7th Annual
Maine Natural Gas Conference

Dr. David Dvorak, PE

New England Combined Heat and Power (CHP)
and University of Maine

PIERCE ATWOOD LLP

Verrill

New England's CHP Technical Assistance Partnership

7th Maine Natural Gas Conference
Falmouth, ME

October 3, 2019

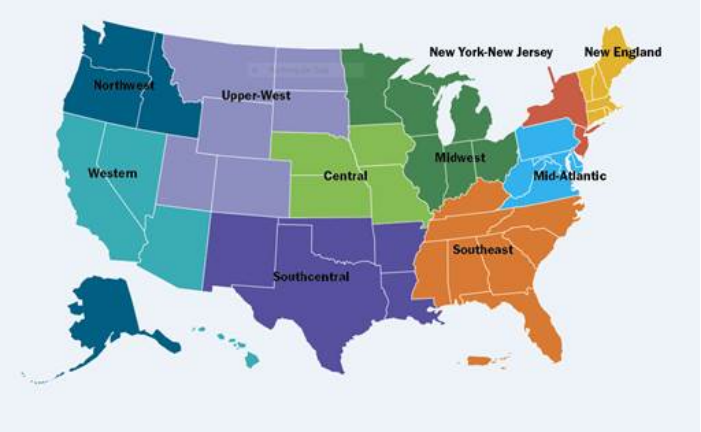
S. David Dvorak, Ph.D., P.E.

Outline

- Who we are, what we do
- CHP basics
- Existing Installations and Technical Potential
- National CHP eCatalog
- CHP for Resiliency and Reliability
- Technical Assistance
- Resources
- Next Steps

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

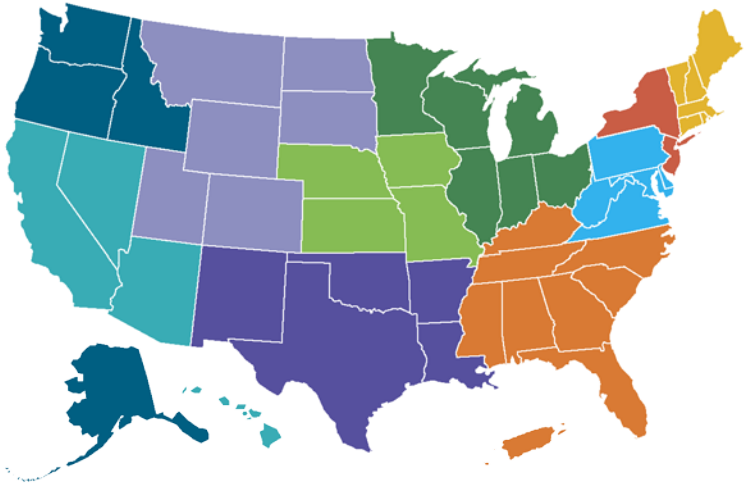
DOE CHP Technical Assistance Partnerships (CHP TAPs)

Upper-West
CO, MT, ND, SD, UT, WY
www.uwchptap.org
Gavin Dillingham, Ph.D.
HARC
281-216-7147
gdillingham@harcresearch.og

Midwest
IL, IN, MI, MN, OH, WI
www.mwchptap.org
Cliff Haefke
University of Illinois at Chicago
312-355-3476
chaefke1@uic.edu

New England
CT, MA, ME, NH, RI, VT
www.nechptap.org
David Dvorak, Ph.D., P.E.
University of Maine
207-581-2338
dvorak@maine.edu

Northwest
AK, ID, OR, WA
www.nwchptap.org
David Van Holde, P.E.
Washington State University
360-956-2071
VanHoldeD@energy.wsu.edu



New York-New Jersey
NJ, NY
www.nynjchptap.org
Tom Bourgeois
Pace University
914-422-4013
tbourgeois@law.pace.edu

Western
AZ, CA, HI, NV
www.wchptap.org
Shawn Jones
Center for Sustainable Energy
858-633-8739
shawn.jones@energycenter.org

Mid-Atlantic
DC, DE, MD, PA, VA, WV
www.machptap.org
Jim Freihaut, Ph.D.
The Pennsylvania State University
814-863-0083
jdf11@psu.edu

Southcentral
AR, LA, NM, OK, TX
www.scchptap.org
Gavin Dillingham, Ph.D.
HARC
281-216-7147
gdillingham@harcresearch.org

Central
IA, KS, MO, NE
www.cchptap.org
Cliff Haefke
University of Illinois at Chicago
312-355-3476
chaefke1@uic.edu

Southeast
AL, FL, GA, KY, MS, NC, PR, SC, TN, VI
www.sechptap.org
Isaac Panzarella, P.E.
North Carolina State University
919-515-0354
ipanzarella@ncsu.edu

