For the first session of a new webinar series:

Advanced Energy 101 for LPCs

co-hosted by

Tennessee Advanced Energy Business Council &
Seven States Power Corporation

Combined Heat and Power Opportunity in TVA Region & DOE Resources

21 October 2020

Isaac Panzarella, Director,
DOE Southeast CHP TAP;
NC Clean Energy Technology Center
NC State University

CHP Technical Assistance Partnerships

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.

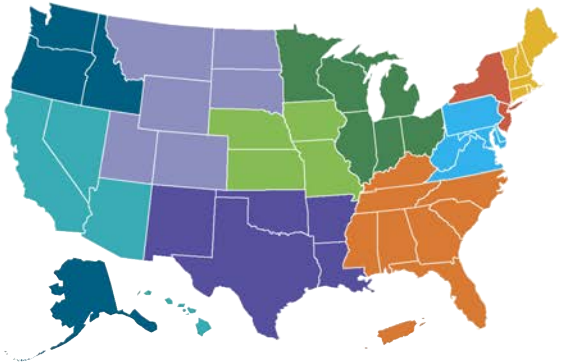
- **Stakeholder Engagement**
  Engage with strategic Stakeholders, including regulators, utilities, and policy makers, to identify and reduce the barriers to using CHP to advance regional efficiency, promote energy independence, and enhance the nation's resilient grid. CHP TAPs provide fact-based, non-biased education to advance sound CHP programs and policies.

- **Technical Services**
  As leading experts in CHP (as well as microgrids, waste 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.

National Manufacturing Day 2019 at the University of Illinois at Chicago

www.energy.gov/chp

DOE CHP Technical Assistance Partnerships (CHP TAPs)



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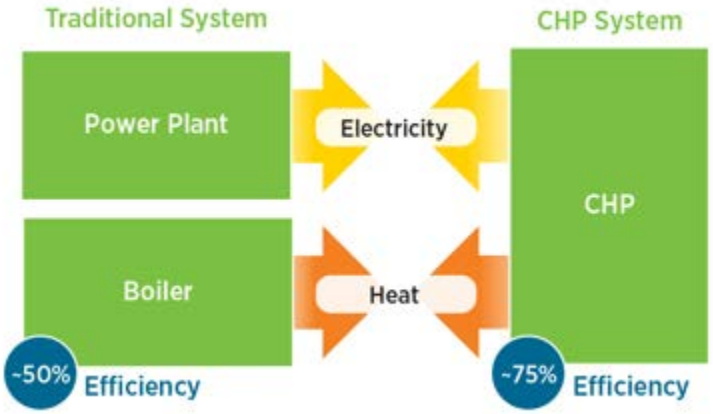
CHP: A Key Part of Our Energy Future

- 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

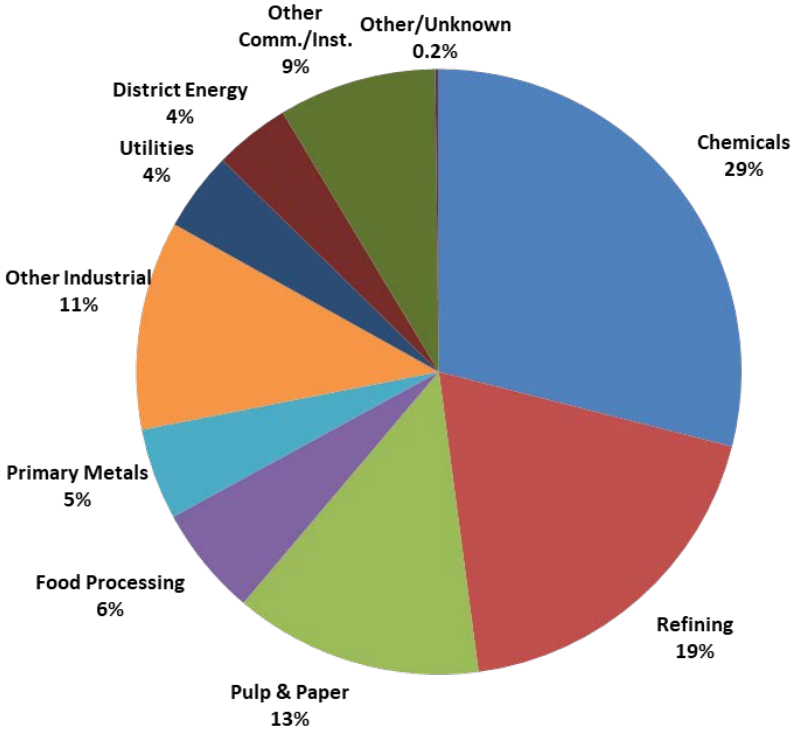


CHP provides efficient, clean, reliable, affordable energy – today and for the future.

