

Assisting West Virginia Companies with Combined Heat and Power

**2017 Governor's Energy Summit:
Advancing Energy Development!**

**October 18 & 19, 2017
West Virginia Office of Energy**

**Bill Valentine
Mid-Atlantic CHP Technical Assistance Partnership**



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CHP Technical Assistance Partnerships

DOE CHP TAPs promote and assist in transforming the market for CHP, waste heat to power and district energy or microgrid with CHP throughout the US. Key services include:

- **Market Opportunity Analysis.**

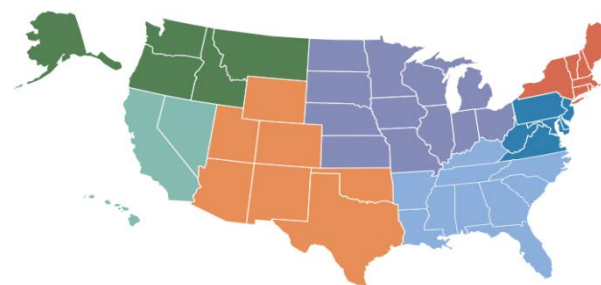
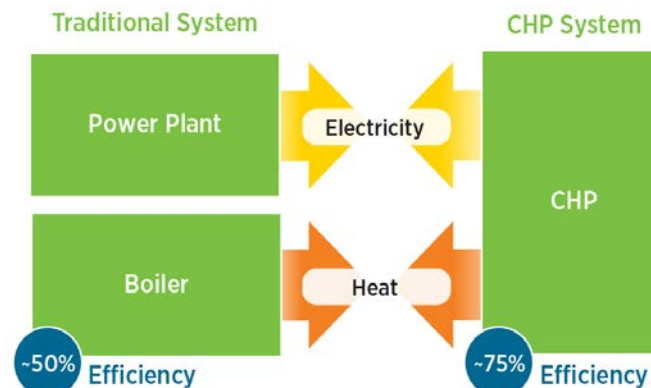
Supporting analyses of CHP market opportunities in diverse markets including industrial, federal, institutional, and commercial sectors

- **Education and Outreach.**

Providing information on the energy and non-energy benefits and applications of CHP to state and local policy makers, regulators, end users, trade associations, and others.

- **Technical Assistance.**

Providing technical assistance to end-users and stakeholders to help them consider CHP, waste heat to power, and/or district energy with CHP in their facility and to help them through the development process from initial CHP screening to installation.



www.energy.gov/chp

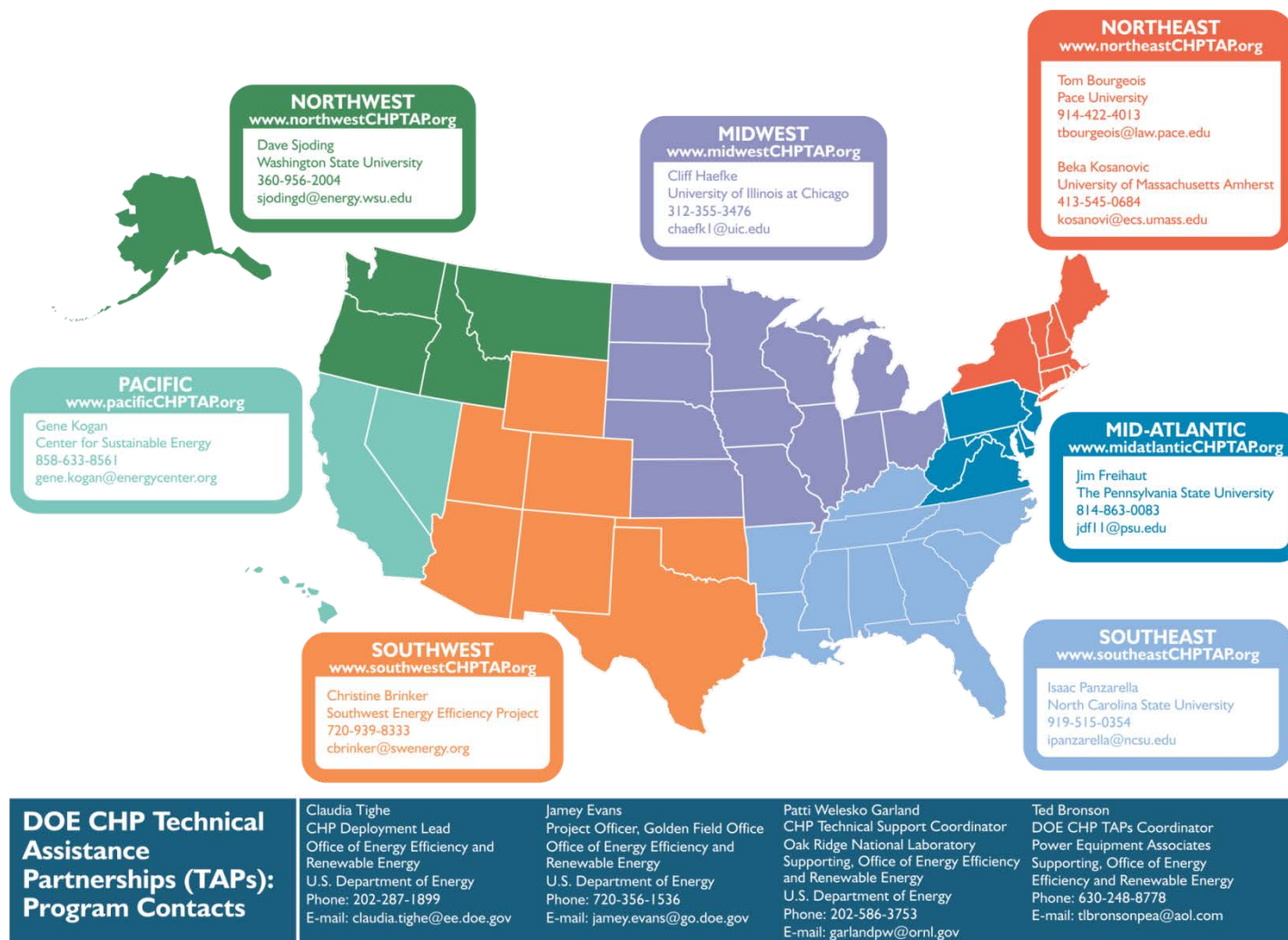


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DOE CHP Technical Assistance Partnerships (CHP TAPs)



