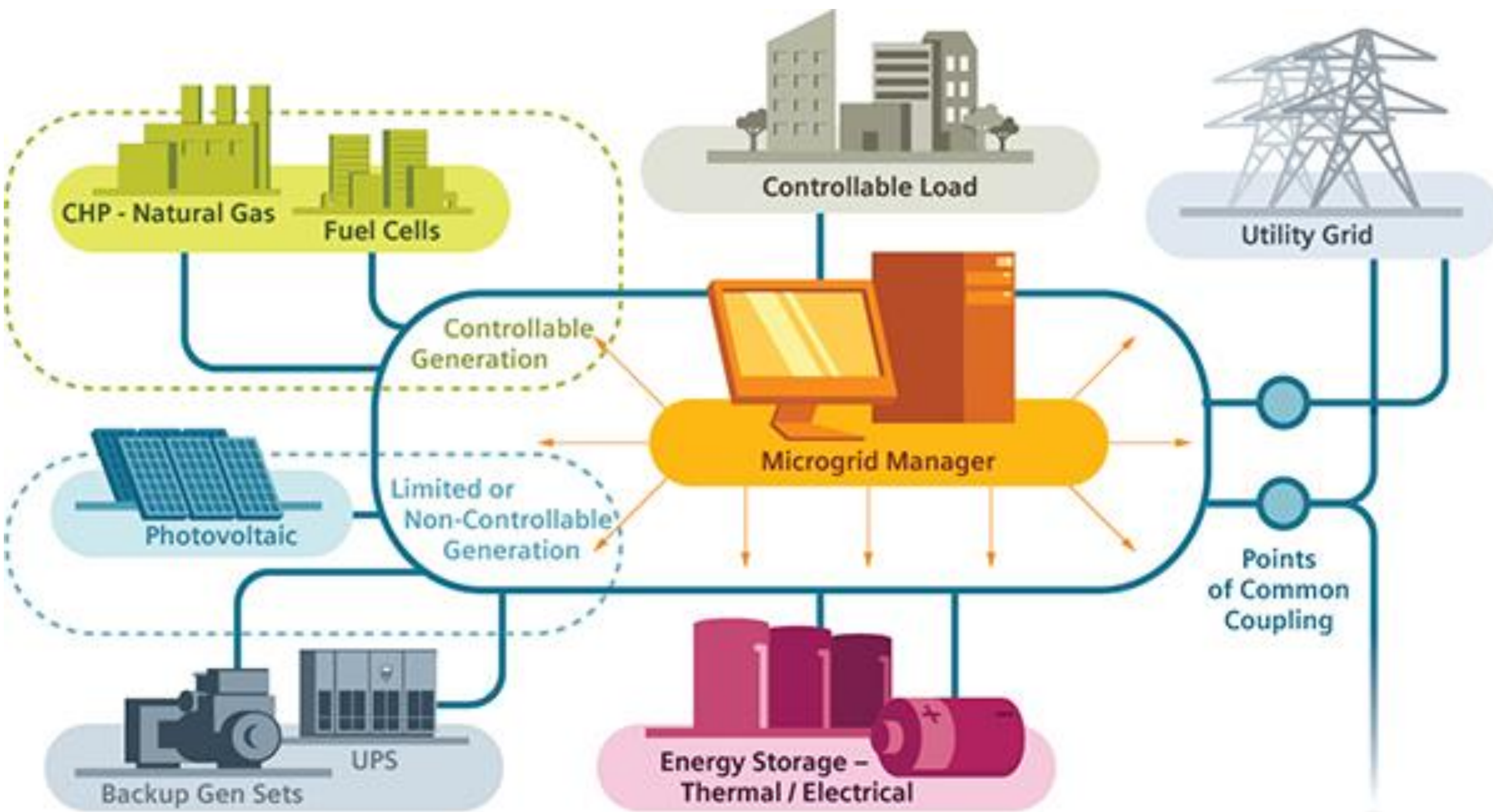
A microgrid can **connect and disconnect** from the larger utility grid to enable it to operate in both **grid-connected** or **island-mode**.

- Microgrids can use *any combination* of distributed energy resource (DER) technologies
  - Can be a single technology, such as combined heat and power (CHP), serving multiple buildings
  - Can be a group of connected DER technologies serving a single facility

- Microgrids are *designed to improve resiliency* of the delivery of electricity to connected facilities in order to perform critical functions when the larger utility grid is down

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

Microgrids Can Incorporate Many Technologies



Microgrid Applications

- **Microgrids are most often deployed in institutional campus settings, like military facilities, government buildings, hospitals, and universities**
  - All buildings owned/operated by a single entity
  - Backup power and ability to sustain grid outages for critical facilities
- **Microgrids could be tied to district energy "downtown loops", providing steam, hot/chilled water *and electricity* to various commercial/industrial facilities**
  - More challenging when each facility is owned and operated by separate entities with different requirements and goals

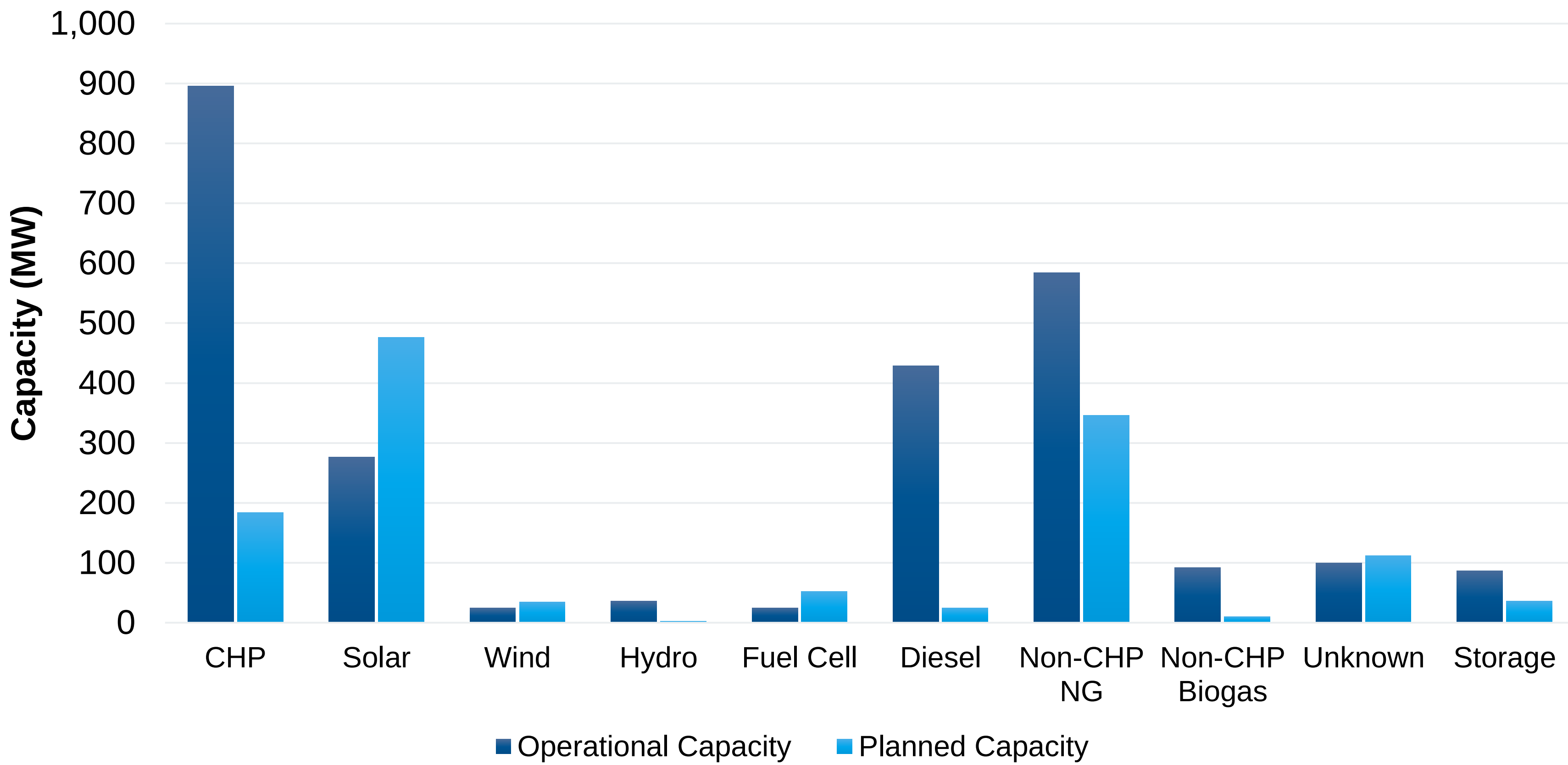
Current Microgrid Market

- As of October 2018, **331 total microgrid projects** in U.S.
  - **211 operational microgrids** identified, with 3.85 GW of total capacity
  - **104 planned microgrid projects** with 1.55 GW of expected capacity
  - 16 microgrids that have been stalled, or whose status is unknown

