

# Combined Heat and Power Opportunities In Illinois

Presentation to the  
Association of Professional Energy Consultants

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September 16, 2022

# Agenda

- DOE CHP Technical Assistance Partnerships
- CHP Concepts and Technologies
- CHP Markets
- Updates in Illinois Legislation
- Next Steps in Evaluating CHP



# 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](http://www.energy.gov/chp)



**CHP Technical Assistance Partnerships**

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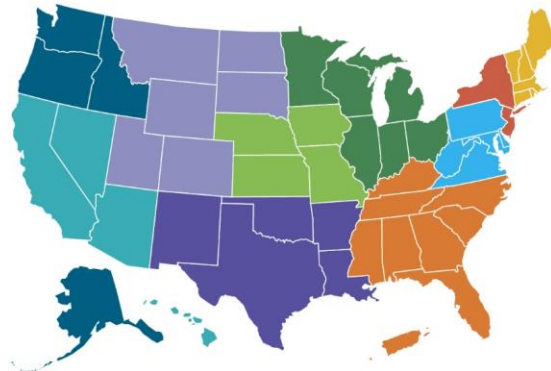
# DOE CHP Technical Assistance Partnerships (CHP TAPs)

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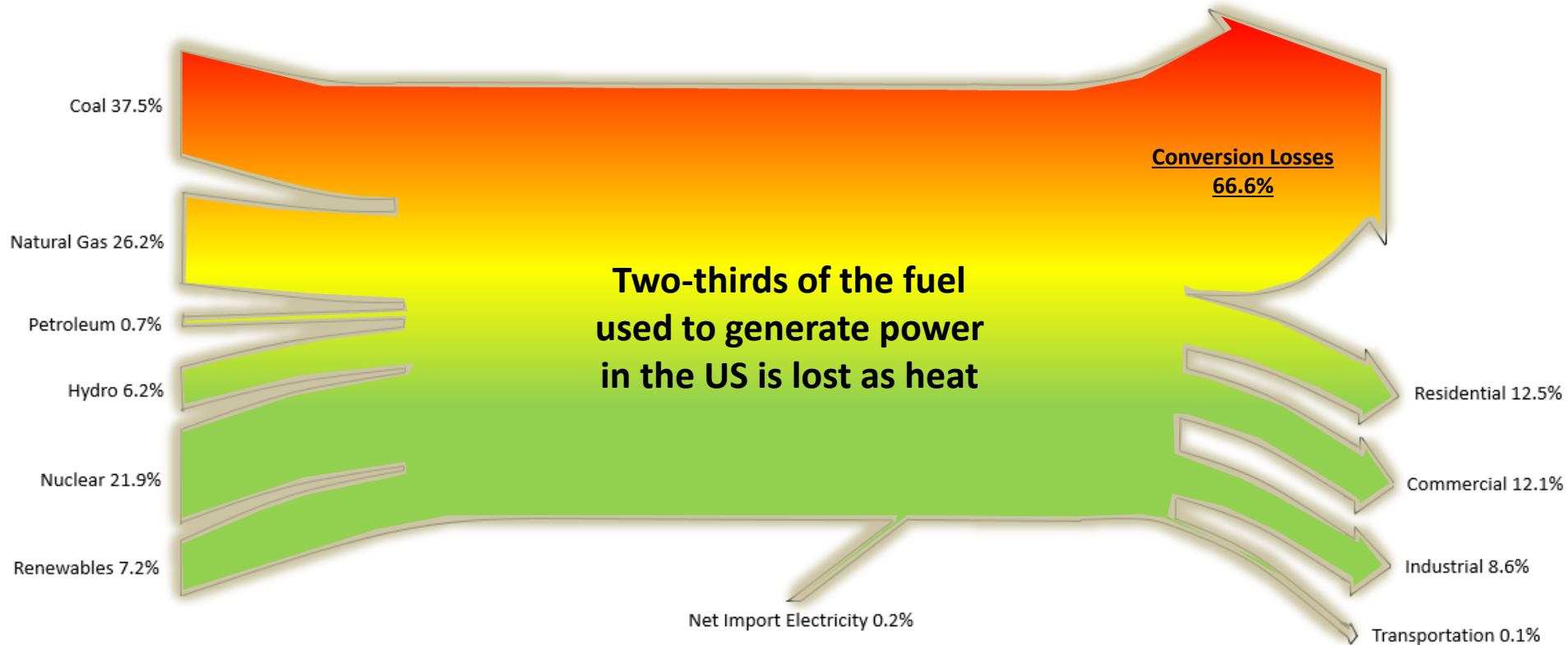
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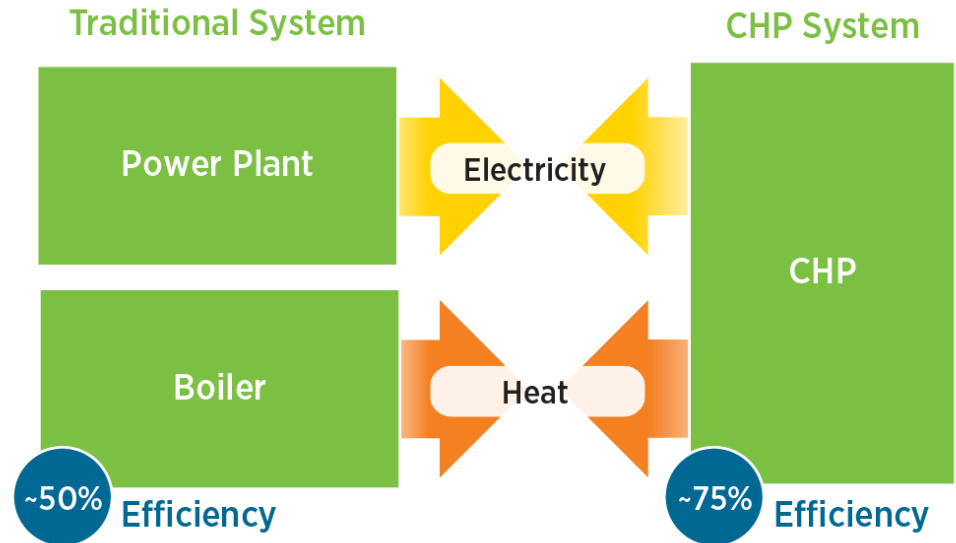
# Energy Utilization in the Utility Sector