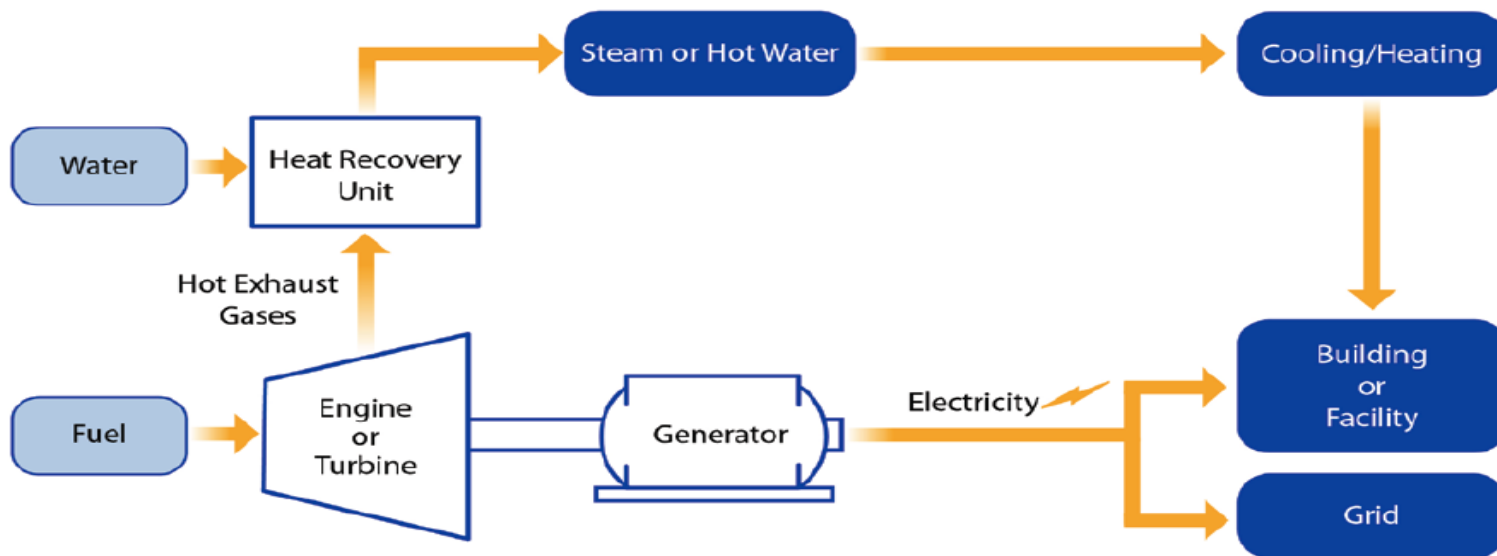
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Defining Combined Heat & Power (CHP)

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

Conventional CHP

(also referred to as Topping Cycle CHP or Direct Fired CHP)



Separate Energy Delivery:

- Electric generation – 33%
- Thermal generation – 80%
- Combined efficiency – 45% to 55%

CHP Energy Efficiency (combined heat and power)
70% to 85%



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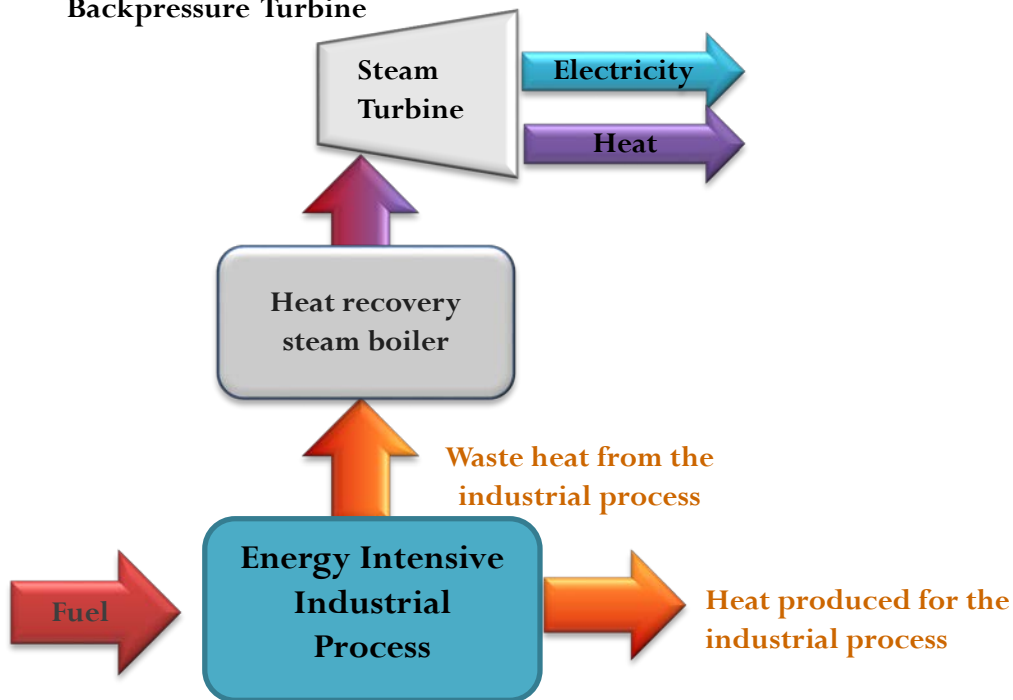
Defining Combined Heat & Power (CHP)

*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*)



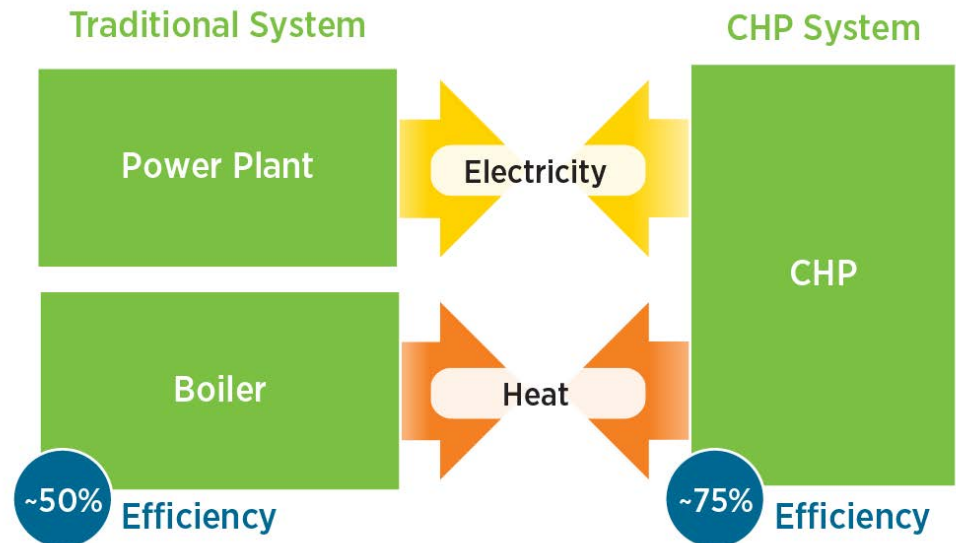
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CHP: A Key Part of Our Energy Future

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



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Benefits of CHP

- CHP is more efficient than separate generation of electricity and heat
- Higher efficiency translates to lower operating cost, (but requires capital investment)
- Higher efficiency reduces emissions of all pollutants
- CHP can also increase energy reliability and enhance power quality
- On-site electric generation reduces grid congestion and avoids distribution costs