- CHP serves as resilient baseload anchor for many microgrids – most operational capacity by technology
- Microgrid market is growing fast, with solar PV increasing compared to current operational capacity

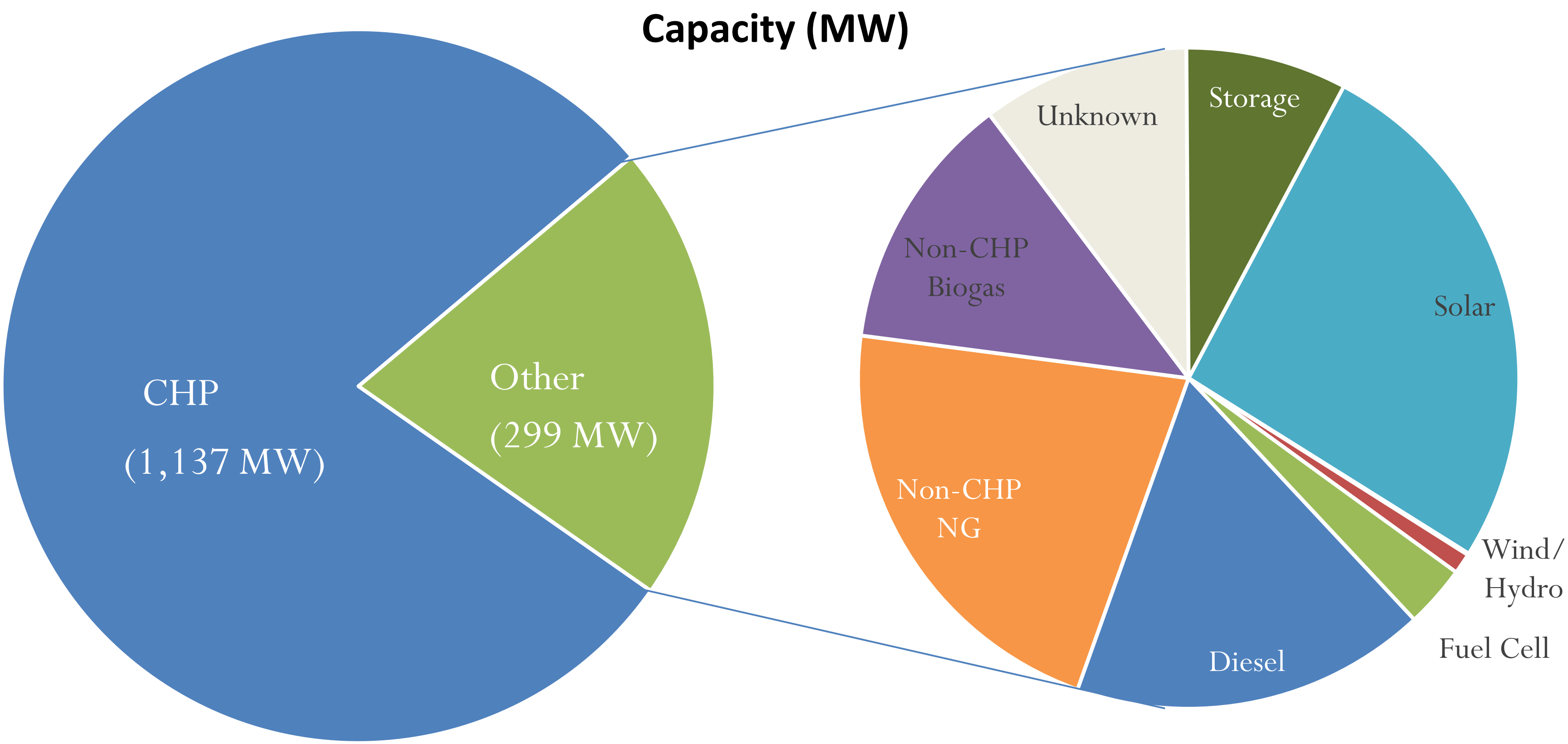
Source: ICF Microgrid Database – microgrids used for more than emergency/standby backup power

U.S. Microgrid Capacity by Technology



Source: ICF Microgrid Database

Technologies Used with CHP in Operational Microgrids*



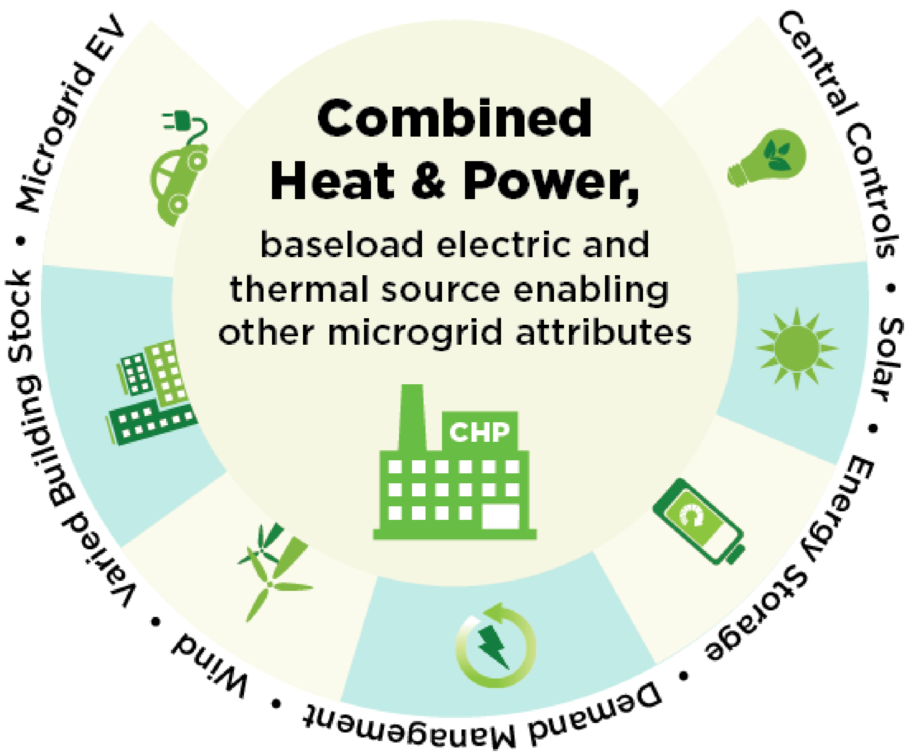
*Only operational microgrids with CHP

Source: ICF Microgrid Database

CHP Microgrids: Status and Benefits

- **For planned and operational microgrids, only 75 out of 314 microgrids use CHP**
  - Twice as many microgrids (150) use solar PV
  - CHP may not be applicable for every microgrid, but *more microgrids could be incorporating CHP*
- **Microgrids with CHP can produce baseload power 24/7 and continue critical operations indefinitely during extended utility outages**
  - Efficient operation, emission reductions, reliable fuel supply
  - Improved power quality, increased resilience, and potential for ancillary services

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

DER Technologies Work Better Together in Microgrids

- CHP can work together with PV, wind, energy storage, and other technologies in resilient microgrids with diverse resources and multiple value streams
  - Active management system with programmable logic controllers to strategically utilize all microgrid resources
- Compared to a single DER technology, a microgrid with multiple DERs can provide:
  - Stronger resilience
  - Higher operational flexibility
  - More use cases
- ***For utilities***, microgrids can offer locational value, increased grid reliability, power quality, ancillary services, and demand response functionality
- ***For end users***, microgrids provide reliable and resilient power with the potential for energy and emissions savings

Microgrid Implementation Drivers

- **End-users choose to install microgrids due to a combination of site-specific factors or *implementation drivers***
  - **Clean Power**
    - Cut emissions through the use of efficient and/or zero-carbon microgrid technologies

  - **Economics**
    - Reduce electricity, heating, cooling, and other costs through various mechanisms, such as self-generation (avoided utility costs), shared operation and maintenance, and lower fuel prices

  - **R&D**
    - Conduct research on new technologies, microgrid configurations, and financing arrangements

Microgrid Implementation Drivers (continued)