Source: www.energy.gov/chp

CHP Today in the United States

Existing CHP Capacity



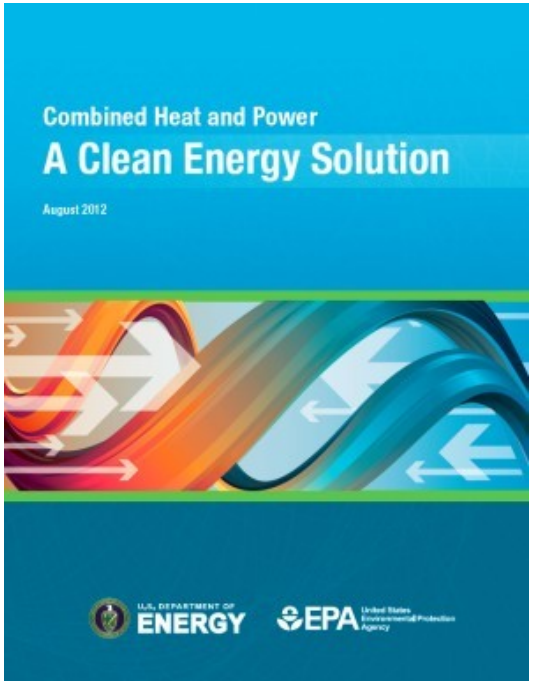
Source: DOE CHP Installation Database (U.S. installations as of Dec. 31, 2019)

- **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 CO_2** compared to separate production

Emerging National Drivers for CHP

- Benefits of CHP recognized by policymakers
  - State Portfolio Standards (RPS, EEPS), Tax Incentives, Grants, standby rates, etc.
- Favorable outlook for natural gas supply and price in North America
- Opportunities created by environmental drivers
- Utilities finding economic value
- Energy resiliency and critical infrastructure
- Interest in hybrid CHP systems

DOE / EPA CHP Report (8/2012)

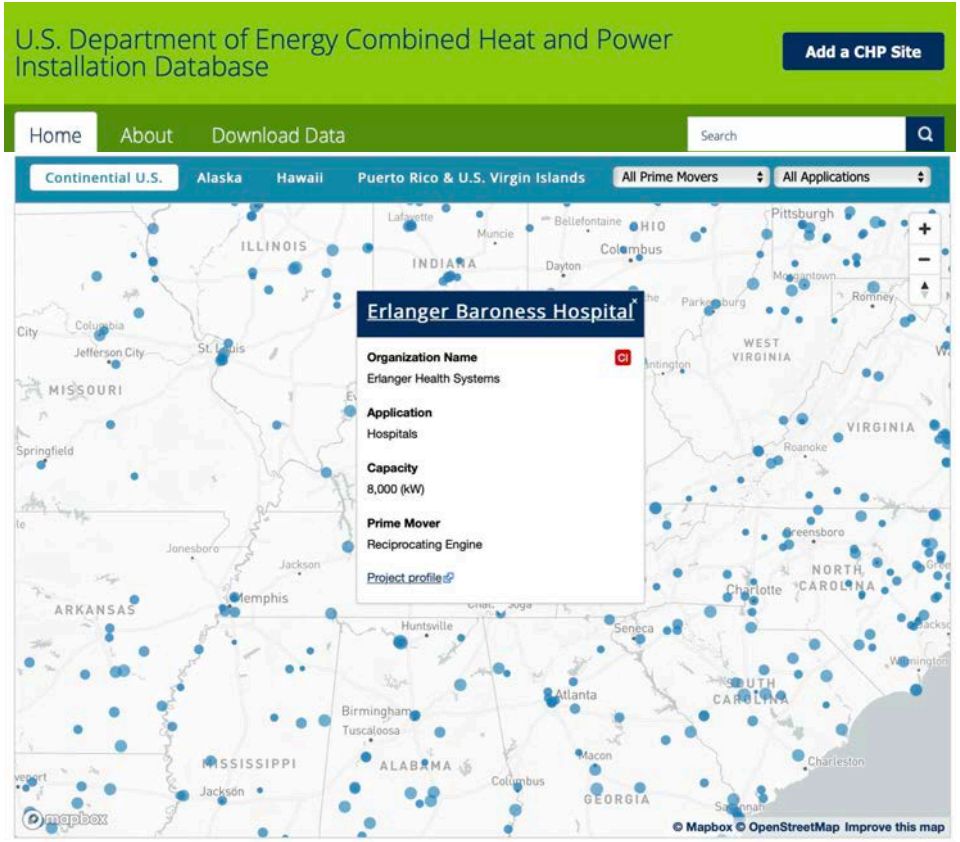


http://www1.eere.energy.gov/manufacturing/distributedenergy/pdfs/chp_clean_energy_solution.pdf

What Are the Benefits of CHP?