Favorable Characteristics for CHP Applications

Important

- Concern about energy costs
- Concern about power reliability
- Concern about sustainability and environmental impacts
- Long hours of operation
- Concurrent thermal loads
- Central heating and cooling distribution system

Helpful

- Future central plant replacement and/or upgrades
- Future facility expansion or new construction projects
- EE measures already implemented
- Access to nearby renewable fuels
- Facility energy champion

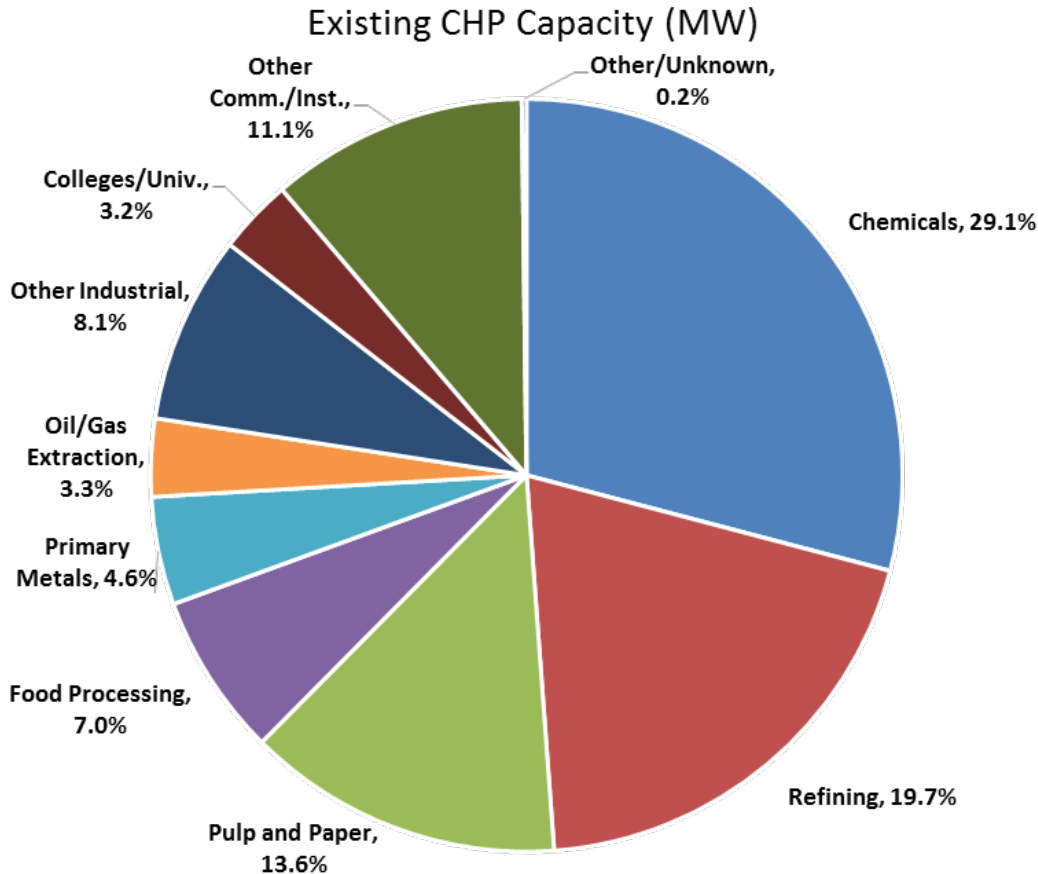


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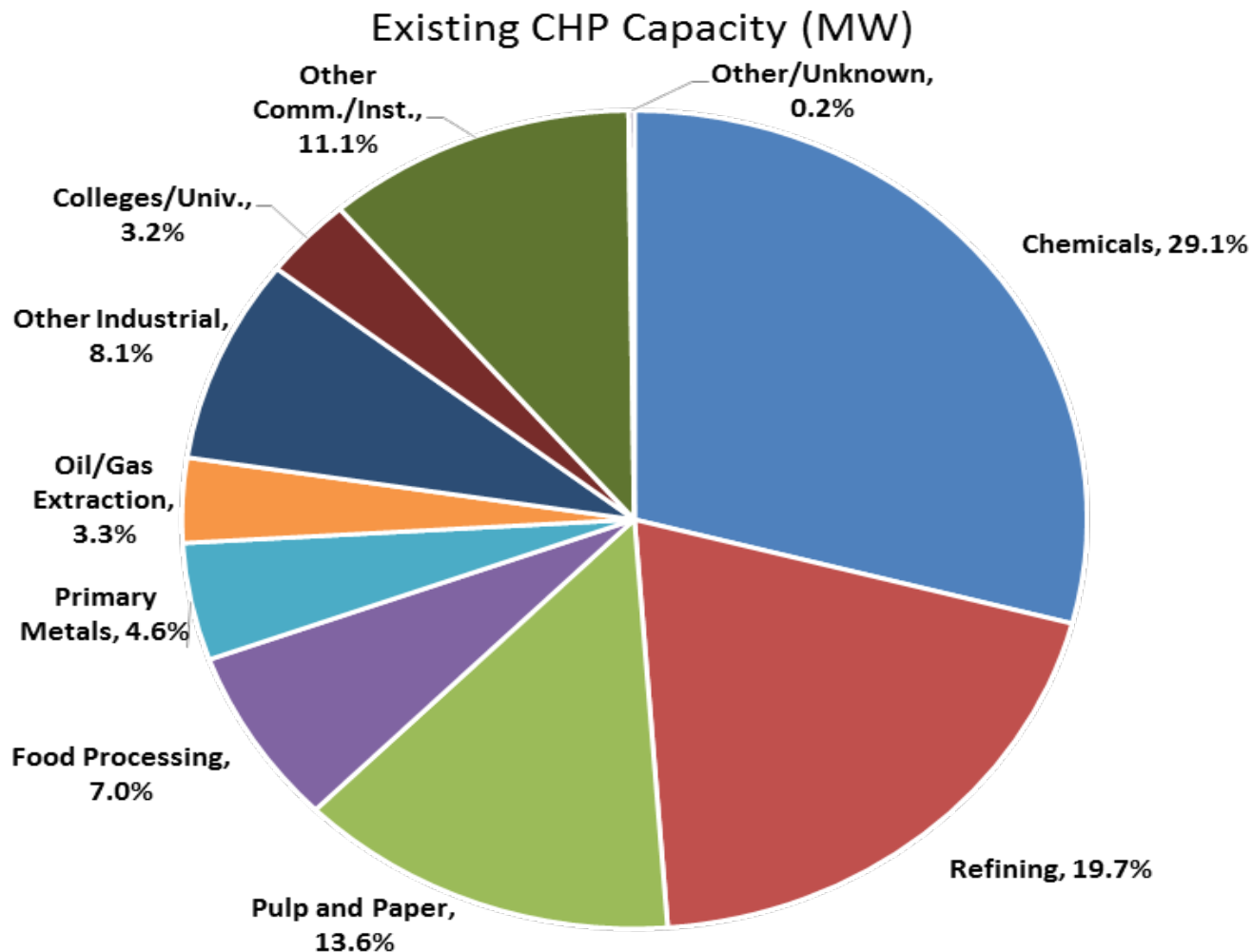
CHP Today in the United States