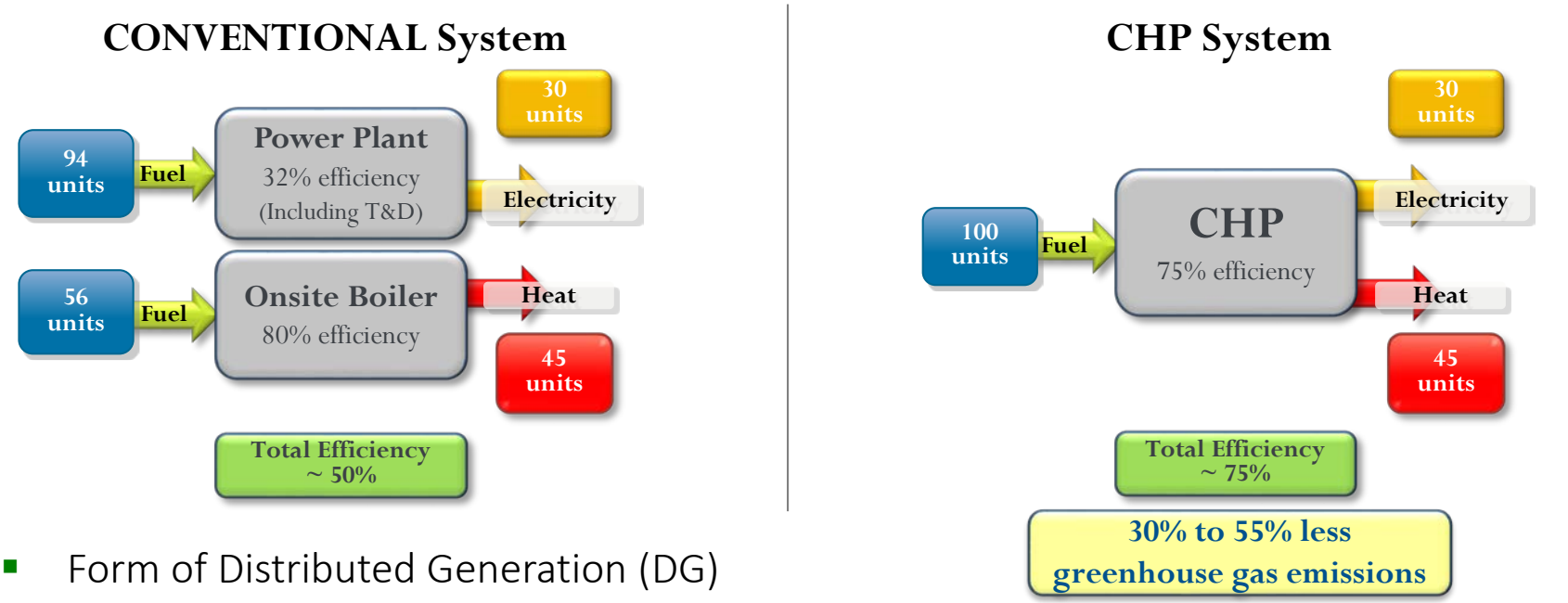
DOE CHP Deployment Program Contacts

www.energy.gov/CHPTAP

Tarla T. Toomer, Ph.D.
CHP Deployment Manager
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy
Tarla.Toomer@ee.doe.gov

Patti Garland
DOE CHP TAP Coordinator [contractor]
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy
Patricia.Garland@ee.doe.gov