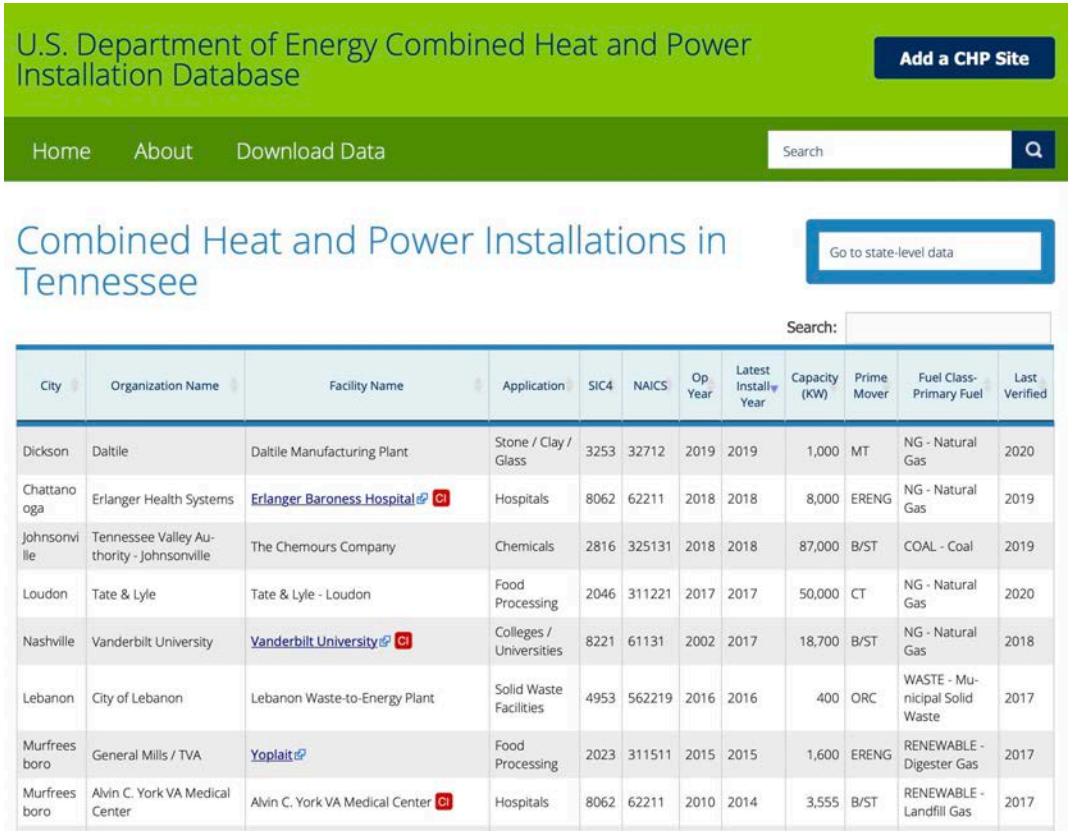
- CHP is **more efficient** than separate generation of electricity and heating/cooling
- Higher efficiency translates to **lower operating costs** (but requires capital investment)
- Higher efficiency **reduces emissions** of pollutants
- CHP can also increase **energy efficiency, resiliency** and enhance power quality
- On-site electric generation can **reduce grid congestion** and avoid distribution costs.

DOE CHP Database



https://doe.icfwebservices.com/chpdb/

CHP Installations in Tennessee



U.S. Department of Energy Combined Heat and Power Installation Database

Add a CHP Site

Home About Download Data Search

Combined Heat and Power Installations in Tennessee

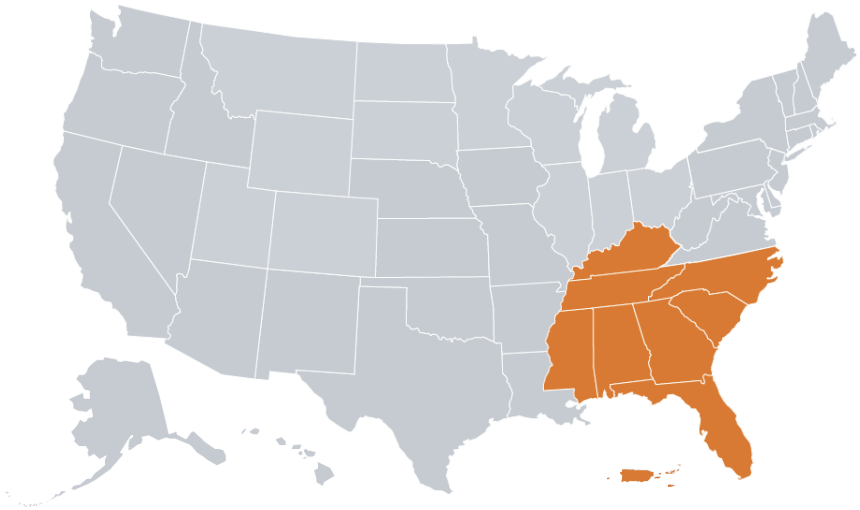
Go to state-level data

Search:

City	Organization Name	Facility Name	Application	SIC4	NAICS	Op Year	Latest Install Year	Capacity (KW)	Prime Mover	Fuel Class-Primary Fuel	Last Verified
Dickson	Daltile	Daltile Manufacturing Plant	Stone / Clay / Glass	3253	32712	2019	2019	1,000	MT	NG - Natural Gas	2020
Chattanooga	Erlanger Health Systems	Erlanger Baroness Hospital CI	Hospitals	8062	62211	2018	2018	8,000	ERENG	NG - Natural Gas	2019
Johnsonville	Tennessee Valley Authority - Johnsonville	The Chemours Company	Chemicals	2816	325131	2018	2018	87,000	B/ST	COAL - Coal	2019
Loudon	Tate & Lyle	Tate & Lyle - Loudon	Food Processing	2046	311221	2017	2017	50,000	CT	NG - Natural Gas	2020
Nashville	Vanderbilt University	Vanderbilt University CI	Colleges / Universities	8221	61131	2002	2017	18,700	B/ST	NG - Natural Gas	2018
Lebanon	City of Lebanon	Lebanon Waste-to-Energy Plant	Solid Waste Facilities	4953	562219	2016	2016	400	ORC	WASTE - Municipal Solid Waste	2017
Murfreesboro	General Mills / TVA	Yoplait	Food Processing	2023	311511	2015	2015	1,600	ERENG	RENEWABLE - Digester Gas	2017
Murfreesboro	Alvin C. York VA Medical Center	Alvin C. York VA Medical Center CI	Hospitals	8062	62211	2010	2014	3,555	B/ST	RENEWABLE - Landfill Gas	2017

https://doe.icfwebservices.com/chpdb/

Southeast Regional CHP Technical Onsite Potential



State	Industrial (MW)	Commercial (MW)	Total (MW)
Alabama	1,634	1,143	2,777
Florida	1,281	5,688	6,969
Georgia	2,739	2,371	5,110
Kentucky	1,809	911	2,720
Mississippi	1,141	691	1,832
North Carolina	2,421	1,931	4,352
South Carolina	1,812	1,251	3,063
Tennessee	2,551	1,632	4,183
Total	**15,388**	**15,618**	**31,006**