- **82.6 GW** of installed CHP at nearly 4,400 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 CO₂** compared to separate production

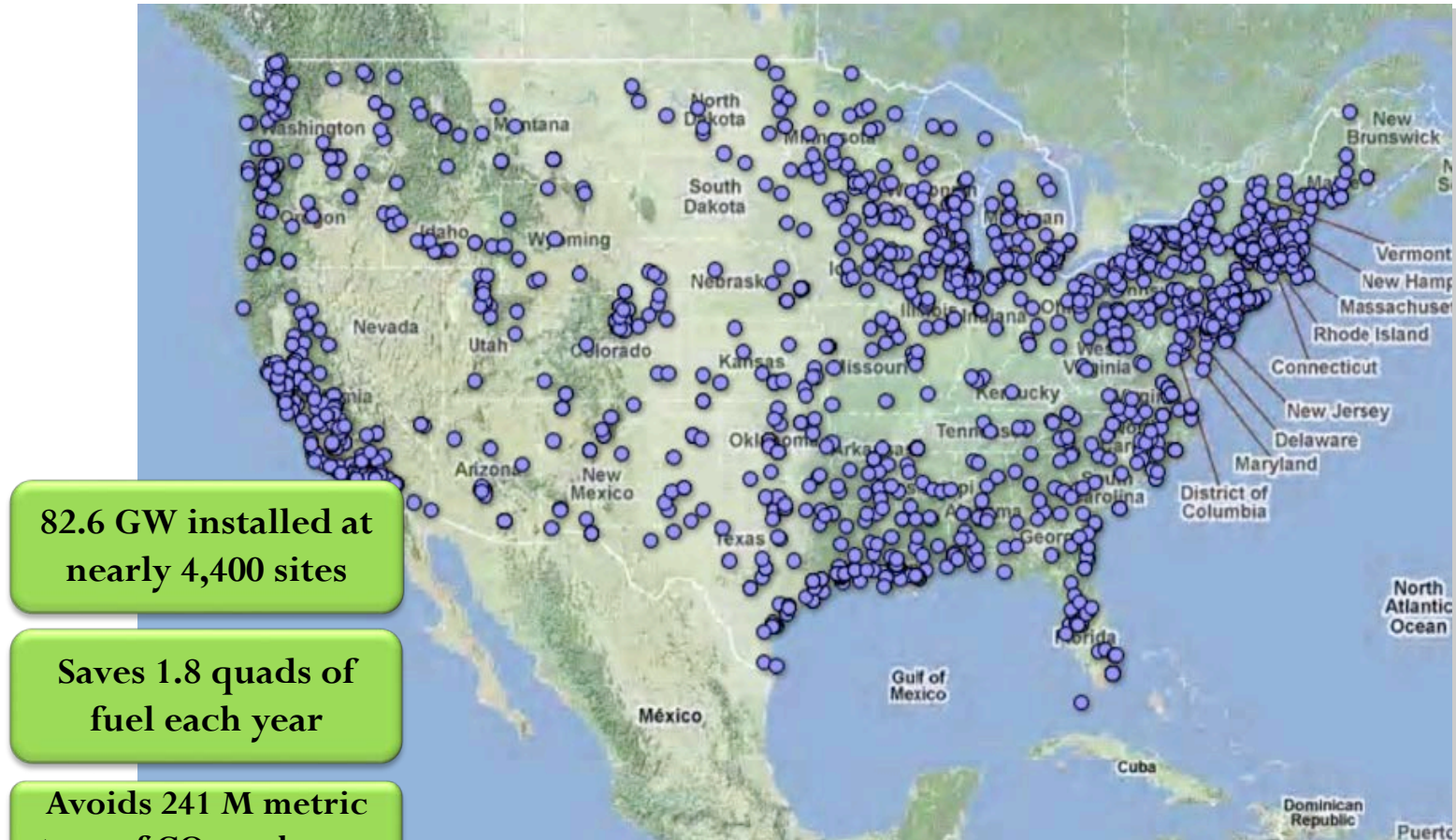
Source: DOE CHP Installation Database (U.S. installations as of December 31, 2016)

CHP Today in the United States



Source: DOE CHP Installation Database (U.S. installations as of December 31, 2016)

CHP Is Used Nationwide In Several Types of Buildings/Facilities



Source: DOE CHP Installation Database (U.S. installations as of Dec. 31, 2016)

CHP in West Virginia

20 sites generating 276 MW of power

Interconnection standard

This standard features two tiers of application, up to 2MW in size. CHP is an eligible technology. Systems over 500kW require \$1M liability insurance.

Net metering

Systems that generate electricity using "alternative" or "renewable energy" resources are eligible, including CHP. There is a system cap of 2MW.

Natural gas availability



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West Virginia Commercial CHP Potential

All Commercial CHP Technical Potential (Including Topping Cycle CHP, WHP CHP and District Energy CHP)

SIC	Commercial Business Type	50-500 kW		0.5 - 1 MW		1 - 5 MW		5 - 20 MW		> 20 MW		Total	
		Sites	50-500 kW (MW)	Sites	0.5-1 MW (MW)	Sites	1-5 MW (MW)	Sites	5-20 MW (MW)	Sites	>20 MW (MW)	Total Sites	Total MW
43	Post Offices	6	0.4	0	0	0	0	0	0	0	0	6	0.4
52	Retail	120	19	3	2	0	0	0	0	0	0	123	20
4222	Refrigerated Warehouses	1	0.1	0	0	0	0	0	0	0	0	1	0.1
4581	Airports	2	0.3	1	1	0	0	0	0	0	0	3	1
4952	Waste Water Treatment Plants	23	3	0	0	0	0	0	0	0	0	23	3
4961	District Energy	0	0	0	0	0	0	0	0	0	0	0	0
5411	Food Stores	49	8	0	0	0	0	0	0	0	0	49	8
5812	Restaurants	104	9	0	0	0	0	0	0	0	0	104	9
6512	Commercial Office Buildings	339	17	136	54	34	20	0	0	0	0	509	92
6513	Multifamily Buildings	20	2	7	4	1	1	0	0	0	0	29	6
7011	Hotels	79	9	2	1	2	4	1	5	0	0	84	20
7211	Laundries	3	0.2	0	0	0	0	0	0	0	0	3	0.2
7374	Data Centers	4	1	0	0	1	1	0	0	0	0	5	2
7542	Car Washes	1	0.1	0	0	0	0	0	0	0	0	1	0.1
7832	Movie Theaters	0	0	0	0	0	0	0	0	0	0	0	0
7991	Health Clubs	9	1	0	0	0	0	0	0	0	0	9	1
7997	Golf/Country Clubs	21	2	0	0	0	0	0	0	0	0	21	2
8051	Nursing Homes	91	9	0	0	0	0	0	0	0	0	91	9
8062	Hospitals	31	9	12	8	21	36	1	6	0	0	65	59
8211	Schools	60	7	0	0	0	0	0	0	0	0	60	7
8221	College/Univ.	23	4	4	3	10	21	6	47	0	0	43	75
8412	Museums	3	0.4	0	0	0	0	0	0	0	0	3	0.4
9100	Government Buildings	80	10	2	1	3	5	1	6	0	0	86	23
9223	Prisons	9	1	2	2	6	9	0	0	0	0	17	13
9711	Military	5	1	1	1	1	2	0	0	0	0	7	4
	Total	1,083	114	170	76	79	100	9	64	0	0	1,342	354