Source: [https://flowcharts.llnl.gov/content/assets/images/charts/Energy/Energy\\_2015\\_United-States.png](https://flowcharts.llnl.gov/content/assets/images/charts/Energy/Energy_2015_United-States.png)

# 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



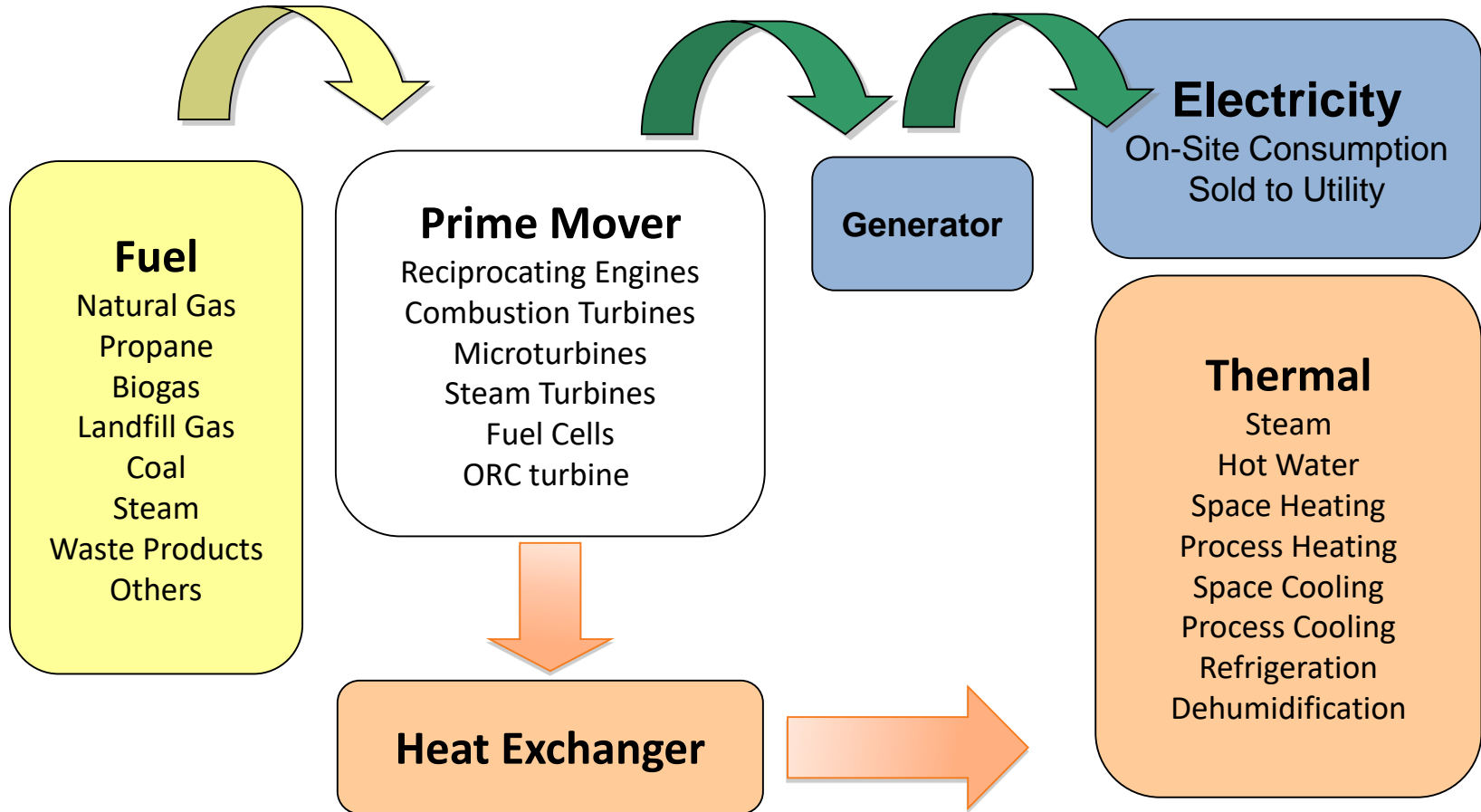
CHP provides efficient, clean, reliable, affordable energy – today and for the future.

Source: [www.energy.gov/chp](http://www.energy.gov/chp)



# Overview of CHP Technologies

# CHP System Schematic





# Configurations

- CHP systems are often categorized based on the type of prime mover that drives the system. There are five predominant prime mover technologies used for CHP systems:
  - Reciprocating engines
  - Gas turbines
  - Microturbines
  - Boiler/steam turbines
  - Fuel cells

These configurations offer good potential for incorporation into packaged CHP systems



# Prime Mover: Reciprocating Engines

- Size Range: 10 kW to 10 MW
- Characteristics
  - Thermal can produce hot water, low pressure steam, and chilled water (through absorption chiller)
  - High part-load operation efficiency
  - Fast start-up
  - Minimal auxiliary power requirements for black start.
- Example Applications:
  - universities, hospitals, water treatment facilities, industrial facilities, commercial buildings, and multi-family dwellings



Reciprocating engine CHP installation at an industrial facility.  
*Photo courtesy of Caterpillar.*



# Prime Mover: Gas Turbines

- Size Range: 1 MW to 300 MW
- Characteristics
  - Produces high quality, high temperature thermal that can include high pressure steam for industrial processes, and chilled water (with absorption chiller)
  - Available in a wide range of capacities and configurations
  - Best efficiency when operated at full load (part-load efficiency is often much lower than full load efficiency)
- Example Applications:
  - hospitals, universities, chemical plants, refineries, food processing, paper, military bases



Gas turbine CHP installation at a university.  
*Photo courtesy of Solar Turbines*