- **Reliability & Resilience**
  - Improve electricity and thermal energy reliability and resilience during grid outages and other major disruptive events
  - Especially important for critical infrastructure facilities
- **Remote Grid**
  - Provide power to remote locations that cannot rely on the power grid, such as an island community
- **Renewables Integration**
  - Incorporate renewable technologies into power generation mix while using other technologies to offset the intermittency of renewables

New Business Models: Microgrids as a Service

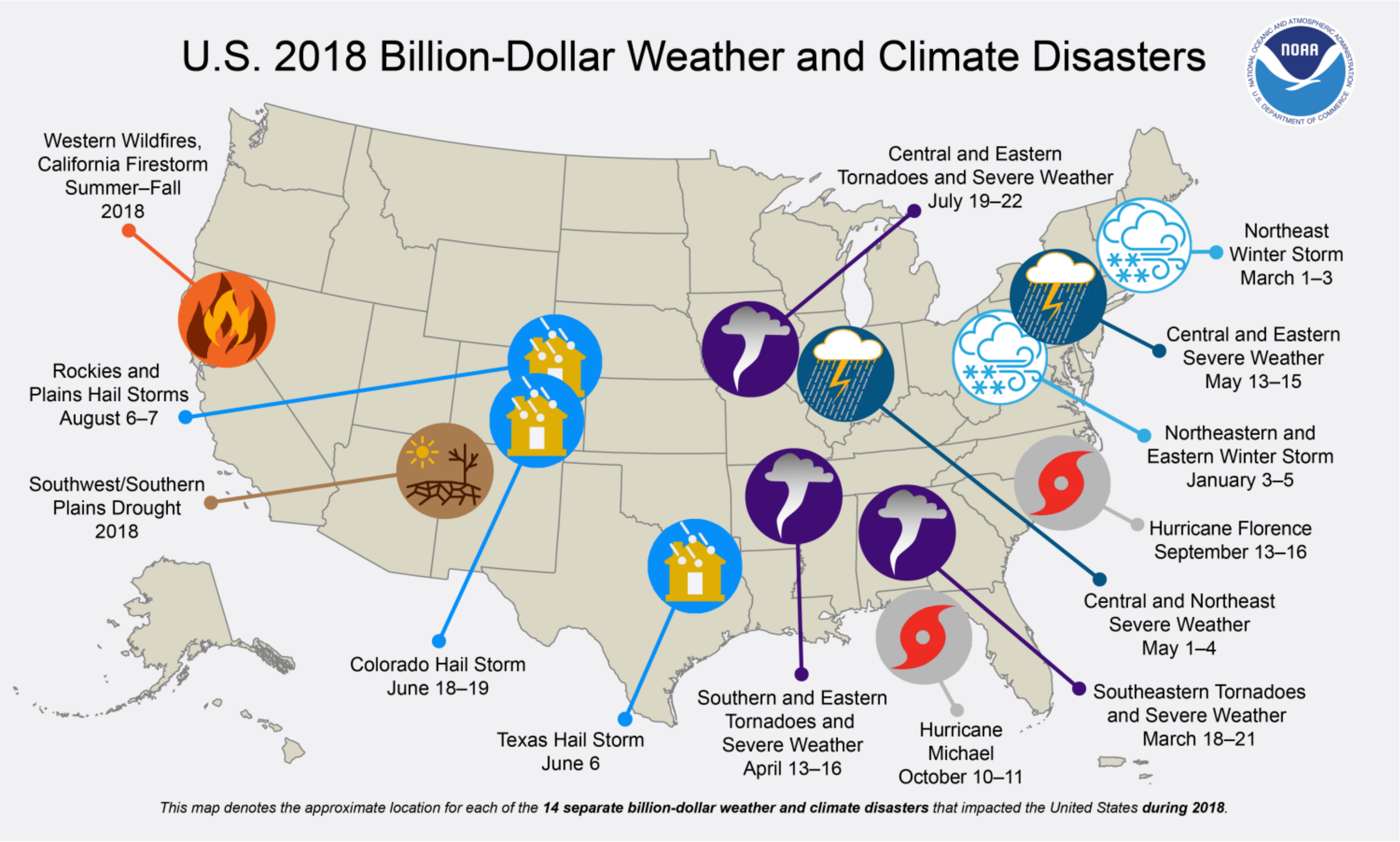
- **Microgrids are complex, with multiple energy resources serving variable loads**
  - Custom-engineered logic controller with inverters, relays, and switchgear to respond to loads and utility signals
- **Business owners do not understand the complexity**
- **Large capital investment, multiple parties involved**
- **Developers are beginning to offer “microgrids as a service”**
  - Power purchase agreements with long-term contracts
  - Developers engineer, finance, install, operate and maintain the microgrid
  - Schneider Electric, PowerSecure (Southern Company), Siemens and more
  - Carlyle Group set up Dynamic Energy Networks for this offering, with $500M initial backing

Utilities can Benefit from CHP Microgrids

- **Utilities could potentially offer microgrids as a *rate-based* service**
  - Benefits for both utilities and customers in local, resilient power
  - Utilities continue to serve their customers' full power needs
  - Several utilities are exploring CHP microgrids for large customers
    - Customer keeps current rate for electricity, with added resiliency benefits
    - Steam is sold to the customer at a discount, producing additional revenue for utility
    - CHP acts as a grid resource for the utility, with excess electricity supplied to grid
- **Unlike other DER technologies, CHP can contribute towards *energy efficiency* goals for both utilities and end-users**
  - CHP produces significant energy efficiency savings compared to separate heat and power

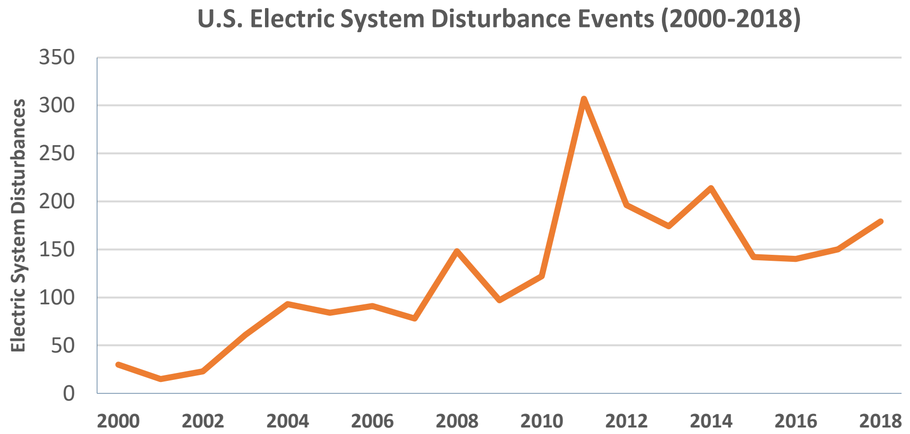
Need for Resilient Critical Infrastructure

Power Outages are Costly

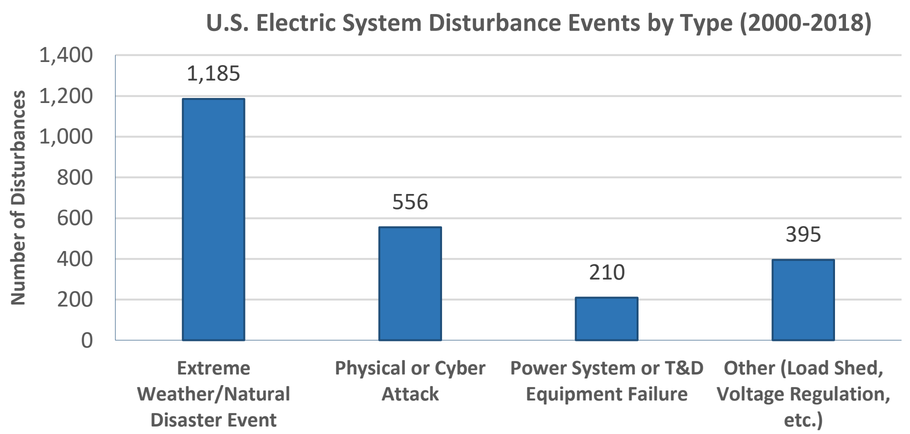


Electric System Disturbances

Electric system outages are increasingly frequent…



And outages are increasingly caused by natural disasters and storm events



Source: U.S. DOE Office of Cybersecurity, Energy Security, and Emergency Response, Electric Disturbance Events (OE-417) Annual Summaries