West Virginia Industrial CHP Potential

All Industrial CHP Technical Potential (Including Topping Cycle CHP and WHP CHP)

SIC	Industrial Business Type	50-500 kW		0.5 - 1 MW		1 - 5 MW		5 - 20 MW		> 20 MW		Total	
		Sites	50-500 kW (MW)	Sites	0.5-1 MW (MW)	Sites	1-5 MW (MW)	Sites	5-20 MW (MW)	Sites	>20 MW (MW)	Total Sites	Total MW
12	Mining, Except Oil and Gas	1	0.1	0	0	0	0	0	0	0	0	1	0.1
13	Oil and Gas Extraction	2	0.5	2	2	3	5	0	0	0	0	7	7
20	Food	15	2	1	1	0	0	0	0	0	0	16	3
22	Textiles	2	1	1	1	1	1	0	0	0	0	4	2
24	Lumber and Wood	63	14	15	11	4	9	2	13	0	0	84	46
25	Furniture	0	0	0	0	0	0	0	0	0	0	0	0
26	Paper	3	1	1	1	4	9	3	34	0	0	11	45
27	Printing	11	1	0	0	0	0	0	0	0	0	11	1
28	Chemicals	20	4	7	6	17	43	11	100	2	51	57	204
29	Petroleum Refining	0	0	3	2	4	11	1	11	0	0	8	25
30	Rubber/Misc Plastics	25	6	3	2	1	2	0	0	0	0	29	11
32	Stone/Clay/Glass	3	1	0	0	1	3	1	15	0	0	5	19
33	Primary Metals	14	4	5	3	4	10	4	42	2	139	29	198
34	Fabricated Metals	3	1	0	0	0	0	0	0	0	0	3	1
35	Machinery/Computer Equip	0	0	1	1	0	0	0	0	0	0	1	1
37	Transportation Equip.	9	1	1	1	1	3	0	0	0	0	11	4
38	Instruments	2	0.2	0	0	1	1	0	0	0	0	3	2
39	Misc. Manufacturing	0	0	0	0	0	0	0	0	0	0	0	0
49	Gas Processing	3	0	3	2	2	3	0	0	0	0	8	6
	Total	176	37	43	32	43	100	22	216	4	190	288	575



Project Snapshot: Hospital

Upper Chesapeake Medical Center
Bel Air, MD

Application/Industry: Hospital

Capacity: 2.0 MW & 350 ton chiller

Prime Mover: Recip engine

Fuel Type: Natural gas

Thermal Use: Steam, chilled water, and hot water

Installation Year: 2016

Energy Savings: \$450,000 in energy savings each year

Highlights: Provides 45% of the existing electricity for the main interconnected loads. Supplies more than 65% of campus electricity with existing diesel generator. Provides 95% of hospital loads with diesel when grid unavailable

Source: <http://www.baltimoresun.com/news/maryland/harford/aegis/ph-ag-apg-cogeneration-plant-start-0720-20160719-story.html>



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SnapProject shot: University District Energy CHP System

University of Illinois at Chicago
Chicago, Illinois

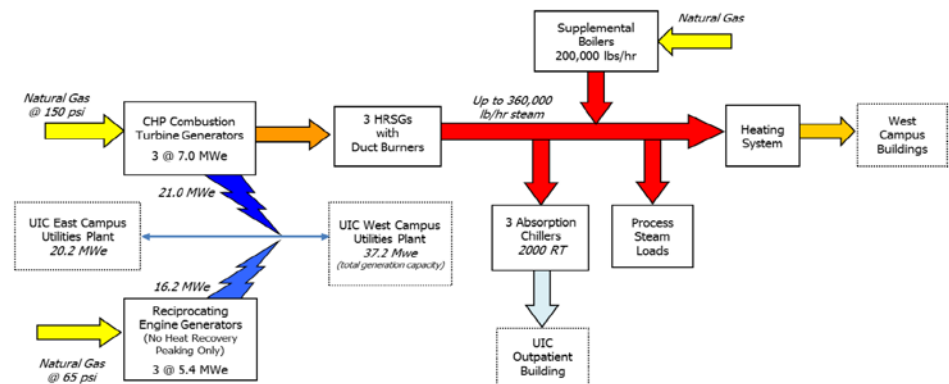


UIC West Campus CHP Facility

Application/Industry: University Campus
Capacity: 21 MW
Prime Mover: Combustion turbines (3)
Fuel Type: Natural gas
Thermal Use: Heating, cooling, hot water
Installation Year: 2001
Energy Savings: \$5 to \$7 million annually

Testimonial: *"The CHP system provides reliable and efficient power and steam to the university. The duct firing capabilities of the combustion turbines enable the CHP system to supply 100% of the required steam to the UIC West Campus."*

- Robert Roman, Director, UIC Utilities



Source: http://www.midwestchptap.org/profiles/ProjectProfiles/UIC_West_Campus.pdf



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Project Snapshot:

3rd Party Build, Own, and Operate

Solvay Specialty Polymers /
DTE Marietta
Marietta, Ohio

Application/Industry: Chemicals

Capacity: 8 MW

Prime Mover: Combustion turbine

Fuel Type: Natural gas

Thermal Use: Process heating

Installation Year: 2015

Testimonial: *"Solvay Specialty Polymers and DTE Energy Services worked together closely to develop a customized energy supply facility to meet our plant's specific needs. The DTE Marietta cogeneration project has provided a reliable, efficient, economic energy supply solution to the Solvay complex to ensure that our plant can meet its production goals."*

- Al Wanosky, Solvay Site Utilities Manager



Source: http://www.midwestchptap.org/profiles/ProjectProfiles/Project_Profile_Solvay_Specialty_Plastics.pdf



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Project Snapshot:

Manufacturing

Proctor & Gamble
Mehoopany, PA

Application/Industry: Paper products

Capacity: 64 MW

Prime Mover: Combustion Turbine

Fuel Type: Marcellus Natural gas

Thermal Use: Manufacturing process (steam and drying)

Installation Year: 2013

Energy Savings: \$16.5M each year

Highlights:

Proctor& Gamble's largest manufacturing facility in the world

CHP part of an effort to save money and reduce CO2 emissions

Export 480 MWH per day



Source: <https://betterbuildingsinitiative.energy.gov/showcase-projects/supreme-sports-club>



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Summary of CHP Potential in West Virginia

Natural gas availability with Marcellus, Rogersville and Utica shale gas reserves.