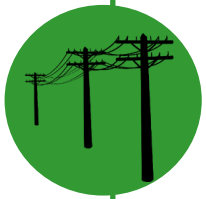
Multiple Pathways for Utility Involvement in CHP

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

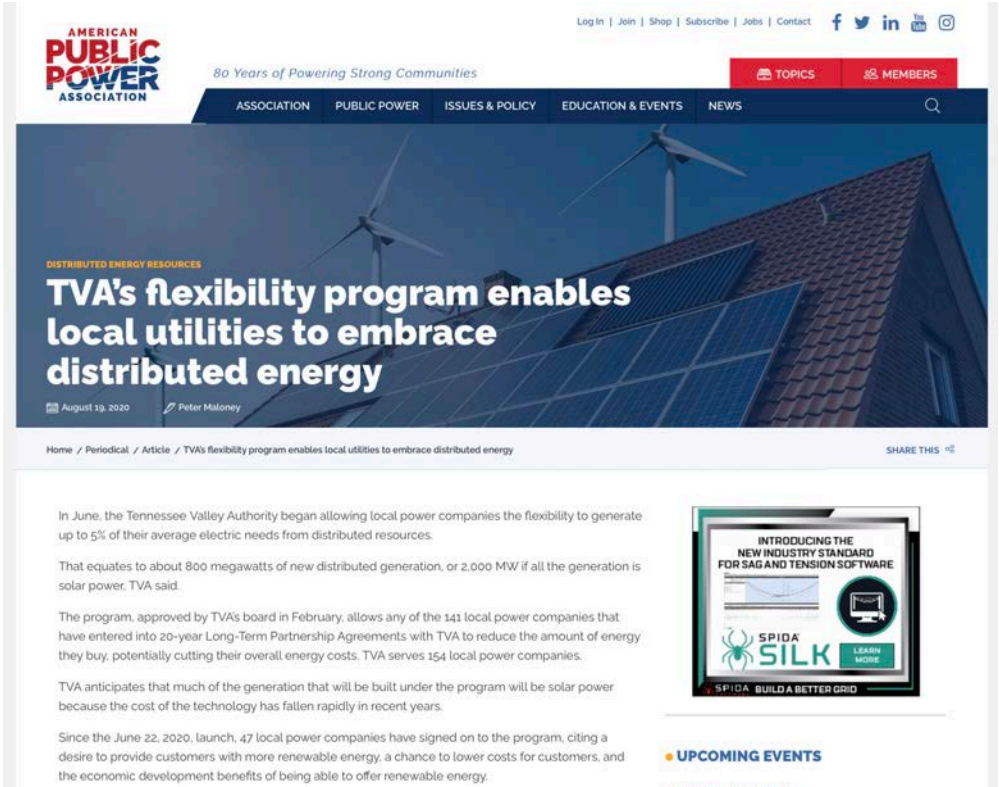
- Encourage customers to install CHP as non-wires alternative to enhance grid stability, alleviate grid congestion, or defer investments



CHP in Utility Energy Efficiency Portfolio

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

TVA's Power Supply Flexibility Program



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DISTRIBUTED ENERGY RESOURCES

TVA's flexibility program enables local utilities to embrace distributed energy

August 19, 2020 Peter Maloney

Home / Periodical / Article / TVA's flexibility program enables local utilities to embrace distributed energy

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In June, the Tennessee Valley Authority began allowing local power companies the flexibility to generate up to 5% of their average electric needs from distributed resources.

That equates to about 800 megawatts of new distributed generation, or 2,000 MW if all the generation is solar power, TVA said.

The program, approved by TVA's board in February, allows any of the 141 local power companies that have entered into 20-year Long-Term Partnership Agreements with TVA to reduce the amount of energy they buy, potentially cutting their overall energy costs. TVA serves 154 local power companies.

TVA anticipates that much of the generation that will be built under the program will be solar power because the cost of the technology has fallen rapidly in recent years.

Since the June 22, 2020, launch, 47 local power companies have signed on to the program, citing a desire to provide customers with more renewable energy, a chance to lower costs for customers, and the economic development benefits of being able to offer renewable energy.

INTRODUCING THE NEW INDUSTRY STANDARD FOR SAG AND TENSION SOFTWARE
SPIDA SILK LEARN MORE
SPIDA BUILD A BETTER GRID

UPCOMING EVENTS

https://www.publicpower.org/periodical/article/tvas-flexibility-program-enables-local-utilities-embrace-distributed-energy

TVA's Power Supply Flexibility Program

- A new program that allows local power companies (LPC) with long term agreements with TVA to develop their own flexible load-side distributed energy generation. Several key features are:
  - Eligible resources include solar PV, combined heat and power (CHP) and natural gas generators.
  - Each LPC may develop an aggregate capacity of energy resources of up to 5% of their "energy", where energy is the average hourly capacity usage, initially based on fiscal years 2015-2019, or one megawatt, whichever is greater.
  - Solar PV is allowed a technology factor of 0.4 due to its lower capacity factor.
  - LPCs are credited for energy produced at TVA's wholesale power rate
- A total of approximately 800 MW could be developed if all 154 LPCs across the Valley participate and develop their maximum allowable capacity with resources other than solar. Approximately 2,000 MW could be developed if all 154 LPCs across the Valley participate and deploy only solar to develop their maximum allowable capacity
- Information available at TVA's Environmental Review Process webpage
  https://www.tva.com/Environment/Environmental-Stewardship/Environmental-Reviews/Flexibility-Proposal