CHP: A Key Part of Our Energy Future

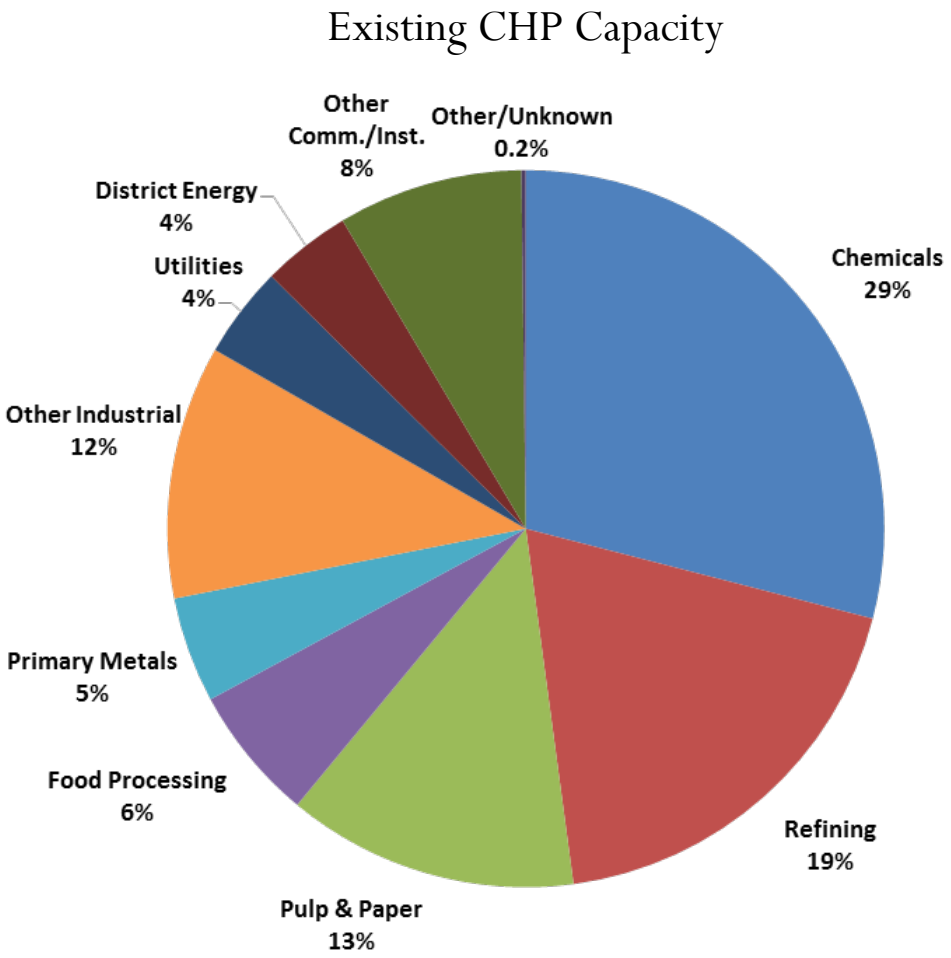


- Form of Distributed Generation (DG)
- An integrated system
- Located at or near a building / facility
- Provides at least a portion of the electrical load
- Uses thermal energy for:
  - Space Heating / Cooling
  - Process Heating / Cooling
  - Dehumidification

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

Source: www.energy.gov/chp

CHP Today in the United States

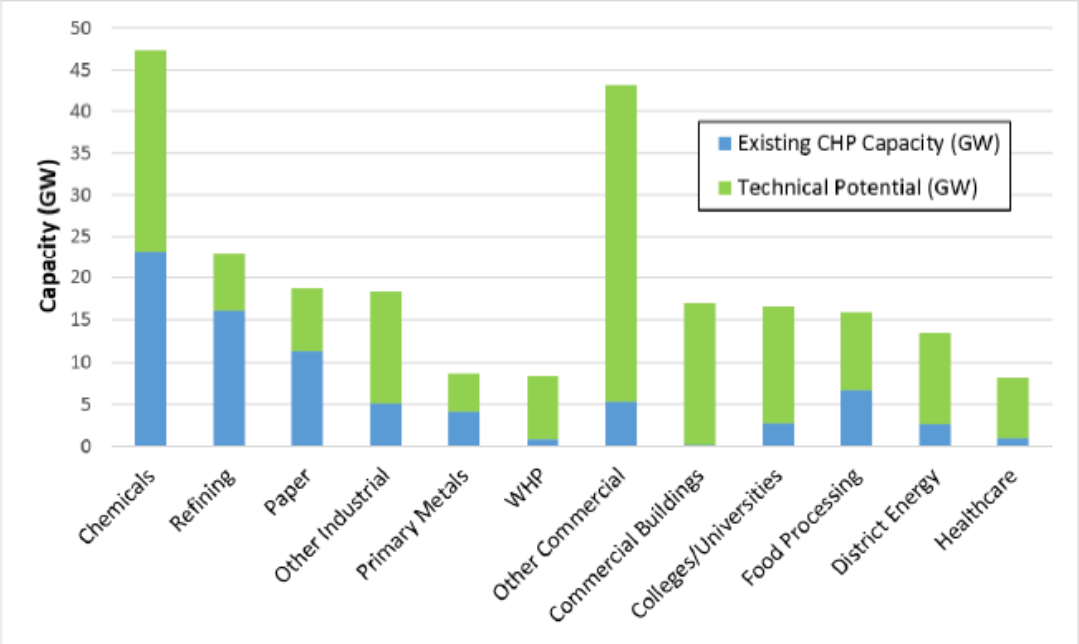


- **81.1 GW** of installed CHP at more than 4,500 industrial and commercial facilities
- 8% of U.S. Electric Generating Capacity; 14% of Manufacturing
- Avoids more than **1.8 quadrillion Btus** of fuel consumption annually
- Avoids **241 million metric tons of CO_2** compared to separate production

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

Non-Traditional CHP Markets are an Untapped Resource

- **Large CHP potential in commercial, institutional, light manufacturing, government and military applications**
- **Markets utilize smaller systems (< 10MW)**
- **Markets have limited CHP experience**
- **Users have limited technical resources**
- **History of issues with system performance and with CHP sales and service support**