Chemical/polymer industry revitalization

Downstream manufacturing

Lumber/wood, metals

Healthcare, Multi family, colleges

Microgrid development

Resiliency for critical Infrastructure



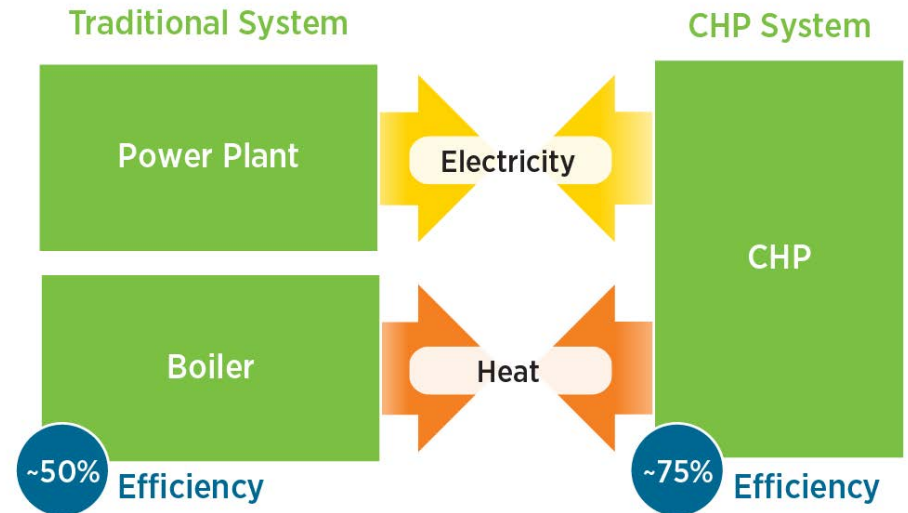
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CHP & Resiliency

- During 'blue sky' operation, CHP provides electrical & thermal energy to offset utility power and boilers, chillers, etc.
- During a long term grid outage, CHP continues to provide electrical & thermal energy which can be a significant life safety issue.



Economic Impact of Grid Outages

- Hurricane Sandy \$70 Billion
- Hurricane Katrina \$40 Billion
- 2003 Blackout \$10 Billion
- Industrial and digital economy firms are losing about \$45.7 billion per year due to power outages (EPRI)

CHP offers the opportunity to keep critical facilities running when the grid is impaired, enabling:

- Business Continuity
- Community Sustainability
- Disaster Preparedness



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Critical Infrastructure

“Critical infrastructure” refers to those assets, systems, and networks that, if incapacitated, would have a substantial negative impact on national security, national economic security, or national public health and safety.”

Patriot Act of 2001 Section 1016 (e)

Applications:

- Hospitals and healthcare centers
- Water / wastewater treatment plants
- Police, fire, and public safety
- Centers of refuge (often schools or universities)
- Military/National Security
- Food distribution facilities
- Telecom and data centers



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Emergence of Resiliency as a Policy Priority

Critical Infrastructure Resiliency is an Emerging Concern

- Connecticut establishes Microgrid Pilot Program in Response to the Two Storms Report (Hurricane Irene, Oct. 29, 2011 Snowstorm)
- New York Commission 2100 Report January 2013 called for accelerated deployment of DG/Microgrids as component of future resiliency planning
- New Jersey established Resiliency Bank in response to Sandy

Business Continuity

- Business downtime, economic losses (beyond traditional CI definition)
- Cascading problems affecting transport (unavailability of gasoline in NJ post Sandy)

Emergency Preparedness & Planning

- Developers reporting inquiries from campuses looking to keep students sheltered
- Nursing homes, public housing, large multi-family buildings keeping people “safe-in-place”



DOE's CHP for Resiliency Accelerator

Purpose

Combined Heat and Power can play a vital role in ensuring that emergency response services are available and critical infrastructure maintains needed electric and thermal energy services to remain operational during disasters.

Offerings

- A forum for collaborating with other Partners
- Direct technical support through DOE's CHP Technical Assistance Partnerships (CHP TAPs)
- Tools and templates to promote deployment of CHP
- National recognition and visibility

Outcomes

- Integrated resiliency plans (local, state, utility)
- CHP for Resiliency Planning Guide



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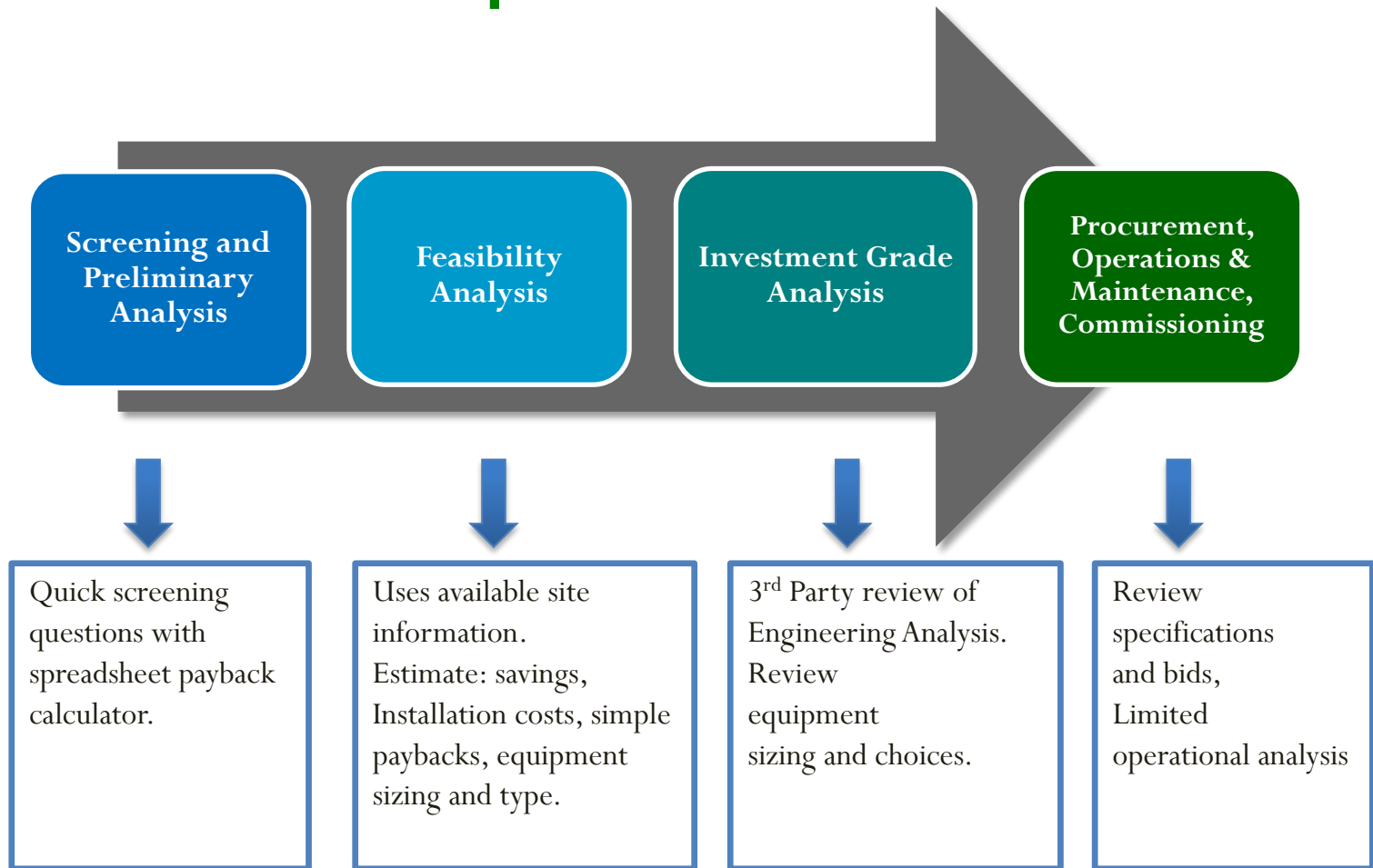
Where Can the TAP help?