# Prime Mover: Microturbines

- Size Range: 30 kW to 330 kW (*modular packages exceeding 1 MW*)
- Characteristics
  - Thermal can produce hot water, steam, and chilled water (through absorption chiller)
  - Compact size and light weight
  - Inverter based generation can improve power quality
- Example Applications:
  - multifamily housing, hotels, nursing homes, waste water treatment, gas & oil production



Microturbine CHP installation at a commercial facility.  
*Photo courtesy of Capstone Turbine Corporation*



# Prime Mover: Steam Turbines

- Size Range: 100 kW to over 250 MW
- Characteristics
  - Requires a boiler or other steam source
  - Can be mated to boilers firing a variety of gaseous, liquid or solid fuels (e.g., coal and biomass fuels such wood, waste products, and pellets).
  - Mature technology with very high durability and reliability
  - Can operated over a wide range of steam pressures
  - Backpressure steam turbines can be used to produce power by replacing pressure reducing valves (PRVs) in existing steam systems
- Example Applications:
  - Industrial applications, district heating and cooling systems, forest products, paper mills, chemicals, food processing, PRVs



# Heat Recovery

- Heat Exchangers
  - Recover exhaust gas from prime mover
  - Transfers exhaust gas into useful heat (steam, hot water) for downstream applications
  - Heat Recovery Steam Generators (HRSG) the most common
- Heat-Driven Chillers
  - Absorption Chiller
    - Use heat to chill water
    - Chemical process (not mechanical)
  - Steam Turbine Centrifugal Chiller

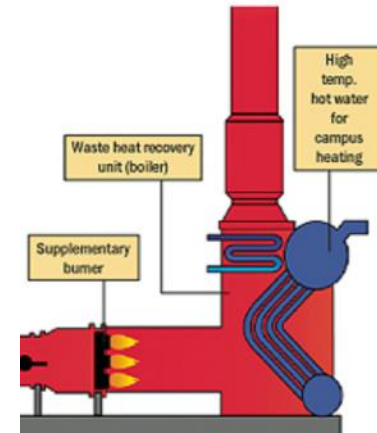


Image Source: University of Calgary

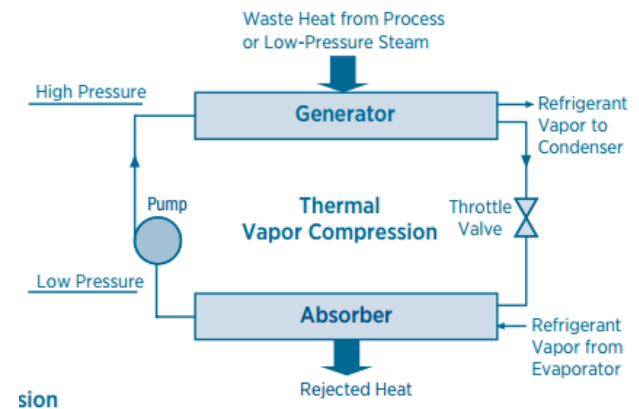


Image Source: DOE - EERE

# Heat Recovery: Absorption Chillers

- Absorption chillers are heat operated refrigeration machines that operate on chemical and physical reactions to transfer heat. The absorption cycle substitutes a physiochemical process for the mechanical compressor used in common refrigeration systems.
- Absorption chillers can be driven with hot water, steam, or prime mover exhaust.
- Absorption chillers are available in sizes from 5 to 3,000 refrigeration tons. This capacity correlates to a CHP electric output of approximately 50 to 10,000 kW.
- For 40°F and higher chilling fluid temperatures (e.g., building air conditioning), a common refrigerant solution mixture is water (refrigerant) and lithium bromide (absorbent). For chilling fluid temperatures below 40°F (e.g., cold storage), a common refrigerant solution mixture is ammonia (refrigerant) and water (absorbent).



A 200-ton single-stage absorption chiller integrated with three 600 kW reciprocating engines that also provide hot water for process and space heating. The system is located at a metal fabrication facility in Fitchburg, Massachusetts. *Photo courtesy of Northeast CHP Technical Assistance Partnership (CHP TAP).*



# 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, energy resiliency, and enhance power quality
- On-site electric generation can reduce grid congestion and avoid distribution costs.