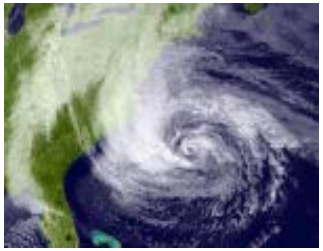
TVA's Power Supply Flexibility Program Principles

1. Energy resource sites must be documented, metered, operated, and connected in a manner consistent with applicable TVA standards
2. Valley Partner energy resources will either displace demand and energy usage that TVA would have otherwise charged to the Valley Partner under the prevailing wholesale power rate structure; or, Valley Partner energy resources will be treated in accordance with an economically equivalent wholesale crediting mechanism
3. Each Valley Partner may deploy energy resources in an aggregated capacity amount not to exceed the greater of (1) 5% of that Valley Partner's energy, where energy is the average hourly capacity usage, initially over TVA fiscal years 2015 through 2019, or (2) one megawatt of aggregated capacity
4. All Valley Partner energy resource facilities must be distribution scale and located within the service territory of the Valley Partner. Exceptions to the location requirement, due to circumstances such as restrictive siting, may be approved by the CEO after notice to the Finance, Rates, and Portfolio Committee.
5. Valley Partner energy resource output must be provided or distributed only to the Valley Partner's end-use customers
6. A Valley Partner's energy resource implementation must be consistent with TVA's Integrated Resource Plan to ensure that TVA's system carbon position is improved

from TVA Board Presentation on February 13, 2020, available at https://www.tva.com/Environment/Environmental-Stewardship/Environmental-Reviews/Flexibility-Proposal

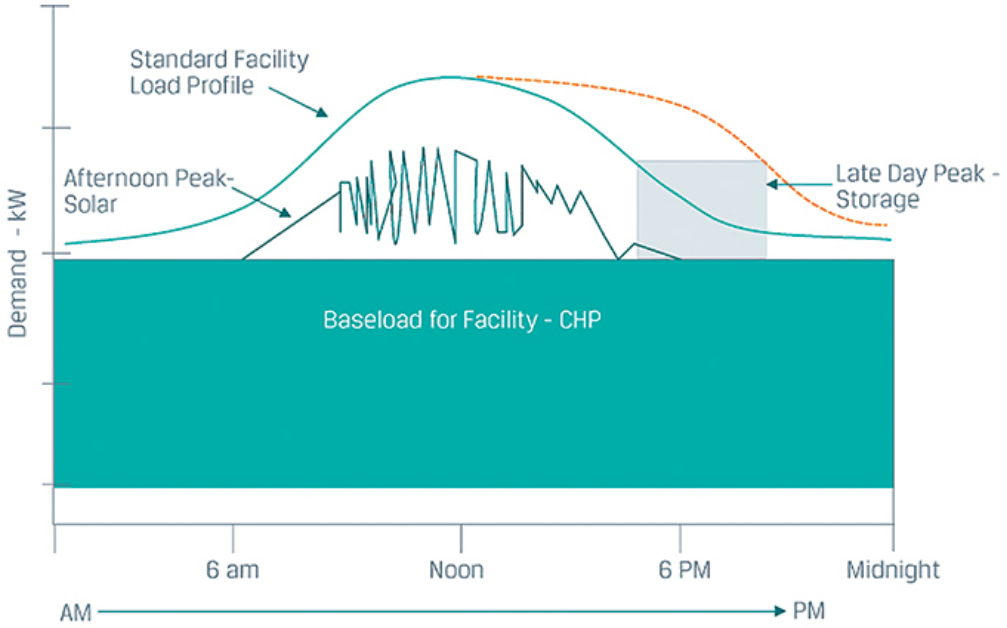
CHP Increases Resilience

- 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



Growth of Hybrid DER Systems

- Hybrid DER approaches offer the opportunity for technologies to complement one another
- Hybrid systems combine characteristics of individual technologies
  - CHP – provides baseload energy
  - Solar – variable renewable generation can now be “firmed”
  - Storage – adding flexibility
- Allows CHP to be a key part of the move toward a distributed/renewable grid



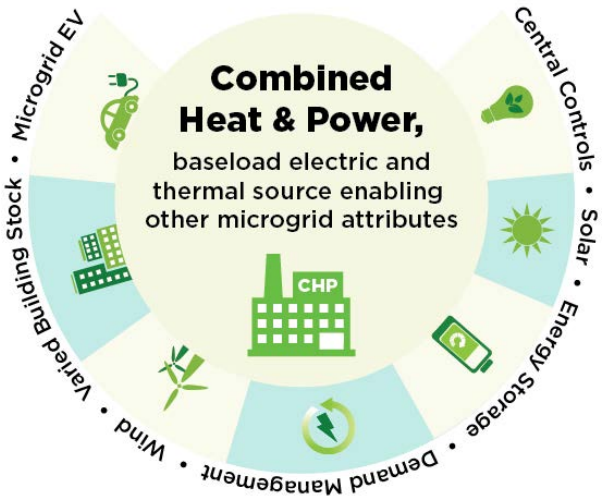
CHP and Microgrids

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**.