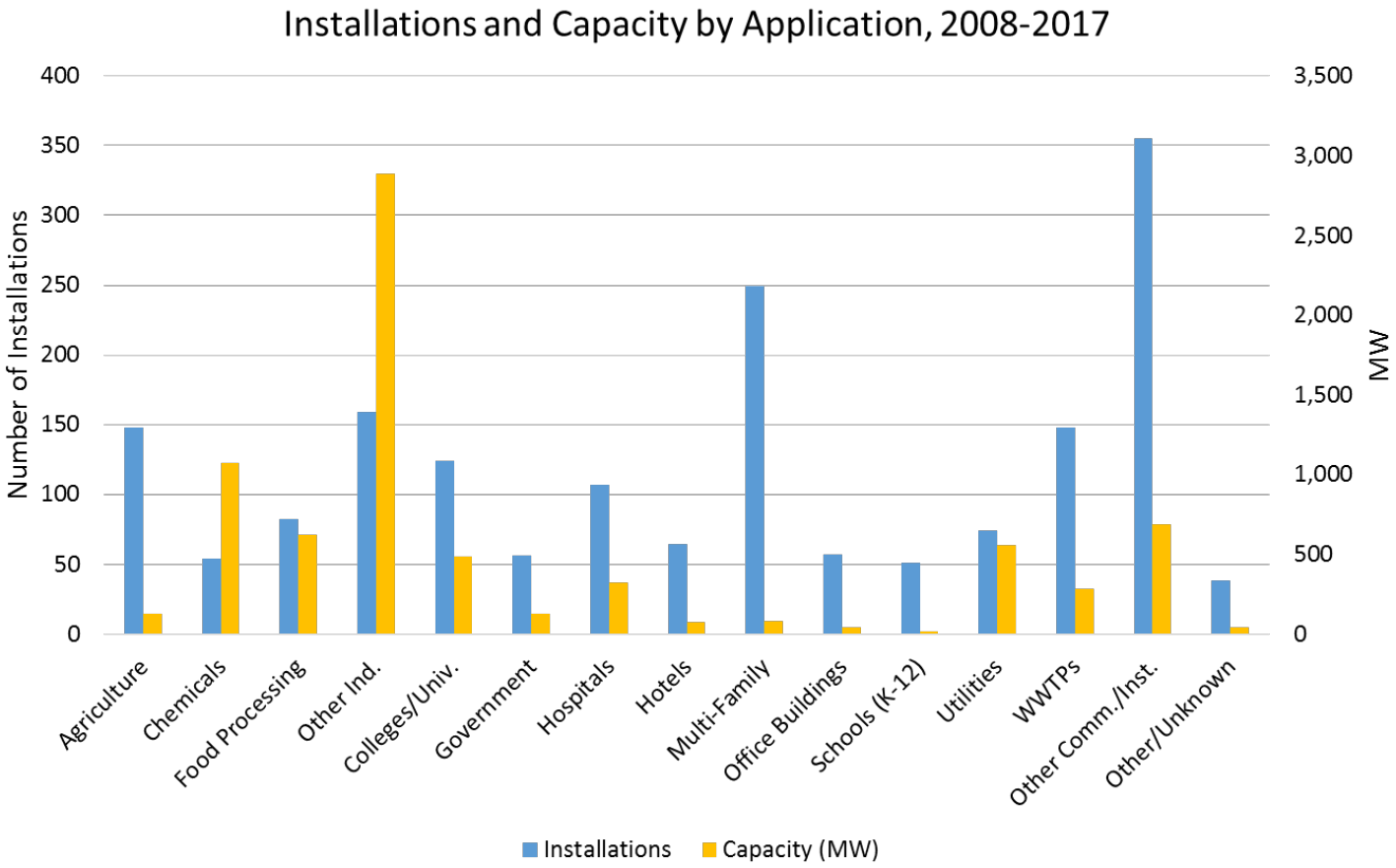


U.S. DOE CHP Deployment Program, 2016.

- **Many perceived risks by both users and suppliers**

CHP is Growing in these Markets

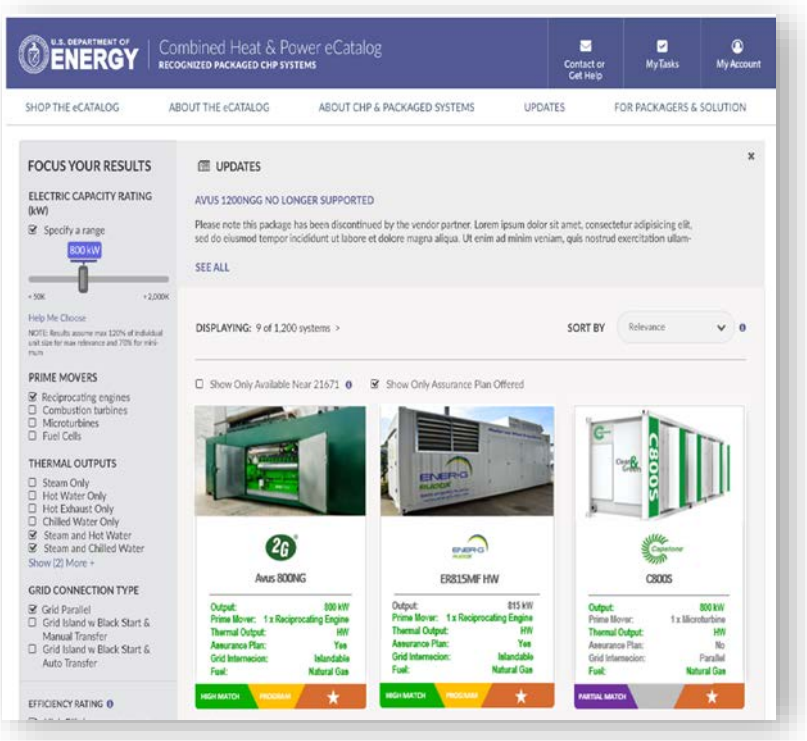
- *Non-traditional markets represented 35% of the capacity and 70% of the projects installed since 2008*



Source: DOE CHP Installation Database (U.S. installations as of Dec. 31, 2017)