- **Prospective End-User Education**
 - Workshops, webinars
 - Energy conferences
- **Technical assistance to end users**
 - Qualification Screenings
 - Feasibility Analysis, Advanced Technical Assistance
- **State Division of Energy assistance**
 - Other state best practices
 - Microgrid development



CHP TAP Assistance throughout Project Development Process

**US DOE
CHPTAP
Services:**



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Next Steps

Contact the Mid Atlantic CHP TAP for assistance if:

- Interested in having a Qualification Screening performed to determine if there is an opportunity for CHP at your site.
- If you already have an existing CHP plant and interested in expansion.
- Need an unbiased 3rd Party Review of a proposal.



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www.midatlanticchptap.org



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Appendix



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



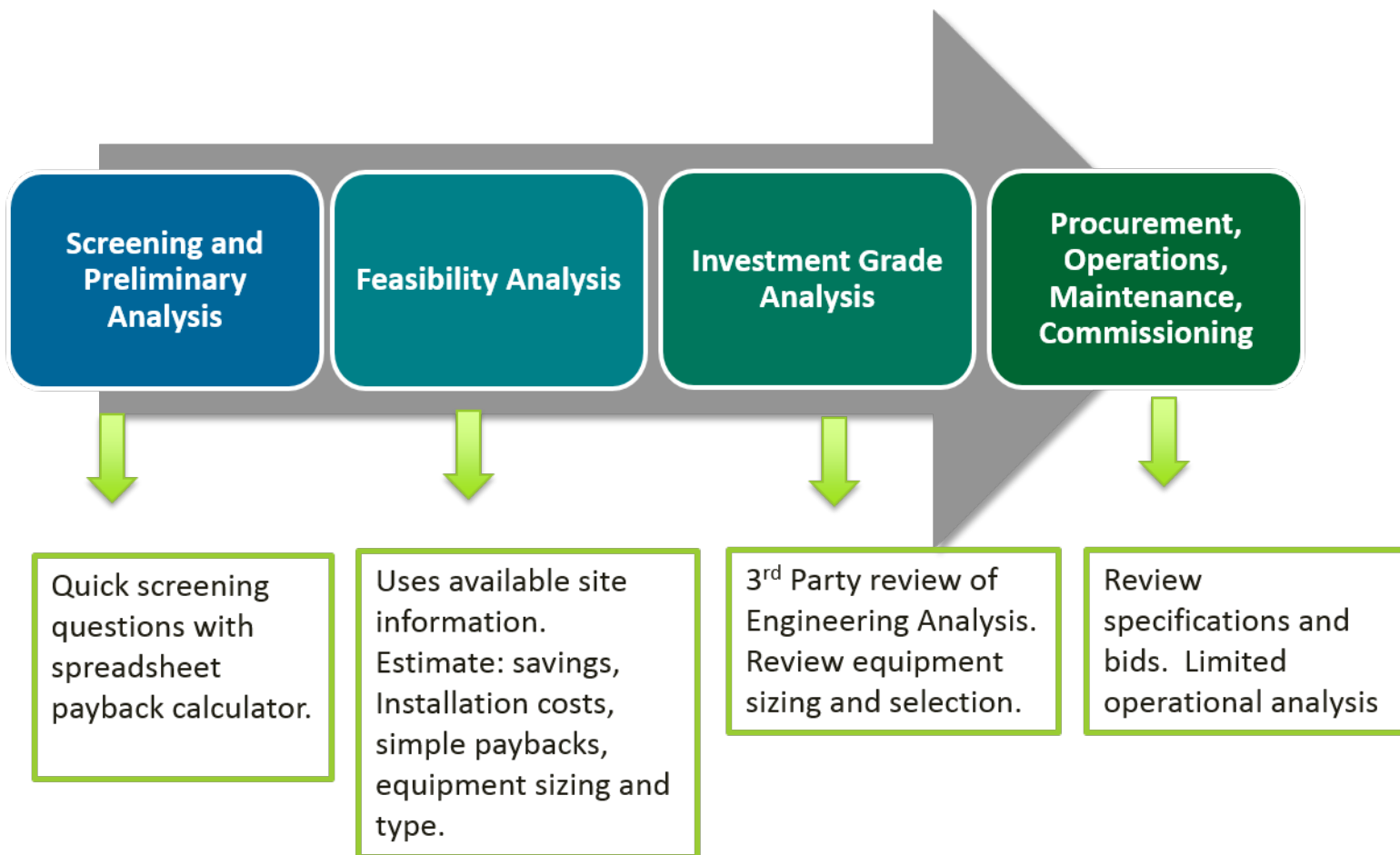
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CHP TAP Technical Assistance

**US DOE
CHP TAP
Services:**



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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 Electricity, 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



Screening Questions



- Do you pay more than \$.06/kWh on average for electricity (including generation, transmission and distribution)?
- Are you concerned about the impact of current or future energy costs on your operations?
- Are you concerned about power reliability?
What if the power goes out for 5 minutes... for 1 hour?
- Does your facility operate for more than 3,000 hours per year?
- Do you have thermal loads throughout the year?
(including steam, hot water, chilled water, hot air, etc.)