Reliability and Resilience: Outage Costs by Customer Class

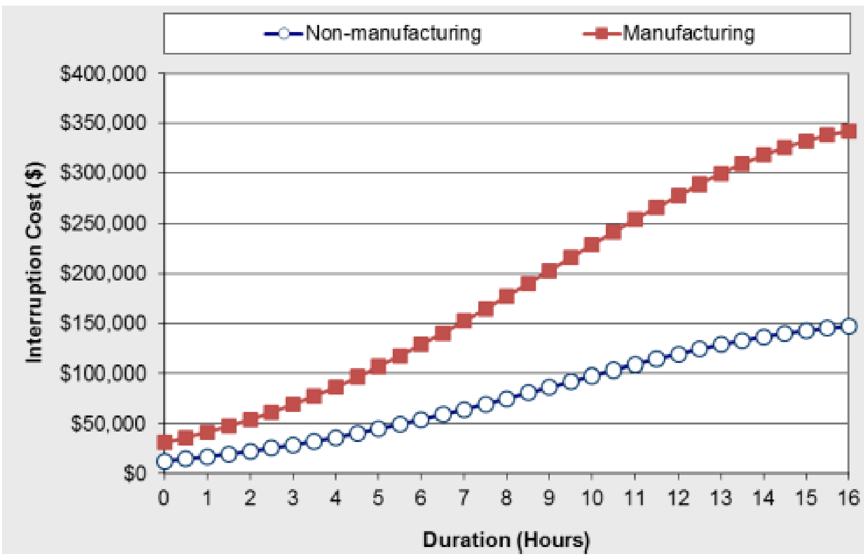
Customer class	Momentary	30 min.	1 hour	4 hours	8 hours	16 hours
Medium and large commercial and industrial (C&I) facilities						
Cost per event	$12,952	$15,241	$17,804	$39,458	$84,083	$165,482
Cost per average kW	$16	$19	$22	$48	$103	$203
Cost per unserved kWh	$190	$37	$22	$12	$13	$13
Small C&I						
Cost per event	$412	$520	$647	$1,880	$4,690	$9,055
Cost per average kW	$187	$237	$295	$857	$2,138	$4,128
Cost per unserved kWh	$2,254	$474	$295	$214	$267	$258
Residential						
Cost per event	$4	$5	$5	$10	$17	$32
Cost per average kW	$3	$3	$3	$6	$11	$21
Cost per unserved kWh	$31	$6	$3	$2	$1	$1

Cost figures in 2013$. Source: Sullivan, Schellenberg, and Blundell 2015.

Medium and Large C&I facilities suffer the highest absolute outage costs, while Small C&I facilities have the highest per-unit outage costs.

Source: *Valuing Distributed Energy Resources: Combined Heat and Power and the Modern Grid. Chittum and Relf, April 2018. ACEEE White Paper. Available at https://aceee.org/white-paper/valuing-der*

Reliability and Resilience: C&I Outage Costs by Sector



Cost figures in 2013$. Source: Sullivan, Schellenberg, Blundell 2015.

Sector	Momentary	30 min.	1 hour	4 hours	8 hours
Medium and large C&I					
Agriculture	$4,382	$6,044	$8,049	$25,628	$41,250
Mining	$9,874	$12,883	$16,366	$44,708	$70,281
Construction	$27,048	$36,097	$46,733	$135,383	$214,644
Manufacturing	$22,106	$29,098	$37,238	$104,019	$164,033
Telecommunications & utilities	$11,243	$15,249	$20,015	$60,663	$96,857
Trade & retail	$7,625	$10,113	$13,025	$37,112	$58,694
Finance, insurance, real estate	$17,451	$23,573	$30,834	$92,375	$147,219
Services	$8,283	$11,254	$14,793	$45,057	$71,997
Public administration	$9,360	$12,670	$16,601	$50,022	$79,793

Sector	Momentary	30 min.	1 hour	4 hours	8 hours
Small C&I					
Agriculture	$293	$434	$615	$2,521	$4,868
Mining	$935	$1,285	$1,707	$5,424	$9,465
Construction	$1,052	$1,436	$1,895	$5,881	$10,177
Manufacturing	$609	$836	$1,110	$3,515	$6,127
Telecommunications & utilities	$583	$810	$1,085	$3,560	$6,286
Trade & retail	$420	$575	$760	$2,383	$4,138
Finance, insurance, real estate	$597	$831	$1,115	$3,685	$6,525
Services	$333	$465	$625	$2,080	$3,691
Public administration	$230	$332	$461	$1,724	$3,205

Cost figures in 2008$. Source: Sullivan et al. 2009.

Manufacturing facilities generally experience higher outage costs than other Large C&I customer segments.

Critical Infrastructure Resilience

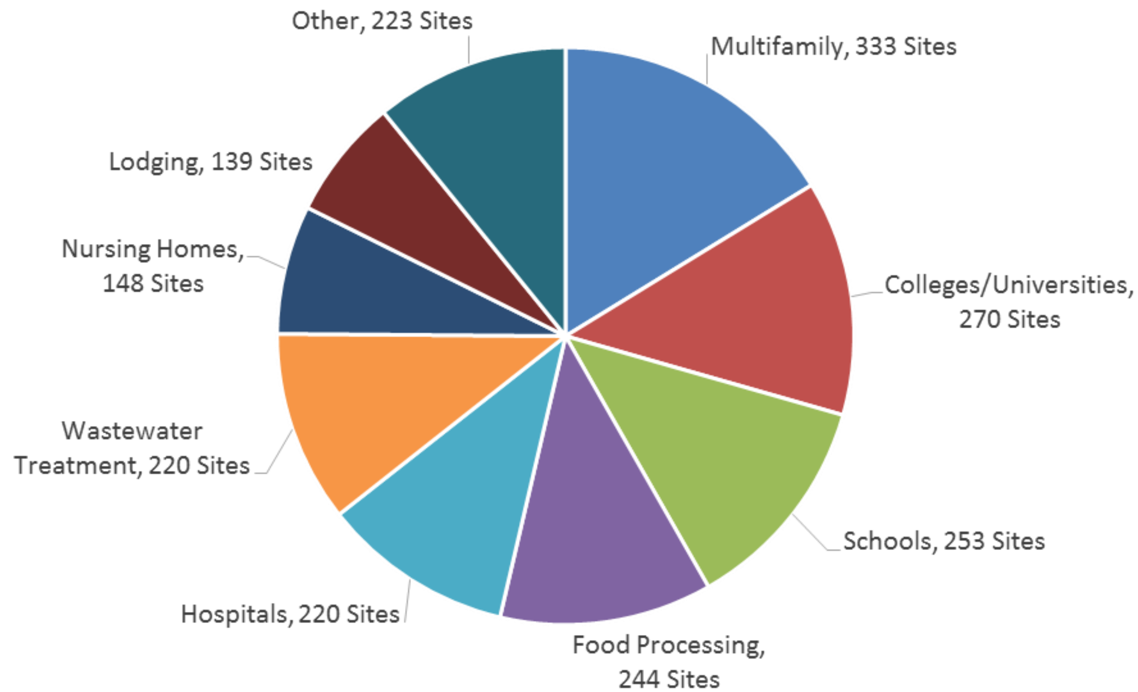
- Critical infrastructure refers to assets, systems, and networks that, if incapacitated, would have a substantial negative impact on national security, economic security, or public health and safety
- Many critical infrastructure facilities have consistent electric and thermal loads that can support CHP
- Microgrid with CHP offers many benefits to critical infrastructure:
  - Improve power quality, reliability, and resiliency
  - 24/7 power and heat with continuous benefits and cost savings
  - Can continue to operate during utility outages, providing uninterrupted electricity and heating/cooling to host facility

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.)