DOE Packaged CHP eCatalog

- **A national web-based catalog (eCatalog) of DOE-recognized packaged CHP systems supported by two groups of partners:**
  - ***CHP Suppliers*** **that assemble, install and/or service packaged CHP systems**
  - ***CHP Engagement*** **partners that provide CHP market deployment programs at the state, local and utility level**
- **End-users search for CHP system characteristics, and get connected to packagers, installers and CHP engagement programs**
- Allows users to **compare** technology options on a common basis



- **Builds on NYSERDA's successful Packaged CHP Catalog Program**

QUICK START

FIND CHP PACKAGES

PRIMARY SITE LOCATION

Zip Code

☑ Installation and Assurance Plan offered in this location

POWER OUTPUT ⓘ

1,000 kW

Help Me Choose

PRIME MOVERS ⓘ

- ☐ Reciprocating engines
- ☐ Combustion turbines
- ☐ Microturbine
- ☐ Fuel Cell

THERMAL OUTPUT ⓘ

- ☐ Hot Water Only
- ☐ Chilled Water Only
- ☐ Hot Water and Chilled Water
- ☐ Steam Only
- ☐ Steam and Hot Water
- ☐ Steam and Chilled Water
- ☐ Steam, Hot Water, and Chilled Water

FUEL TYPE ⓘ

- ☐ Natural Gas
- ☐ Propane
- ☐ Digester Gas
- ☐ Landfill Gas

GRID CONNECTION TYPE ⓘ

- ☐ Grid Parallel Only
- ☐ Grid Island, Black Start, Manual Transfer
- ☐ Grid Island, Black Start, Auto Transfer

FIND PACKAGES

or SHOP ENTIRE eCATALOG

PACKAGED **CHP SYSTEMS. RIGOROUS RECOGNITION** PROCESS.

The Packaged Combined Heat and Power Catalog (eCatalog) is a voluntary public/private partnership designed to increase deployment of CHP in commercial, institutional and multi-family buildings and manufacturing plants. The core of the eCatalog are CHP Packagers who commit to provide pre-engineered and tested Packaged CHP systems that meet or exceed DOE performance requirements and CHP Solution Providers who commit to provide responsible installation, commissioning, maintenance and service of recognized Packaged CHP systems and also provide a single point of responsibility.

MARKET ENGAGEMENT PROGRAMS: INCENTIVIZING CHP IN YOUR AREA

MAXIMIZE YOU CHP INVESTMENT WHEN YOU INSTALL QUALIFYING SYSTEMS

State, local and utility programs are designed to remove barriers and or incentivize technologies that improve energy efficiency, reduce electric demand, improve resiliency and/or reduce emissions. CHP systems often qualify for these programs. State and local agencies, as well as utilities with CHP programs that have selected to use the eCatalog an integral part of their program have entered their locations where their programs are in effect. When you search the eCatalog, using your site ZIP code, the equipment cards will show an icon indicating that the equipment is eligible for a program. Also the specific program entity will appear on the right margin of the equipment detail sheets.

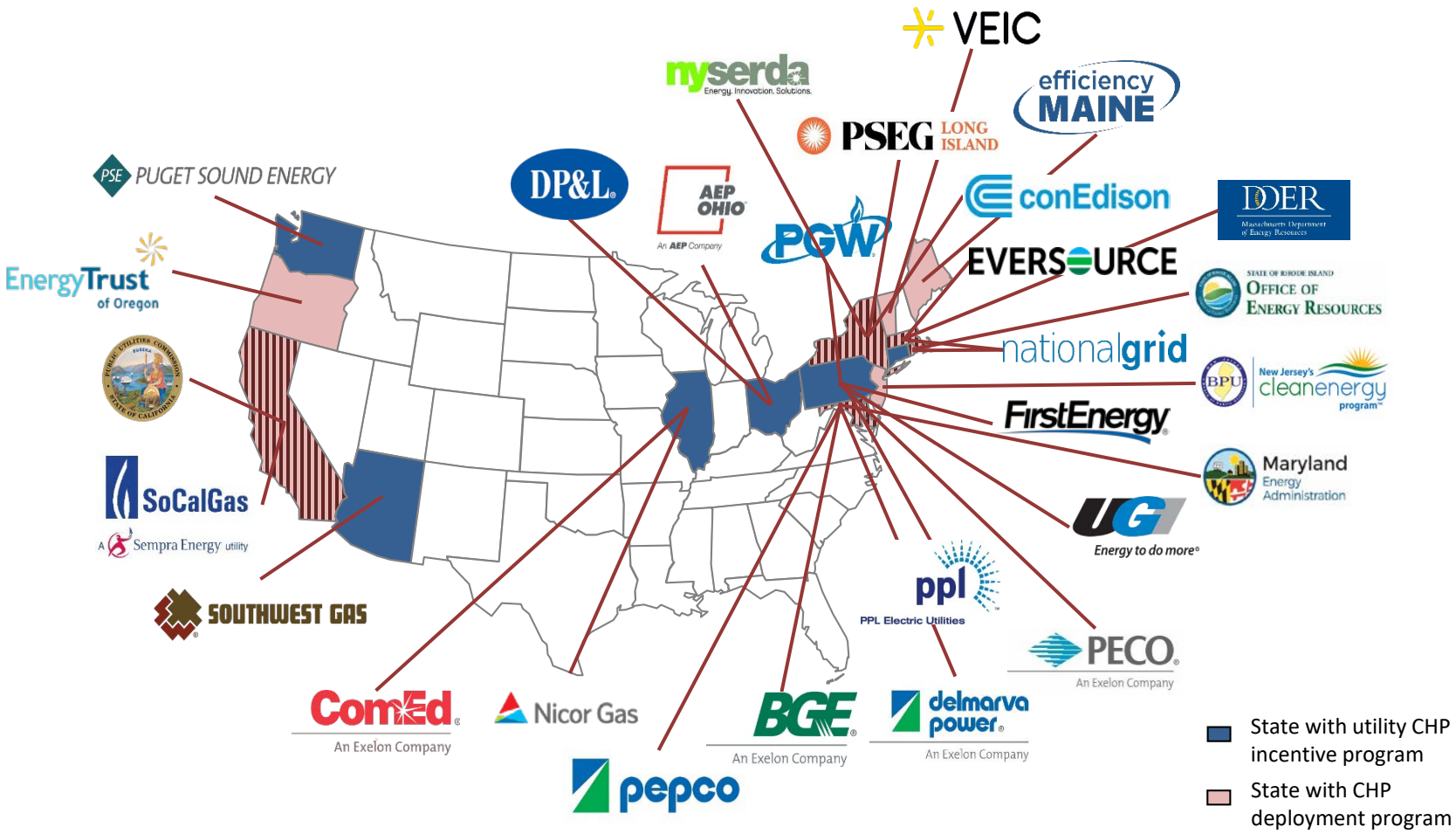
ABOUT CHP & PACKAGE SYSTEMS | SHOP THE ECATALOG | BECOME A PACKAGER OR SOLUTION PROVIDER