# CHP Market Sectors

# Small-Medium CHP Applications

- Hospitals
- Light Industrial
- Apartment Buildings/ Condos
- Community Colleges
- Large Schools
- Nursing Homes
- Community Centers
- Athletic Clubs
- Municipal Pools
- Correctional Institutions



# Larger CHP Applications

- Mid-stream Oil & Gas Processing
- Oil Refineries
- Chemical Plants
- Heavy Industrial
- Hospital Campuses
- College Campuses



# CEJA: Issues/ Opportunities

- ▶ Incentives:
  - ▶ Portfolio Standards
    - ▶ NEW Cogeneration included in eligible “Renewable Energy Resources”
  - ▶ Energy Efficiency Programs / NEW Opt Out
  - ▶ Electrification
  - ▶ NEW Distributed Generation Rebate Program (Up to 5 MW)
- ▶ Phase out of > 25 MW Fossil Fuel Fired Units
  - ▶ Smaller Units Unaffected
- ▶ Potential Opportunities for Cogen Under Other New Programs
  - ▶ Immediate need for cogen proponents to participate in ICC and other proceedings that will be shaping various new programs

Source: Midwest Cogeneration Association

# Incentives: Energy Efficiency Programs

## ▶ Energy Efficiency Programs

- ▶ EE Rate Cap Raised to 4%
- ▶ Electric Utility Cumulative Persisting Annual Savings Targets Extended Beyond 2030
- ▶ Electrification Programming Allowed

## ▶ New EE Program Opt Out Provisions

- ▶ Replaces the 10MW large customer exemption that had previously been in place
- ▶ Large energy customers are back in utility EE portfolios
- ▶ Eligible large private energy customer for opt-out
  - ▶ 10MW peak demand
  - ▶ Federal, state, municipal and other public facilities
  - ▶ Multiple sites
- ▶ Notice Requirements
  - ▶ Independent audit (specialized processes = self audit)
  - ▶ Customer's EE plans
- ▶ Opt-out limited to single 4-year plan cycle

# New Federal Regulations

- 10% ITC has increased to 30%!
  - Base ITC of 6% with 5x increase (30%) by meeting or being exempt from the prevailing wage and apprentice requirements
  - + 10% if made in America Requirements are met (40% by 01/24; 55% afterwards)
  - + 10% for placing projects in “Energy Communities”
  - Must Begin construction by 01/01/2025
- Potential for up to 50% ITC!



# New Federal Regulations

- **ITC for Tax-exempt entities!:**
  - Direct Pay Option
    - The Act allows certain entities, including tax-exempt entities, states and political subdivisions, the Tennessee Valley Authority, Alaska Native Corporations, and Indian tribal governments, to take direct pay equal to the amount of certain specified credits.
  - Transfer of Credits
    - To properly transfer, the transferee must pay for the credit in cash, and the buyer is not allowed to deduct the amount paid for such credit or subsequently transfer the credit. The payment will not be included in the gross income of the original recipient. A penalty for excessive transfers are imposed. An excessive transfer is a transfer of credit in excess of what the transferee could properly claim.