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

CHP in Critical Infrastructure Installations by Sub-Sectors



More than 8.5 GW of CHP is installed at over 1,300 sites identified as critical infrastructure

Source: CHP Installation Database, 2018 - https://doe.icfwebservices.com/chpdb/

Natural Gas Distribution Service Reliability

Survey Overview

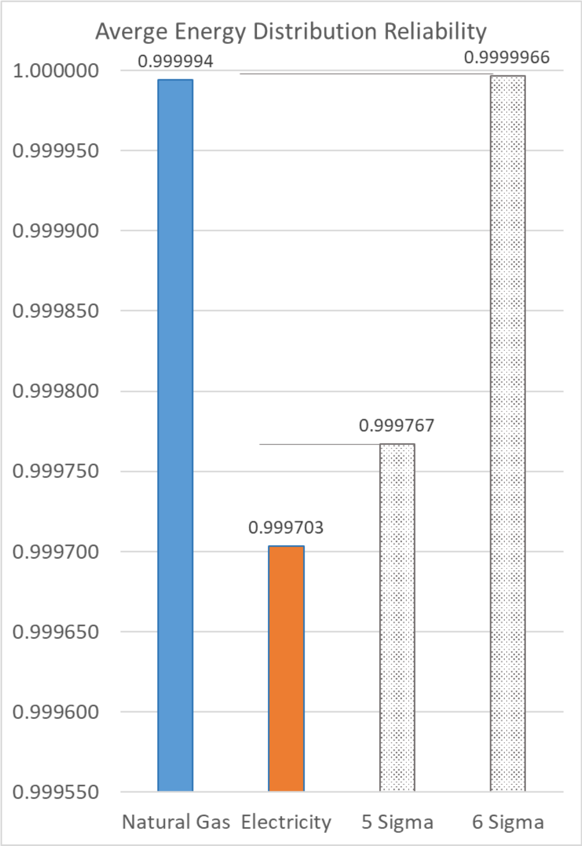
- Gas Technology Institute (GTI) conducted a survey of several North American natural gas distribution companies to obtain data on:
  - Distribution service reliability/availability. That is, the percent of time in any given year when natural gas service might not be available.
  - Annual outage rates. That is, the likelihood in a year time period that a customer could expect a disruption in natural gas service
- These data were compared with representative data from electric distribution service, using metrics that align with IEEE 1366 Electric Distribution Reliability Indices

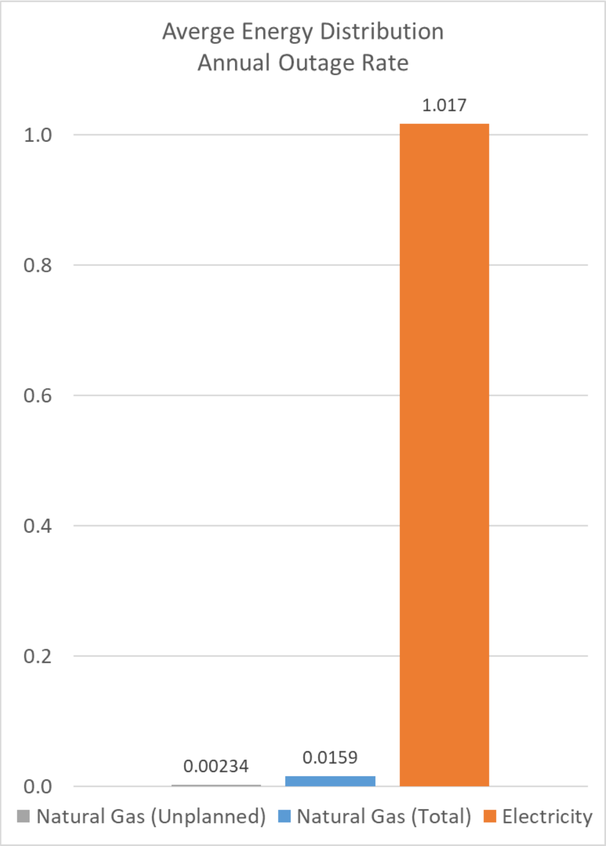
Source: Gas Technology Institute (GTI)

Energy Distribution Service Reliability

Summary of Survey Results

- Electric distribution approaches “five sigma” reliability with demonstrably higher annual outage rates (mainly unplanned)
- Natural gas distribution achieves “six sigma” reliability levels and exceptionally low outage rates
  - Most outages are due to planned maintenance
  - Third-party excavation leading cause of unplanned outages





Source: Gas Technology Institute (GTI)

Resilience Improved with Microgrids

Microgrids Improve Power Reliability and Resilience

- **Microgrids provide a variety of reliability and resilience benefits to customers located both within and outside the microgrid**
  - Microgrid customers can benefit from immediate continuation of service in the event of a utility-system outage
  - By removing dependence on the utility power, microgrids also benefit other utility customers by reducing demands on local grid infrastructure, decreasing the likelihood of equipment failure on the utility system
- **CHP systems are ideal for resilient baseload power**
  - CHP systems operate 24/7 and efficiently utilize heat that would otherwise be wasted, leading to significant energy and emissions savings
  - Natural gas generators are resilient to weather events, with a reliable fuel supply
  - Can be configured to automatically transition to island mode and support renewable generation during a utility power outage

Reliability, Resilience, and Power Quality Benefits of CHP Microgrids

Reliability	Resilience	Power Quality
▪ CHP systems located closer to loads than central generators, reducing likelihood of outages ▪ Fast-ramping capabilities **allow quick response** to changes in grid-supplied power, flexibility to serve dynamic loads ▪ CHP systems **reduce stress** on local distribution grid, extending life of grid components **and reducing risk of outage** caused by individual distribution equipment failure	▪ CHP systems operate near-continuously, can **provide firm backup generation** during outages ▪ **Island-capable systems** can maintain heat/power service to loads within the microgrid network during outages, fulfill **load shedding** requests during high demand periods ▪ During Hurricane Sandy in 2012, every islanding-capable CHP that received NYSERDA incentives stayed online	▪ CHP microgrids serving large, power quality-sensitive C&I customers such as data centers, and high-tech manufacturing **provide high-quality power** without service interruptions or voltage dips ▪ By locating generation closer to loads, CHP and district energy systems **prevent voltage fluctuation and other power quality issues** that typically arise on the distribution system

Sources: Same as previous slide

Factoring Outage Costs into Microgrid Planning

- **Based on the cost of power outages and the historical frequency of local outages, microgrid planners can estimate the value that resilient microgrids will provide**
  - Based on frequency and duration of outages, convert to expected mitigation of outage costs on an annual basis
  - Incorporate annual mitigated outage costs into financial pro forma
- **The impact that mitigated outage costs will have on a microgrid project depends on several factors**
  - Customer class and sector
  - Frequency and duration of outages
  - Relative cost of microgrid equipment and installation

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

Resilience Planning with DOE

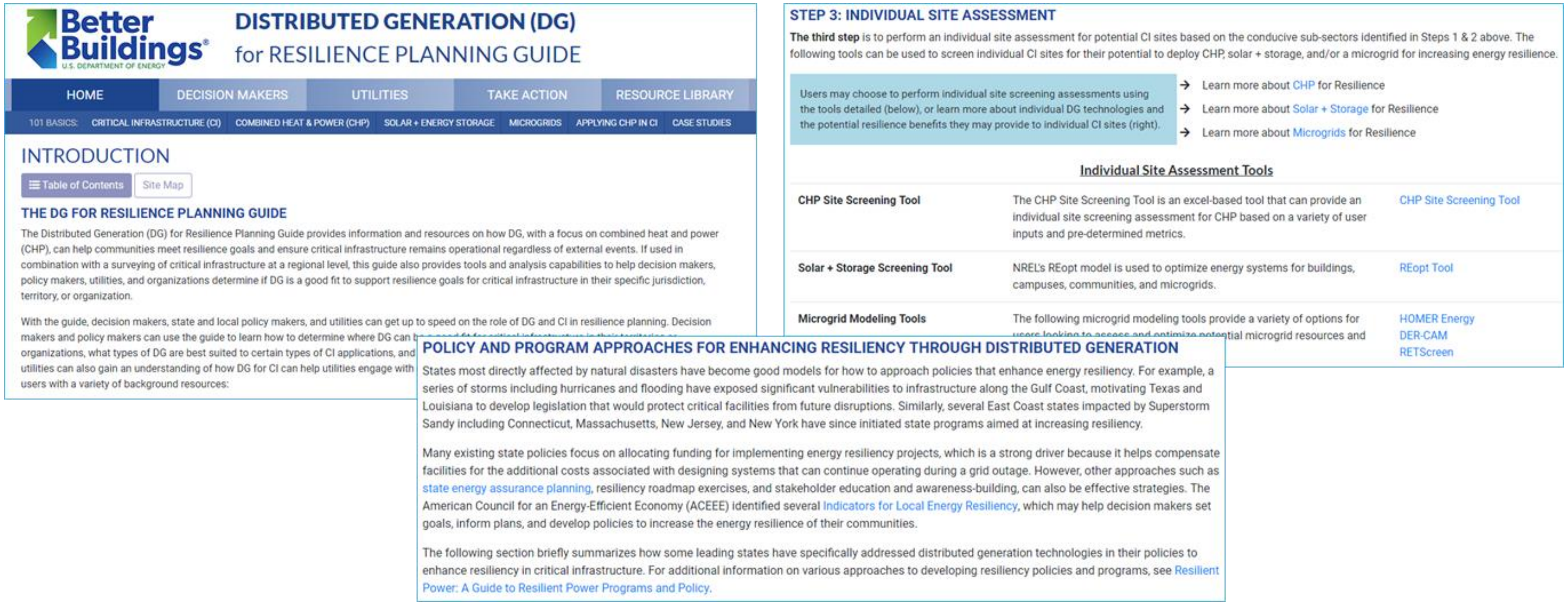
Resilience Planning with DOE Resiliency Accelerator