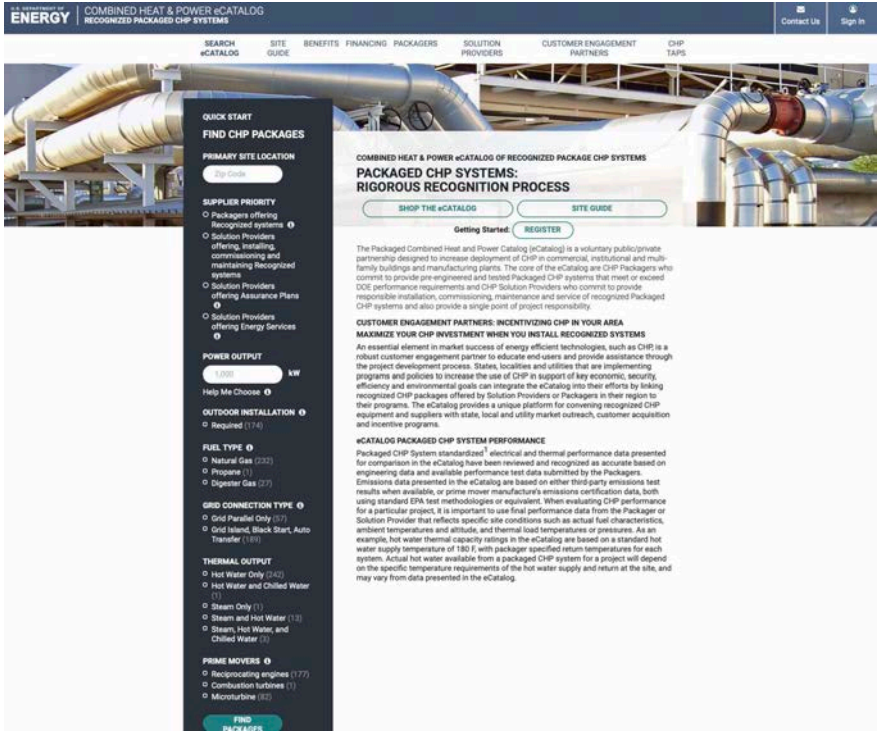
Source: U.S. Department of Energy Microgrid Exchange Group

- 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



DOE Packaged CHP eCatalog

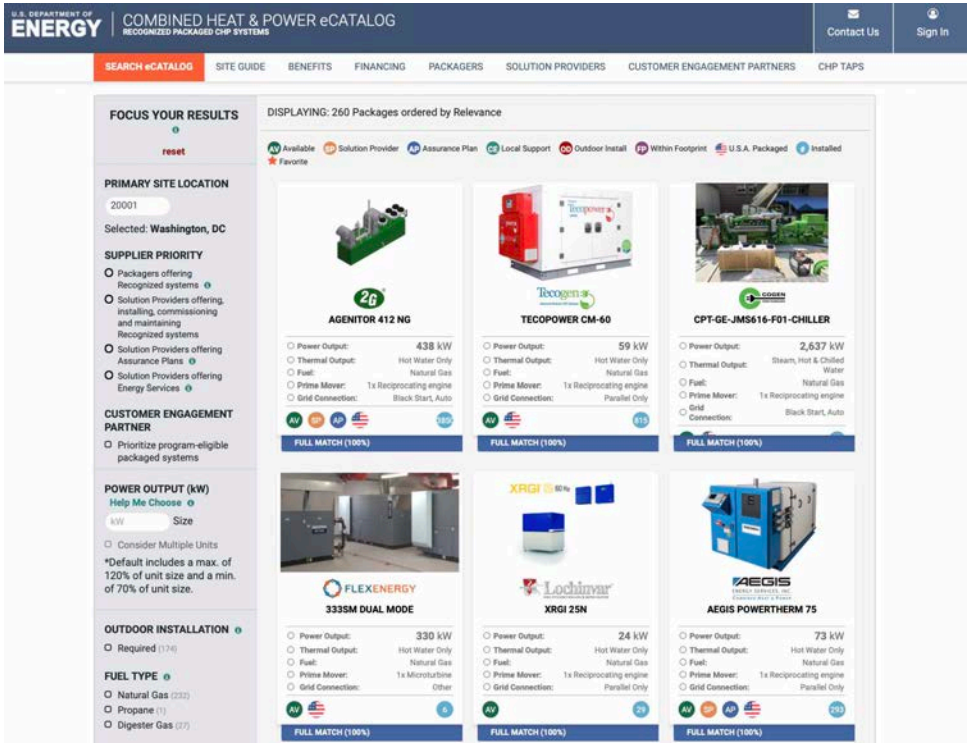
- A national web-based searchable catalog (*eCatalog*) of DOE-recognized packaged CHP systems and suppliers with the goal to reduce risks for end-users and vendors through partnerships with:
  - *CHP Packagers and Solution Providers* that assemble, install, commission and service packaged CHP systems
  - *CHP Engagement* partners that provide CHP market deployment programs at the state, local and utility level
- Pre-engineered and tested packaged CHP systems that meet DOE performance requirements
- End-users and design engineers search for applicable CHP system characteristics, and get connected to packagers, installers and CHP engagement programs
- Allows users to compare technology options on a common basis