DOE Packaged CHP Accelerator

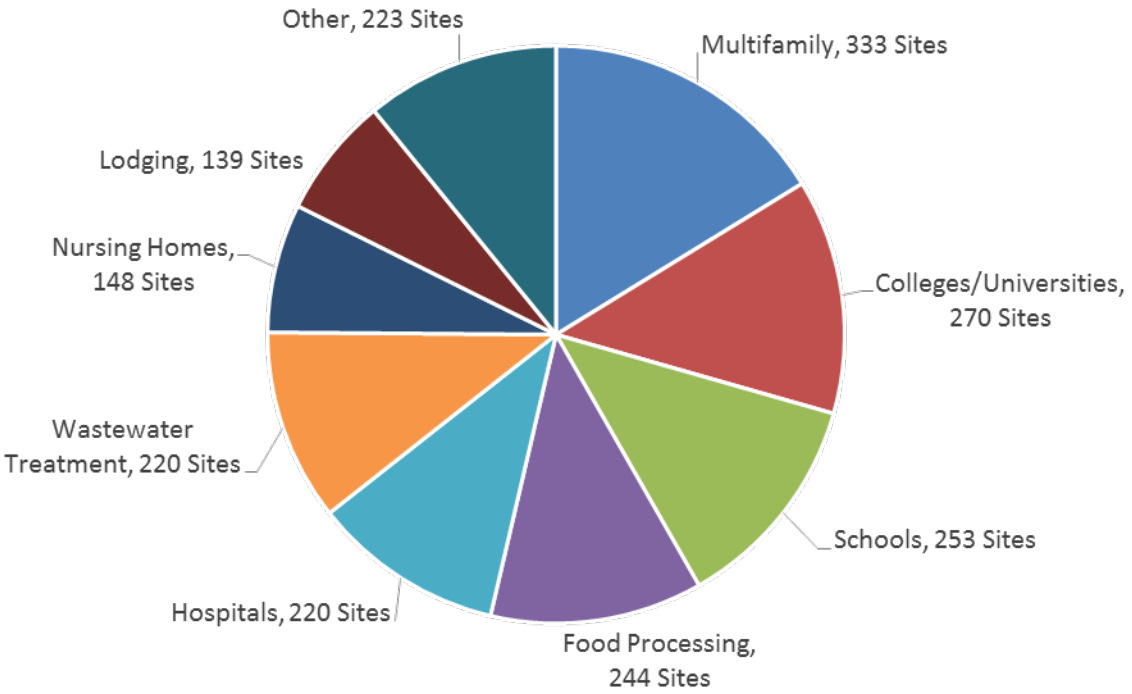
Better Buildings Accelerators *demonstrate, catalyze and validate innovative approaches to increase investment in efficient energy technologies*

- A venue to populate and launch the Packaged CHP eCatalog – success requires state/utility market engagement programs to promote CHP deployment, publicize the eCatalog, and provide technical and market assistance
- *CHP Supplier Partners* – CHP system packagers and solution providers participating in the national *eCatalog* of packaged CHP systems
- *CHP Engagement Partners* – Utilities, federal agencies, states, cities or other market entities committed to promoting packaged CHP (via the *eCatalog*)

State and Utility CHP Programs are Growing



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/

Critical Infrastructure Resilience with CHP

- 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
- 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

CHP Meets Critical Infrastructure Power Reliability Requirements

- If the CHP system is connected to the grid, it should:
  - Be designed to disconnect and keep operating following a power disturbance, and
  - Should cover the critical loads of the facility.