- The DOE Resiliency Accelerator includes resources and tools designed to assist with resilience planning efforts
  - Distributed Generation for Resiliency Planning Guide
  - CHP for Resilience Screening Tool
  - Issue Brief on Performance of DERs in Disaster Events
  - Partner Profiles

https://betterbuildingsinitiative.energy.gov/accelerators/combined-heat-and-power-resiliency

Distributed Generation (DG) for Resilience Planning Guide

- **Provides information and resources on how DG (w/a focus on CHP), can help communities meet resilience goals and ensure critical infrastructure remains operational regardless of external events**



Better Buildings U.S. DEPARTMENT OF ENERGY

DISTRIBUTED GENERATION (DG) for RESILIENCE PLANNING GUIDE

HOME | DECISION MAKERS | UTILITIES | TAKE ACTION | RESOURCE LIBRARY

101 BASICS: CRITICAL INFRASTRUCTURE (CI) | COMBINED HEAT & POWER (CHP) | SOLAR + ENERGY STORAGE | MICROGRIDS | APPLYING CHP IN CI | CASE STUDIES

INTRODUCTION

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THE DG FOR RESILIENCE PLANNING GUIDE

The Distributed Generation (DG) for Resilience Planning Guide provides information and resources on how DG, with a focus on combined heat and power (CHP), can help communities meet resilience goals and ensure critical infrastructure remains operational regardless of external events. If used in combination with a surveying of critical infrastructure at a regional level, this guide also provides tools and analysis capabilities to help decision makers, policy makers, utilities, and organizations determine if DG is a good fit to support resilience goals for critical infrastructure in their specific jurisdiction, territory, or organization.

With the guide, decision makers, state and local policy makers, and utilities can get up to speed on the role of DG and CI in resilience planning. Decision makers and policy makers can use the guide to learn how to determine where DG can b... organizations, what types of DG are best suited to certain types of CI applications, and ... utilities can also gain an understanding of how DG for CI can help utilities engage with ... users with a variety of background resources:

STEP 3: INDIVIDUAL SITE ASSESSMENT

The third step is to perform an individual site assessment for potential CI sites based on the conducive sub-sectors identified in Steps 1 & 2 above. The following tools can be used to screen individual CI sites for their potential to deploy CHP, solar + storage, and/or a microgrid for increasing energy resilience.

Users may choose to perform individual site screening assessments using the tools detailed (below), or learn more about individual DG technologies and the potential resilience benefits they may provide to individual CI sites (right).

→ Learn more about CHP for Resilience
→ Learn more about Solar + Storage for Resilience
→ Learn more about Microgrids for Resilience

Individual Site Assessment Tools

CHP Site Screening Tool	The CHP Site Screening Tool is an excel-based tool that can provide an individual site screening assessment for CHP based on a variety of user inputs and pre-determined metrics.	CHP Site Screening Tool
Solar + Storage Screening Tool	NREL's REopt model is used to optimize energy systems for buildings, campuses, communities, and microgrids.	REopt Tool
Microgrid Modeling Tools	The following microgrid modeling tools provide a variety of options for ... potential microgrid resources and	HOMER Energy DER-CAM RETScreen

POLICY AND PROGRAM APPROACHES FOR ENHANCING RESILIENCY THROUGH DISTRIBUTED GENERATION

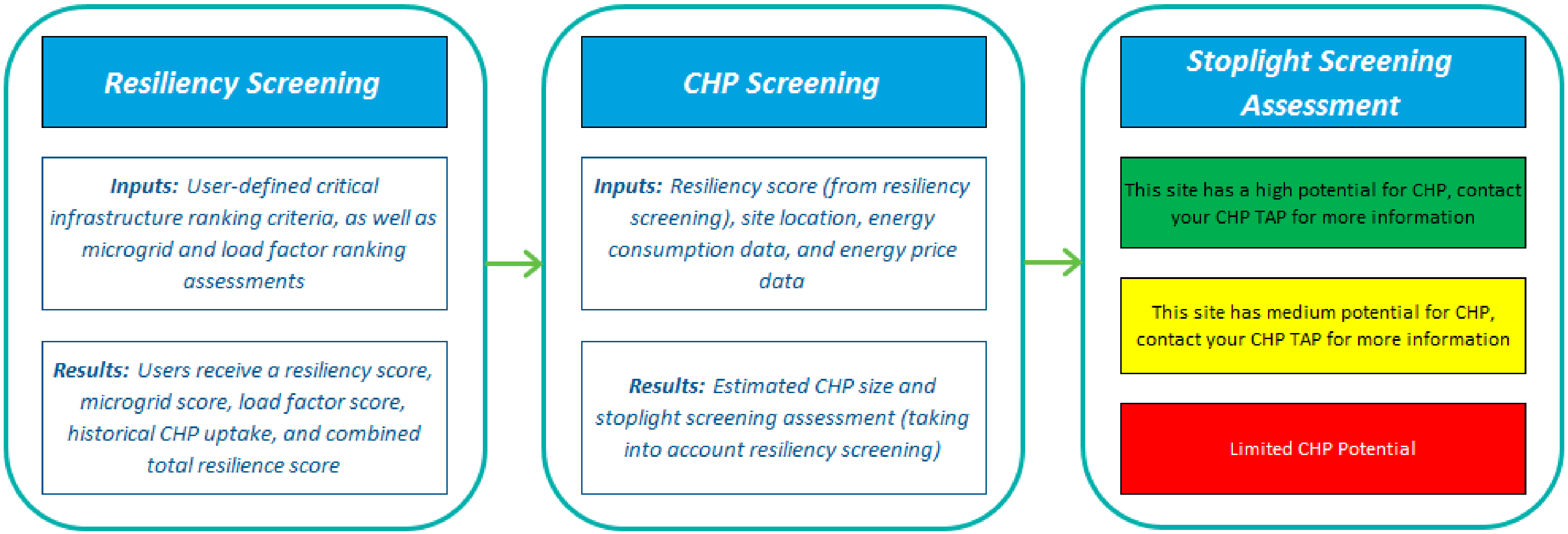
States most directly affected by natural disasters have become good models for how to approach policies that enhance energy resiliency. For example, a series of storms including hurricanes and flooding have exposed significant vulnerabilities to infrastructure along the Gulf Coast, motivating Texas and Louisiana to develop legislation that would protect critical facilities from future disruptions. Similarly, several East Coast states impacted by Superstorm Sandy including Connecticut, Massachusetts, New Jersey, and New York have since initiated state programs aimed at increasing resiliency.

Many existing state policies focus on allocating funding for implementing energy resiliency projects, which is a strong driver because it helps compensate facilities for the additional costs associated with designing systems that can continue operating during a grid outage. However, other approaches such as state energy assurance planning, resiliency roadmap exercises, and stakeholder education and awareness-building, can also be effective strategies. The American Council for an Energy-Efficient Economy (ACEEE) identified several Indicators for Local Energy Resiliency, which may help decision makers set goals, inform plans, and develop policies to increase the energy resilience of their communities.

The following section briefly summarizes how some leading states have specifically addressed distributed generation technologies in their policies to enhance resiliency in critical infrastructure. For additional information on various approaches to developing resiliency policies and programs, see Resilient Power: A Guide to Resilient Power Programs and Policy.

https://resilienceguide.dg.industrialenergytools.com/

The CHP for Resilience Screening Tool



Resiliency Screening Factors: Government Continuity, Locational Ranking, Leverage/Scalability, Life Safety, Economic Impact, Microgrid, and Load Factor

Access the tool at the accelerator website under "Featured Resources":
https://betterbuildingsinitiative.energy.gov/accelerators/combined-heat-and-power-resiliency

CHP Technical Assistance Partnerships
SOUTHCENTRAL

Issue Brief – Examining the Performance of Different DERs in Disaster Events

- Different DERs are impacted by various types of natural disasters (flooding, high winds, extreme temperature, etc.)
- Goal: To assist stakeholders in evaluating the technology options best able to meet their resilience priorities

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

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

Issue Brief – Examining the Performance of Different DERs in Disaster 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	◒	○	◒	●	◒	○

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

CHP for Resiliency Accelerator Partner Profiles

- 20 partner profiles
  - Resilience Planning
  - Program or Project Implementation
  - Lessons Learned
  - Additional Information
- Discussions with a wide variety of partners including: city and state energy managers/planners, PUC employees, utility engineers, and many more

Better Buildings
U.S. DEPARTMENT OF ENERGY

State of Missouri

CHP for Resiliency Accelerator Partner Profile

1. Resilience Planning

In 2015, the Division of Energy developed a Comprehensive Energy Plan for the state of Missouri that included a number of actions that could help the state diversify and promote the security of energy supply. The plan includes recommendations specific to CHP, and proposes an examination of the potential for CHP at all current and planned state facilities, promotes public-private partnerships to develop CHP, and suggests establishing cost-based standby rates and interconnection standards that reflect best practices for CHP.