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

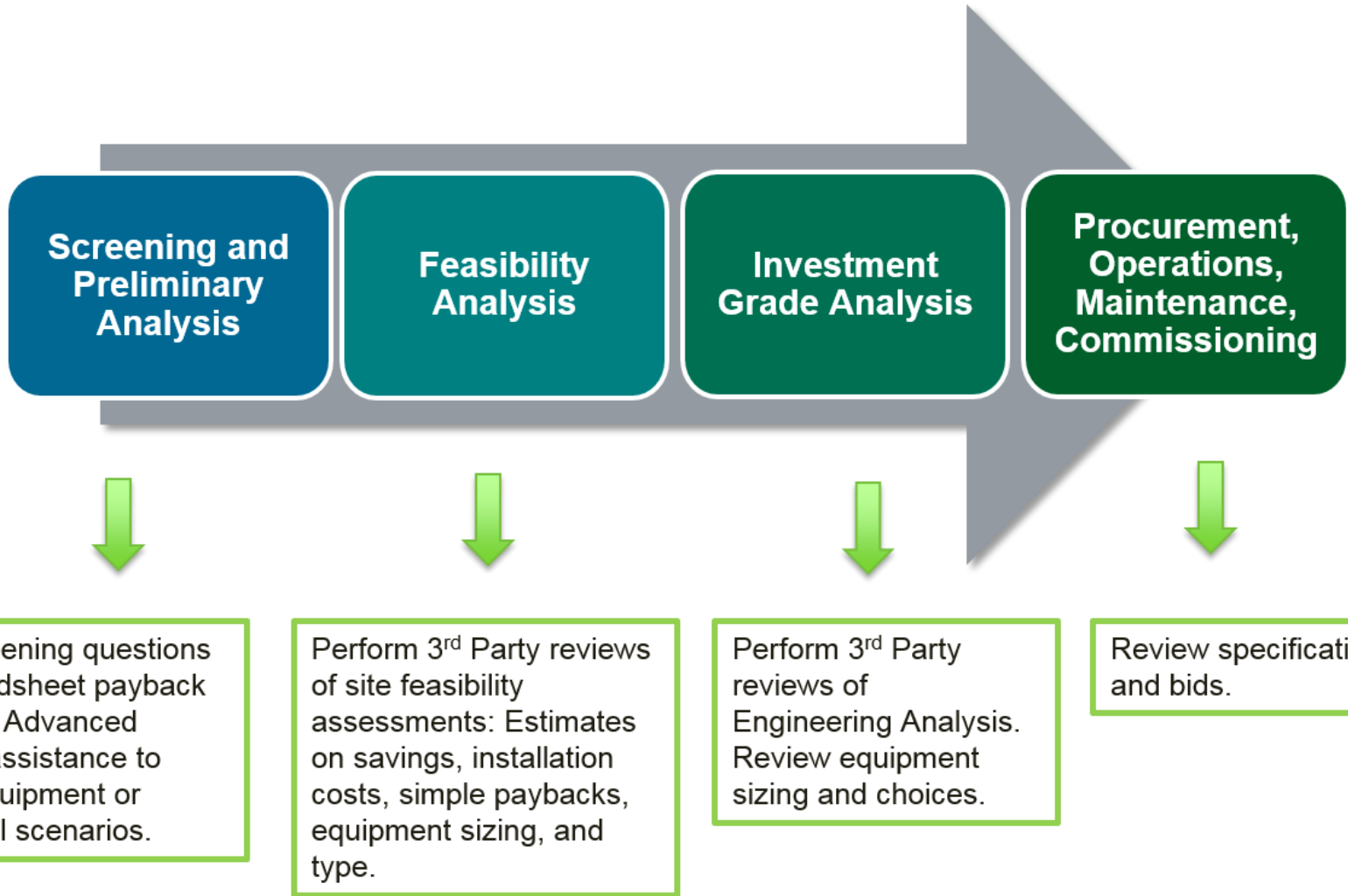


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# CHP TAP Role: Technical Assistance



# Screening Questions

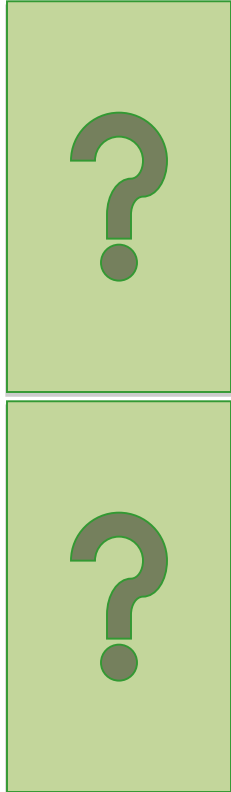


- Do you pay more than \$.06/kWh on average for electricity (including generation, transmission and distribution)?
- Are you concerned about the impact of current or future energy costs on your operations?
- Are you concerned about power reliability? What if the power goes out for 5 minutes... for 1 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.)