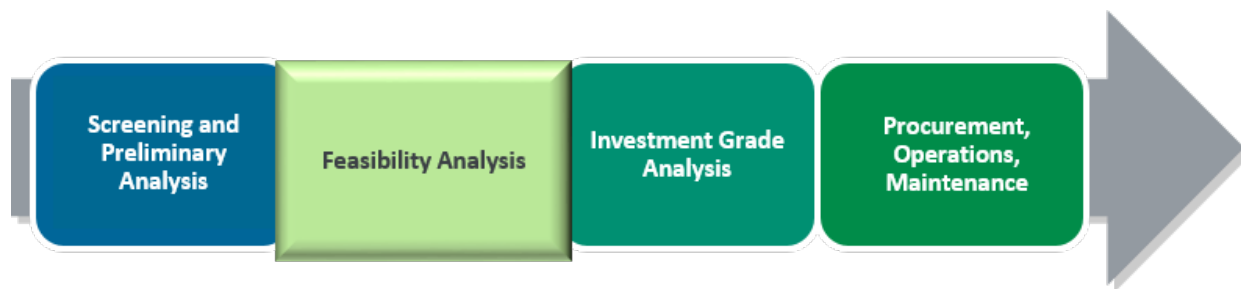


Screening Questions (cont.)

- Does your facility have an existing central plant?
- Do you expect to replace, upgrade, or retrofit central plant equipment within the next 3-5 years?
- Do you anticipate a facility expansion or new construction project within the next 3-5 years?
- Have you already implemented energy efficiency measures and still have high energy costs?
- Are you interested in reducing your facility's impact on the environment?
- Do you have access to on-site or nearby biomass resources? (i.e., landfill gas, farm manure, food processing waste, etc.)



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



Finding the Best Candidates: Some or All of These Characteristics

- High and constant thermal load
- Favorable spark spread
- Need for high reliability
- Concern over future electricity prices
- Interest in reducing environmental impact
- Existing central plant
- Planned facility expansion or new construction; or equipment replacement within the next 3-5 years



Attractive CHP Markets



Industrial

Chemicals
Refining
Food processing
Petrochemicals
Natural gas
pipelines
Pharmaceuticals
Rubber and
plastics
Pulp and paper



Commercial

Data centers
Hotels and casinos
Multi-family housing
Laundries
Apartments
Office buildings
Refrigerated
warehouses
Restaurants
Supermarkets
Green buildings



Institutional

Hospitals
Schools (K-12)
Universities & colleges
Wastewater treatment
Correctional Facilities



Agricultural

Dairies
Wood waste
(biomass)
Concentrated
animal feeding
operations



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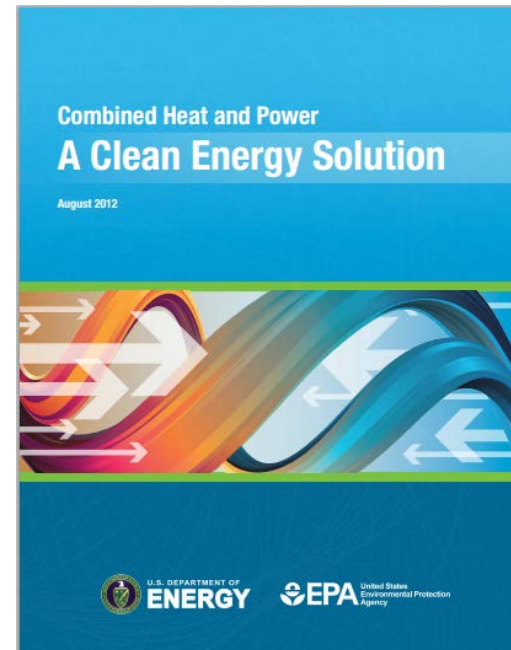
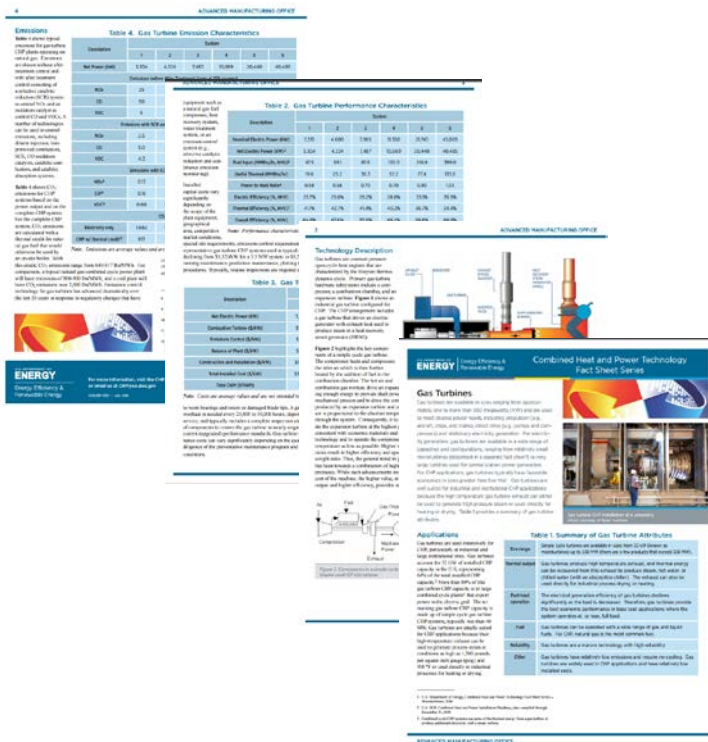
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CHP Project Resources

DOE CHP Technologies Fact Sheet Series

Good Primer Report



www.eere.energy.gov/chp

www.energy.gov/chp-technologies



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CHP Project Resources

DOE Project Profile Database
(100+ case studies)

DOE Database of Incentives & Policies (DSIRE)



energy.gov/chp-projects

www.dsireusa.org



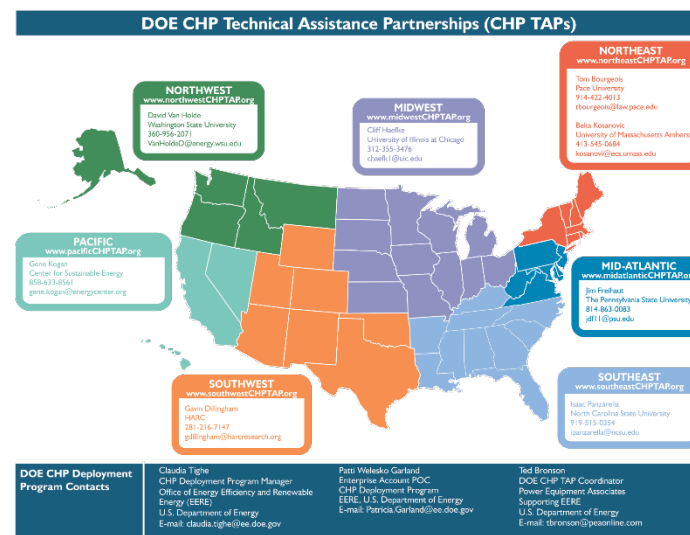
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CHP Project Resources

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



Low-Cost CHP Screening and Other Technical Assistance from the CHP TAP



energy.gov/chp-contacts

energy.gov/chp-installs



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