The Division is focused on enhancing economic development activities by promoting the combined energy efficiency and resiliency benefits associated with CHP. The role of CHP in providing energy resilience for critical facilities during electric outages caused by severe weather or other natural disasters is a key area of emphasis.

On a broader scale, the State of Missouri has adopted an initiative to move beyond emergency support functions to intermediate and long term recovery support functions (RSF) by establishing interagency working groups. The goal of this collaboration is to improve ongoing response efforts in the areas of infrastructure, health and social services, housing, economic, natural and cultural resources, and community planning. As a participant in the RSF working groups, the Division of Energy highlights the role of CHP technologies in providing secure energy solutions.

2. Program or Project Implementation

The Division of Energy is focusing its CHP awareness and outreach efforts in the institutional sector, specifically hospitals, universities & colleges, correctional facilities, and residential care facilities. As part of these efforts, the Division has enabled feasibility assessments for resilient energy solutions by hosting and participating in workshops, such as the Eastern Missouri Combined Heat and Power (CHP) Summit in 2018, and engaging with US DOE's Central CHP Technical Assistance Partnership, which has provided no-cost technical assistance for healthcare and other facilities, including DePaul Hospital Missouri correctional facilities.

The Division is also working with utilities and the public service commission to address barriers to CHP. This includes recognizing CHP as an energy efficiency measure that can contribute to the state's efficiency targets and intervening in utility rate cases to facilitate non-discriminatory standby service tariffs for CHP technologies. Further, the Division recommended authorization for Spire (a natural gas company serving customers in Missouri, Alabama and Mississippi) to assist customers with deploying CHP to serve critical loads and offered guidelines for utilities to support and co-deliver CHP programs in the state.

https://betterbuildingssolutioncenter.energy.gov/accelerators/combined-heat-and-power-resiliency/chpr-partner-profiles

Examples of CHP Policies and Programs for Resilience

Policy, Program or Organization	Details and Accomplishments
Texas State Legislature	• Passed HB 1831 and HB 4409 in 2009, requiring the state to identify all critical infrastructure assets and conduct an economic feasibility analysis of CHP for all major renovations and new construction
Louisiana State Legislature	• Passed Resolution No. 171 in 2012 – similar to Texas State Legislature HB 1831 & HB 4409
The Missouri Department of Economic Development, Division of Energy	• Published the Missouri Comprehensive State Energy Plan – includes recommendations to incorporate CHP based on energy savings, meeting state energy goals, and providing energy security benefits • Participated in the US DOE CHP Resiliency Accelerator and identified hospitals as a target market sector for outreach • Further identified target hospital CI sites throughout the state
The Illinois State Energy Assurance Plan	• Supports the use of CHP in creating resiliency benefits for critical infrastructure and the grid as a whole
The Michigan Agency for Energy	• Sponsored the "CHP Roadmap for Michigan," – models future CHP penetration given a number of different scenarios and possible policies including efficiency incentives, utility rate reform and resiliency benefits

Source: CHP Policies and Incentive Database (dCHPP). https://www.epa.gov/chp/dchpp-chp-policies-and-incentives-database;
DG for Resilience Planning Guide, U.S. DOE. 2018. https://resilienceguide.dg.industrialenergytools.com/

Project Snapshots

Resilience and Reliability with CHP

Project Snapshot: Dell Children's Medical Center

- **Location:** Austin, TX
- **Microgrid Equipment & Technologies**
  - 4.3 MW gas turbine CHP
  - 1.5 MW backup diesel generator
- **Key Characteristics**
  - CHP Plant (Mueller Energy Center), is owned and operated by Austin Energy
  - During a disaster, the hospital can become a place of refuge, due to the extended power supply
  - CHP provides excess chilled water to surrounding facilities
- **Benefits**
  - CHP provides efficient steam generation for critical hospital procedures
  - Microgrid helped medical center to achieve LEED certification
  - Beneficial partnership between medical center campus and local utility (Austin Energy)

dell children's
medical center of central texas

Dell Children's Medical Center, photo courtesy of Seton/Ascension

Project Snapshot: Colorado College Tutt Library

Location: Colorado Springs, CO

Application/Industry: College/University

Capacity (MW): 130 kW

Prime Mover: Microturbine

Fuel Type: Natural Gas

Thermal Use: Space heating

Installation Year: 2017

Emissions Savings: Net-zero energy building

Source:
https://www.coloradocollege.edu/newsevents/newsroom/cc-s-net-zero-energy-library-opens#.XD33kFVKipo

Key Characteristics

While transforming Tutt Library to meet academic demands, including new lab and classroom space, Colorado College installed an array of technologies at the site to establish the largest net-zero academic library. With a CHP system, geothermal field, and two solar arrays, the library can generate all the power needed for its on-site facilities.

Project Snapshot: University of Texas Medical Branch at Galveston

- **Location:** Galveston, TX
- **Application/Industry:** Hospital
- **Capacity:** 11.9 MW
- **Prime Mover:** Combustion turbine
- **Fuel Type:** Natural gas
- **Thermal Use:** Steam for steam, DHW
- **Installation Year:** 2016
- **Resilience Benefits**
  - Hurricane Ike severely damaged UTMB campus and energy/steam infrastructure
    - Hospital unable to operate for 90 days, $2 million loss of business revenue/day, lost research materials, etc.
  - Converted buildings to DHW, distributed steam overhead to buildings, elevated boilers and chillers, and built flood wall around CHP system
  - During Harvey, CHP system operated throughout in island mode, and all infrastructure was well protected

utmb Health

The UTMB CHP systems protected by a flood wall, photos courtesy of Affiliated Engineers

Project Snapshot: Village Creek Water Reclamation Plant

- **Location:** Fort Worth, TX
- **Application/Industry:** WWTP
- **Capacity:** 5.2 MW
- **Prime Mover:** Combustion turbine
- **Fuel Type:** Natural gas
- **Thermal Use:** Steam turbines to drive
- centrifugal blower, Digester heat
- **Installation Year:** 2012

"I highly recommend this type of project. Not only do you save money but you reduce your footprint and utilize resources that were once wasted." -Ana Julia Peña-Tijerina, Sr. Professional Engineer

Project Snapshot: University of California, San Diego

Location: San Diego, CA

Microgrid Equipment & Technologies

- 33 MW CHP ((2) 13.5 MW combustion turbines, 3 MW steam turbine, 2.8 MC fuel cell)
- 3.8 million gallon thermal energy storage + 2.5 (5 MWh) Battery storage
- 2.9 MW solar PV, 300 kW solar thermal
- 4,000 smart-controllable thermostats

Key Characteristics

- Microgrid control at central utilities plant
- Automatic Substation Control System allows CHP system to island in the event of a grid outage
- High-end maser controller provides microgrid optimization

Benefits

- Improved energy security on campus
- Arbitrage opportunities from DERs has provided significant economic benefits to UCSD, in addition to significant peak demand reduction
- Advanced controls and monitoring allow advanced outage detection for enhanced resilience

Microgrid CHP and solar generation, photos courtesy of LBNL and UC San Diego

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

CHP TAP Role: Technical Assistance

Screening and Preliminary Analysis

Quick screening questions with spreadsheet payback calculator; Advanced technical assistance to explore equipment or operational scenarios.

Feasibility Analysis

Perform 3rd Party reviews of site feasibility assessments: Estimates on savings, installation costs, simple paybacks, equipment sizing, and type.