# 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



# CHP TAP Resources



**CHP Technical Assistance Partnerships**

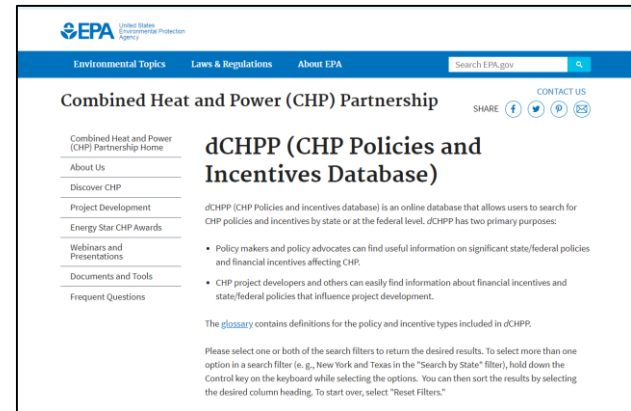
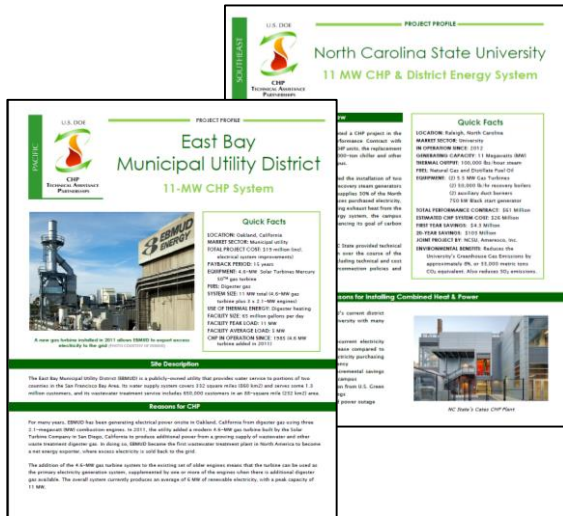
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# CHP Project Resources

DOE Project Profile Database

EPA dCHPP (CHP Policies and Incentives Database)



[energy.gov/chp-projects](http://energy.gov/chp-projects)

[www.epa.gov/chpdchpp-chp-policies-and-incentives-database](http://www.epa.gov/chpdchpp-chp-policies-and-incentives-database)

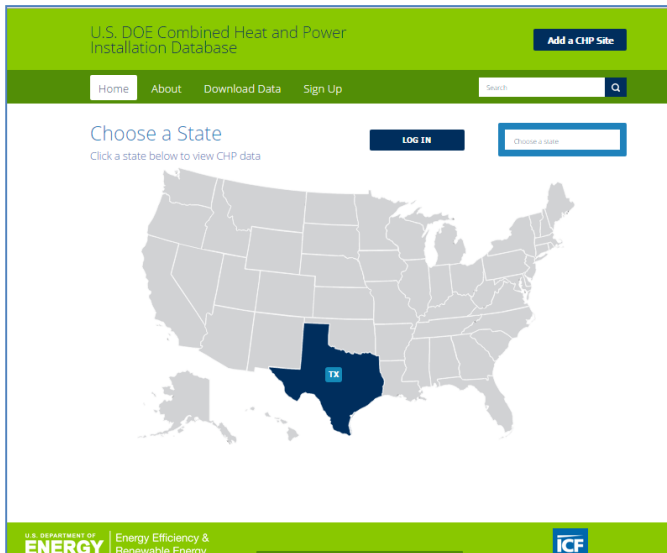


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# CHP Project Resources

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



[energy.gov/chp-installs](http://energy.gov/chp-installs)

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

DOE CHP Technical Assistance Partnerships (CHP TAPs)

**DOE CHP Deployment Program Contacts**  
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[energy.gov/CHPTAP](http://energy.gov/CHPTAP)