Requirements for Critical Infrastructure Power Reliability	
Black-start capability	The CHP system must have an electrical signal from a battery system or onsite backup generator to provide "black-start" capability when there is a grid outage.
Generator capable of operating independently of the grid	The CHP electric generator must be able to continue or maintain operation without a grid power signal. High frequency generators (microturbines) or DC generators (fuel cells) need to have inverter technology that can operate independently from the grid.
Ample carrying capacity	The facility must match the size of the critical loads to the CHP generator.
Parallel utility interconnection and switchgear controls	The CHP system must be able to properly disconnect itself from the utility grid and switch over to providing electricity to critical facility loads.

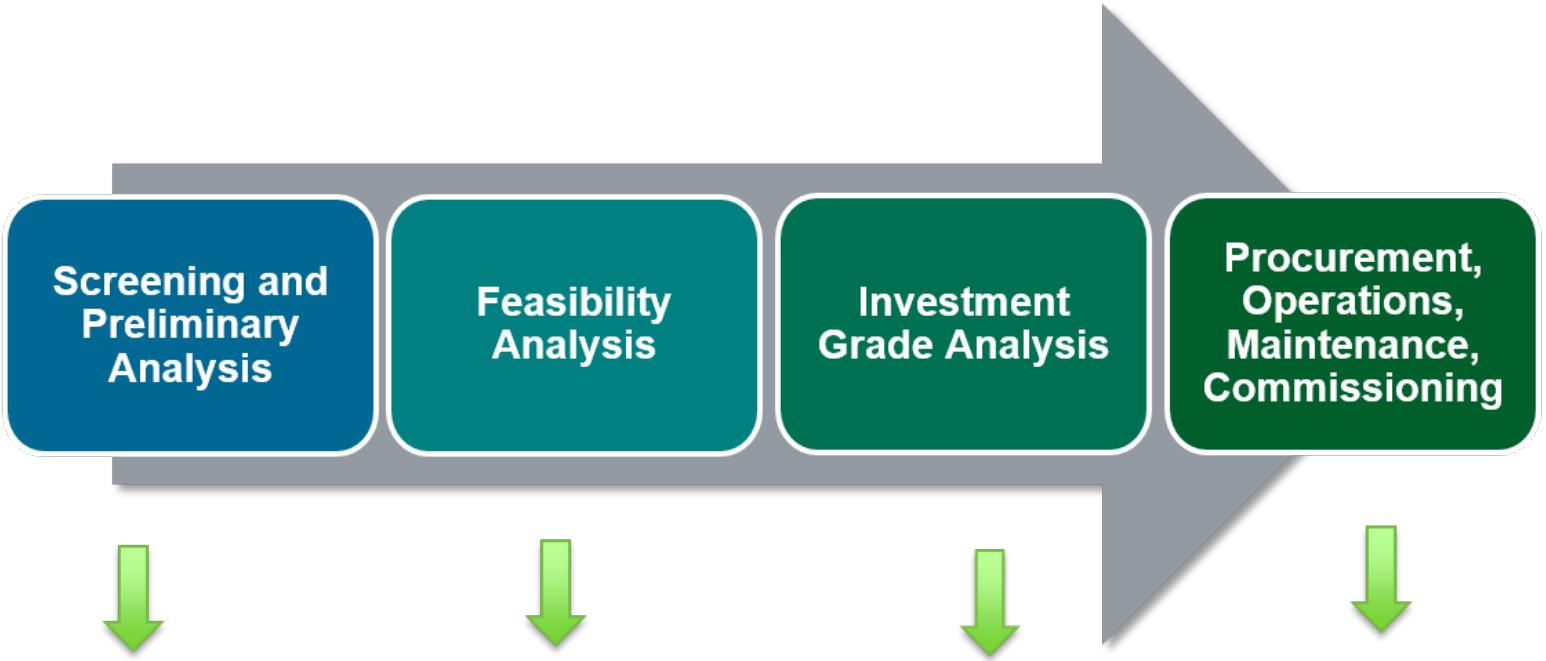
Source: Guide to Using Combined Heat and Power for Enhancing Reliability and Resiliency in Buildings, U.S. DOE. 2013.

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.

CHP TAP Role: Technical Assistance



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

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

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

Review specifications and bids.