Investment Grade Analysis

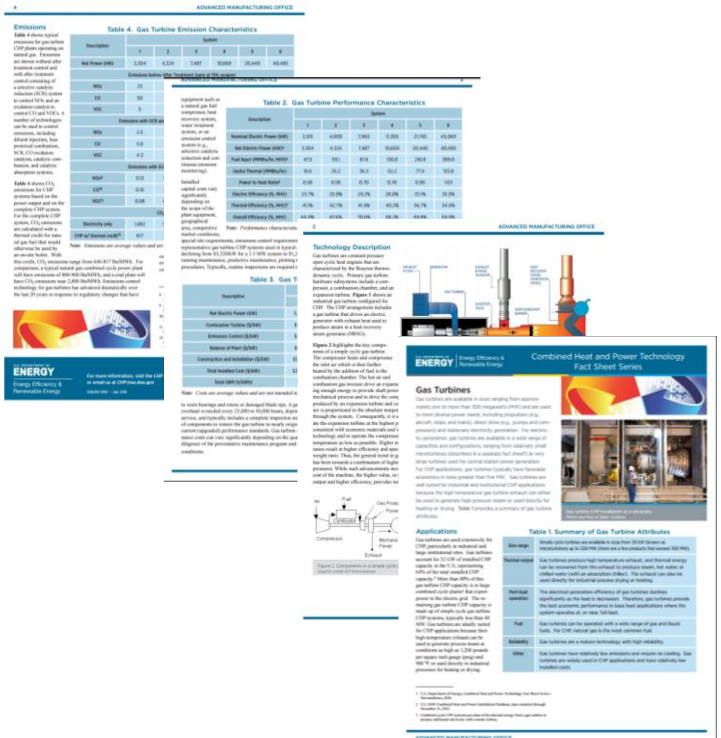
Perform 3rd Party reviews of Engineering Analysis. Review equipment sizing and choices.

Procurement, Operations, Maintenance, Commissioning

Review specifications and bids.

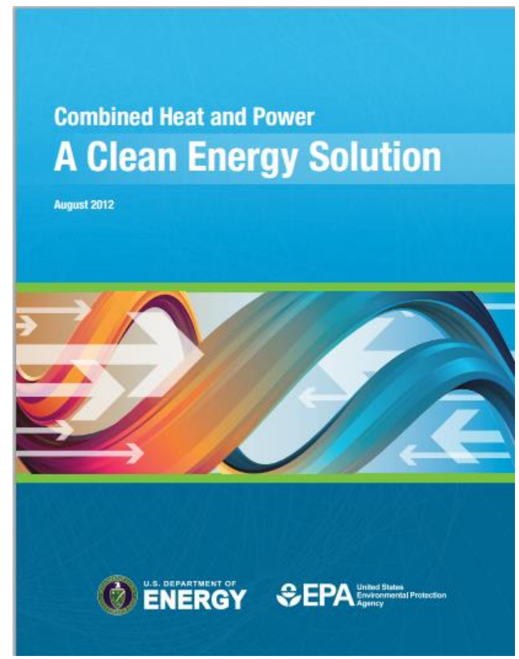
CHP Project Resources

DOE CHP Technologies Fact Sheet Series



www.energy.gov/chp-technologies

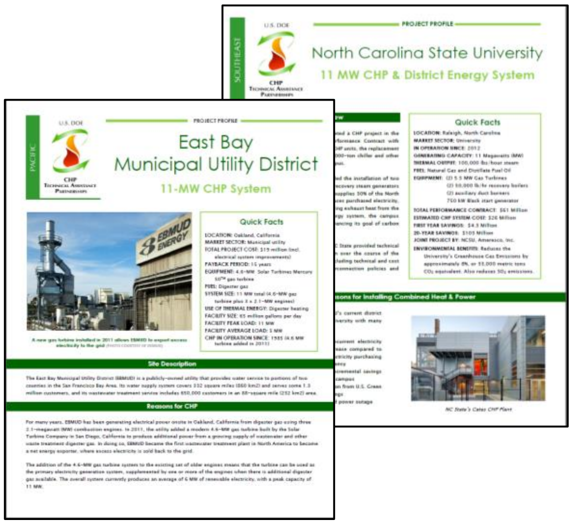
Good Primer Report



www.eere.energy.gov/chp

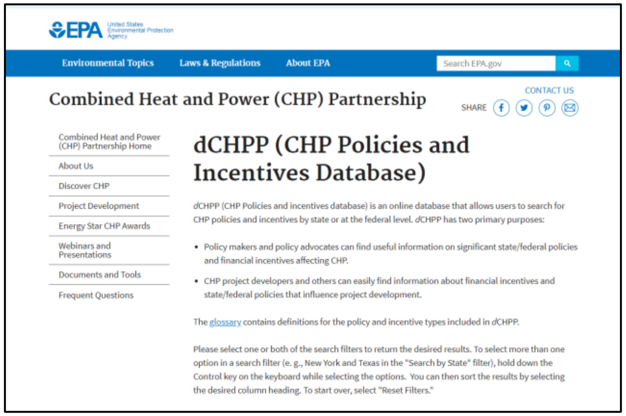
CHP Project Resources

DOE Project Profile Database



energy.gov/chp-projects

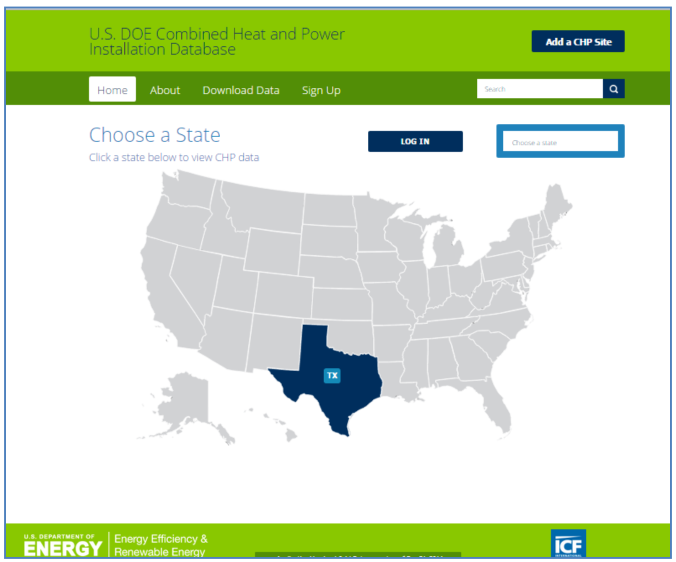
EPA dCHPP (CHP Policies and Incentives Database



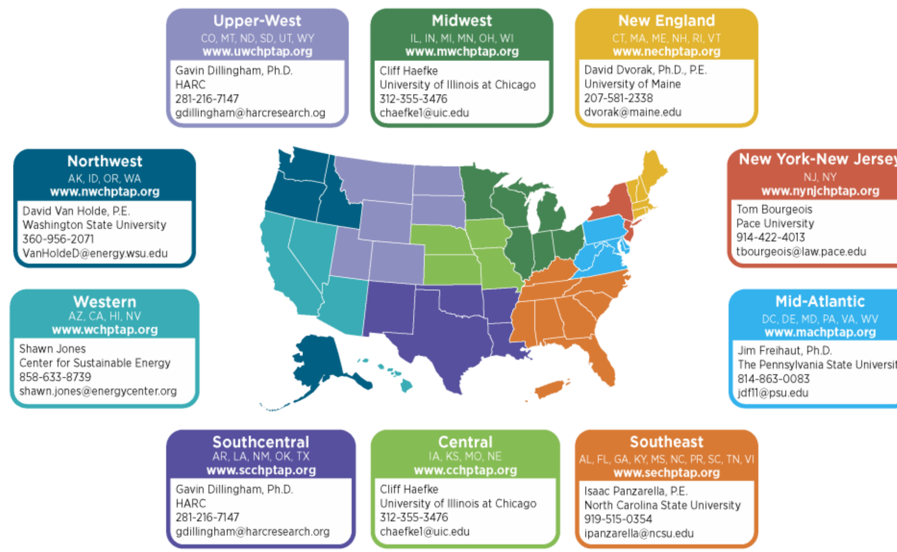
www.epa.gov/chpdchpp-chp-policies-and-incentives-database

CHP Project Resources

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



And of course… No Cost CHP Screening and Other Technical Assistance from the CHP TAP



Next Steps

Resources are available to assist in developing CHP Projects.

Contact the Southcentral CHP TAP to:

- Perform Microgrid with CHP Qualification Screening for a particular facility
- Conduct a resilience assessment
- Identify existing CHP sites for Project Profiles
- Advanced Technical Assistance

Summary

- Microgrids with CHP is a proven technology providing energy savings, reduced emissions, and opportunities for resiliency
- Emerging drivers are creating new opportunities to evaluate microgrids with CHP and numerous example exist to learn more how sites have incorporated this technology
- Engage with the US DOE Southcentral CHP TAP to learn more about the technical assistance offerings in evaluating microgrids with CHP

Thank You!

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