https://chp.ecatalog.lbl.gov/

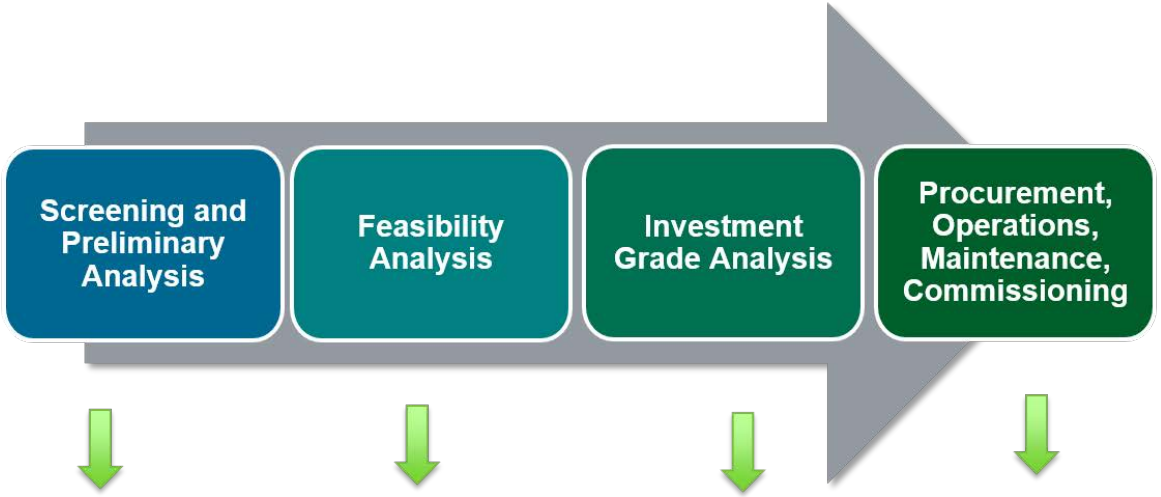
DOE Packaged CHP eCatalog status as of October 2020

- 34 recognized Packagers
- 22 recognized Solution Providers
- 260 Package Offerings
  - ✓ 177 recip engine
  - ✓ 82 microturbine
  - ✓ 1 gas turbine
  - ✓ 232 natural gas
  - ✓ 27 digester gas
  - ✓ 57 grid parallel only
  - ✓ 189 grid islandable/auto transfer
  - ✓ 24 kW to 7.5 MW
  - ✓ Multiple suppliers and packages in every zip code
- 10 Customer Engagement Partners



https://chp.ecatalog.lbl.gov/

CHP TAP Role: Technical Assistance



DOE CHP TAP Screening Analysis

High level assessment to determine if site shows potential for a CHP project

Quantitative Analysis

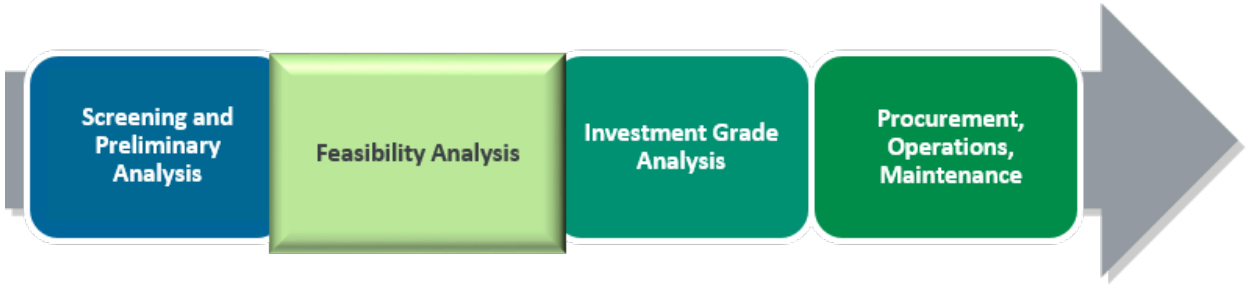
- Energy Consumption & Costs
- Estimated Energy Savings & Payback
- CHP System Sizing

Qualitative 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**

A Feasibility Analysis Typically Involves



- Electrical load profiling
- Thermal load profiling
- Unit sizing
- Thermal use determination (what to do with the heat)
- Installation cost estimations
- Financial calculations (simple payback, ROI, etc.)
- Cost/savings information compared to what your facility would pay if the CHP system were not installed

Next Steps

Contact the Southeast CHP TAP for assistance if:

- Your utility is looking at CHP as a flexible generation resource
- Interested in having a qualification screening performed to determine if there is an opportunity for CHP at your industrial or commercial site
- If you already have an existing CHP plant and are interested in expanding
- Need an unbiased 3rd Party Review of a proposal

Thank You!...

Questions?

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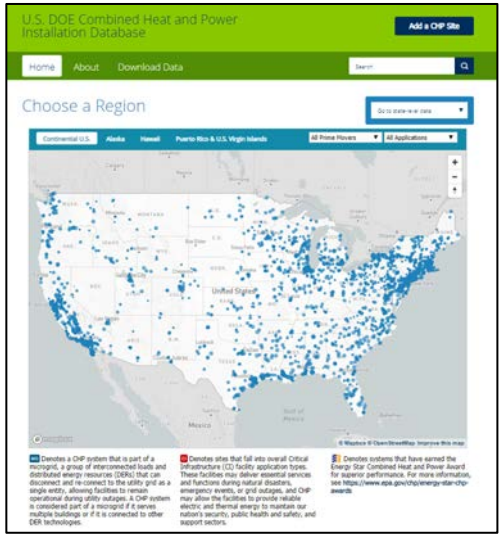
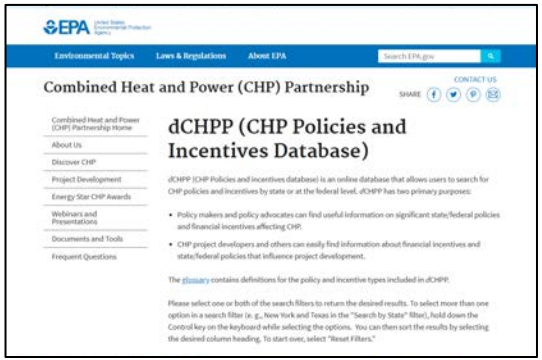
CHP Databases