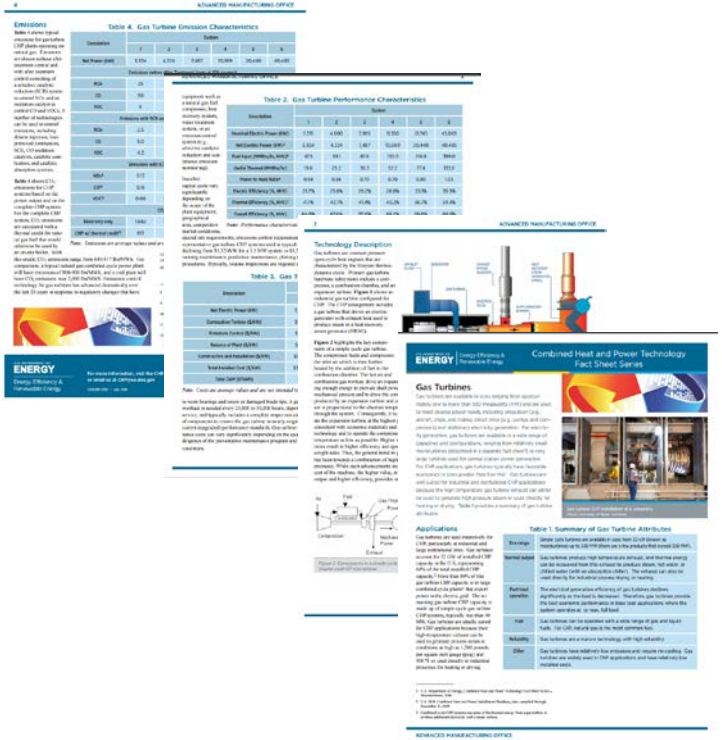
DOE TAP CHP Screening Analysis

- **High level assessment to determine if site shows potential for a CHP project**
  - **Qualitative Analysis**
    - **Energy Consumption & Costs**
    - **Estimated Energy Savings & Payback**
    - **CHP System Sizing**
  - **Quantitative Analysis**
    - **Understanding project drivers**
    - **Understanding site peculiarities**

Annual Energy Consumption		
	Base Case	CHP Case
Purchased Electricty, kWh	88,250,160	5,534,150
Generated Electricity, kWh	0	82,716,010
On-site Thermal, MMBtu	426,000	18,872
CHP Thermal, MMBtu	0	407,128
Boiler Fuel, MMBtu	532,500	23,590
CHP Fuel, MMBtu	0	969,845
Total Fuel, MMBtu	532,500	993,435
Annual Operating Costs		
Purchased Electricity, $	$7,060,013	$1,104,460
Standby Power, $	$0	$0
On-site Thermal Fuel, $	$3,195,000	$141,539
CHP Fuel, $	$0	$5,819,071
Incremental O&M, $	$0	$744,444
Total Operating Costs, $	$10,255,013	$7,809,514
Simple Payback		
Annual Operating Savings, $		$2,445,499
Total Installed Costs, $/kW		$1,400
Total Installed Costs, $/k		$12,990,000
Simple Payback, Years		**5.3**
Operating Costs to Generate		
Fuel Costs, $/kWh		$0.070
Thermal Credit, $/kWh		($0.037)
Incremental O&M, $/kWh		$0.009
Total Operating Costs to Generate, $/kWh		**$0.042**

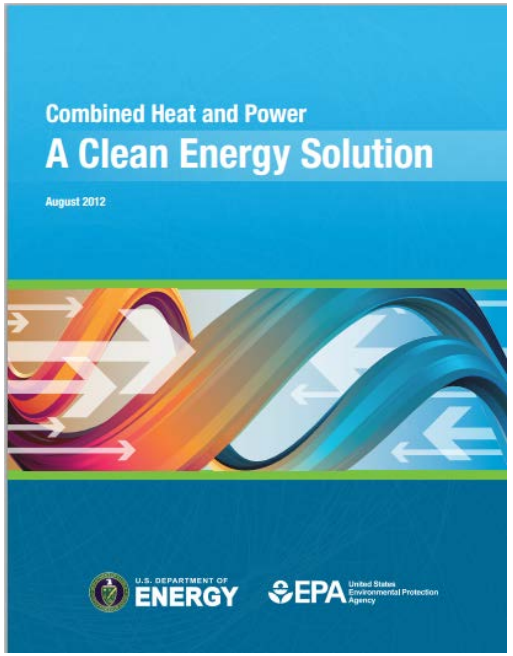
CHP Project Resources

DOE CHP Technologies Fact Sheet Series



www.energy.gov/chp-technologies

Good Primer Report



www.eere.energy.gov/chp

Summary

- CHP gets the most out of a fuel source, enabling
  - **High overall utilization efficiencies**
  - **Reduced environmental footprint**
  - **Reduced operating costs**
- The National CHP eCatalog offers lower perceived risk of CHP in non-traditionial markets, also reduced cost and lead time.
  - ➢ **Supplier and Engagement partners are critical to the success of the CHP eCatalog**
- CHP can be used in different strategies, including **critical infrastructure resiliency** and emergency planning

Next Steps

Contact your Regional CHP TAP for assistance if:

- You are interested in having a "no-**cost"** Qualification Screening performed to determine if there is an opportunity for CHP on-site.
- If you have an existing CHP plant and are interested in expanding **the plant**.
- **If you need** an unbiased 3rd Party Review of a proposal.

NEW ENGLAND

CHP
TECHNICAL ASSISTANCE
PARTNERSHIPS

Thank You

Questions?

New England CHP Project Director:
S. David Dvorak, Ph. D., P.E.
dvorak@maine.edu

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

A program sponsored by

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

www.energy.gov/chp