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



energy.gov/chp-installs

EPA dCHPP (CHP Policies and Incentives Database



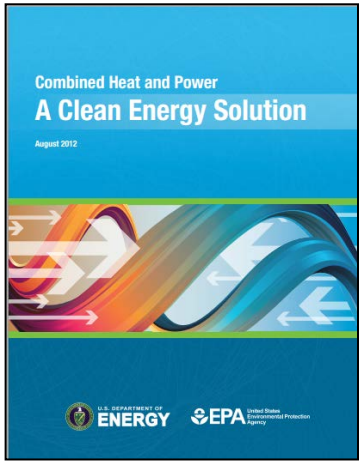
www.epa.gov/chpdchpp-chp-policies-and-incentives-database

CHP Resources

CHP Issue Brief Series

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

Good Primer Report



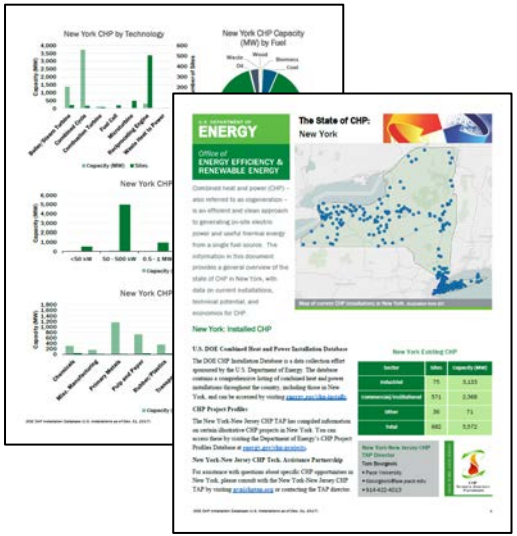
https://www.energy.gov/eere/amo/downloads/chp-clean-energy-solution-august-2012

CHP Resources

DOE CHP Technologies Fact Sheet Series

www.energy.gov/chp-technologies

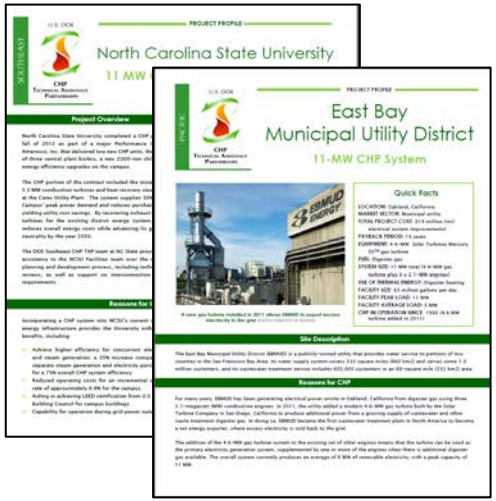
State of CHP Pages



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

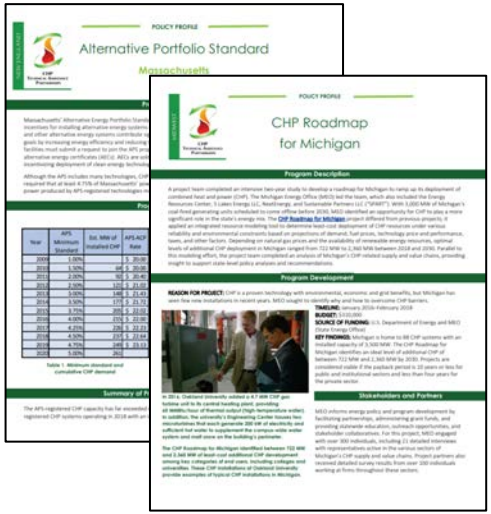
CHP Project Resources

DOE Project Profile Database



energy.gov/chp-projects

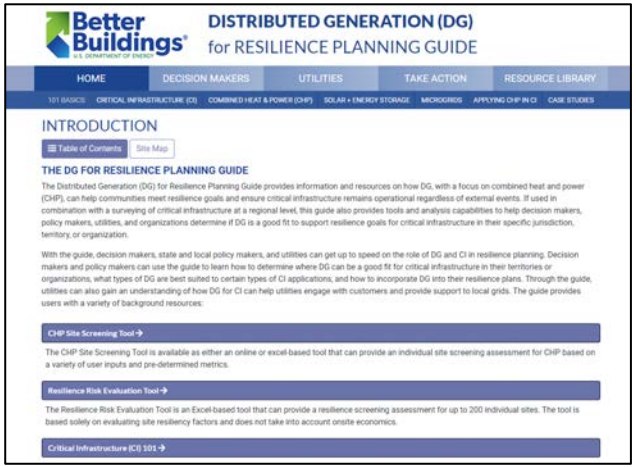
DOE Policy/Program Profiles



energy.gov/chptap

CHP 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