# Summary

- CHP gets the most out of a fuel source, enabling
  - High overall utilization efficiencies
  - Reduced environmental footprint
  - Reduced operating costs
- Emerging drivers are creating new opportunities to evaluate CHP today
- Proven technologies are commercially available and cover a full range of sizes and applications



# Next Steps

- Contact Midwest 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 expanding it
  - Need an unbiased 3rd Party Review of a proposal



# Thank You

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**CHP Technical Assistance Partnerships**

[www.energy.gov/chp](http://www.energy.gov/chp)



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# Comparison of CHP Characteristics <sup>[1, 2]</sup>

Characteristic	Technology				
	Reciprocating Engine	Gas Turbine	Microturbine	Fuel Cell	Steam Turbine
Size Range	10 kW – 10 MW	1 – 300 MW	30 kW – 330 kW (larger modular units available)	5 kW – 1.4 MW (larger modular units available)	100 kW – 250 MW
Electric Efficiency (HHV)	30% – 42%	24% – 36%	25% – 29%	38% – 42%	5% – 7%
Overall CHP Efficiency (HHV)	77% – 83%	65% – 71%	64% – 72%	62% – 75%	80%
Total Installed Cost (\$/kW) [3]	\$1,400 – \$2,900	\$1,300 – \$3,300	\$2,500 – \$3,200	\$4,600 – \$10,000	\$670 – \$1,100 [4]
O&M Cost (¢/kWh)	0.9-2.4	0.9-1.3	0.8-1.6	3.6-4.5	0.6-1.0
Power to Heat Ratio	0.6 – 1.2	0.6 – 1.0	0.5 – 0.8	1.3 – 1.6	0.07 – 0.10
Thermal Output (Btu/kWh)	2,900 --6,100	3,400 --6,000	4,400 --6,400	2,200 --2,600	30,000 --50,000

- Notes:**
- 1) Unless noted otherwise, information based on U.S. Department of Energy, [CHP Technology Fact Sheet Series](#), 2016, 2017.
  - 2) All performance and cost characteristics are typical values and are not intended to represent a specific product.
  - 3) Costs will vary depending on site specific conditions and regional variations.
  - 4) Costs shown are for a steam turbine only, and do not include costs for a boiler, fuel handling equipment, steam loop, and controls.



# Comparison of CHP Characteristics

*continued...*

Characteristic	Technology				
	Reciprocating Engine	Gas Turbine	Microturbine	Fuel Cell	Steam Turbine
Fuel Pressure (psig) [1]	1-75	100-500 (may require fuel compressor)	50-140 (may require fuel compressor)	0.5-45	n/a
Part Load Efficiency	Good at both part-load and full-load	Better at full-load	Better at full-load	Better at full-load	Good at both part-load and full-load
Type of Thermal Output	LP steam, hot water, space heating, chilled water	LP-HP steam, hot water, process heating, chilled water	LP steam, hot water, chilled water	LP steam, hot water, chilled water	LP-HP steam, hot water, chilled water
Fuel	Can be operated with a wide range of gas and liquid fuels. For CHP, the most common fuel is natural gas.			Hydrogen, natural gas, propane, methanol	Steam turbines for CHP are used primarily where a solid fuel (e.g., coal or biomass) is used in a boiler. [2]

- Notes:**
- 1) Adapted from Catalog of CHP Technologies, U.S. Environmental Protection Agency Combined Heat and Power Partnership, 2015.
  - 2) Backpressure steam turbines can be used to produce power by replacing pressure reducing valves (PRVs) in existing steam systems.



# Comparison of CHP Characteristics

*continued...*

Characteristic	Technology				
	Reciprocating Engine	Gas Turbine	Microturbine	Fuel Cell	Steam Turbine
Emissions	CHP technologies are capable of meeting or exceeding air quality regulations throughout the United States, including states such as California that have demanding limits for NOx, CO, and VOC emissions. To achieve compliance, a CHP technology may need to integrate an exhaust treatment technology such as an oxidation catalyst or a selective catalytic reduction system.				
Other	Reciprocating engines start quickly and operate on typical natural gas delivery pressures.	Gas turbines and microturbines have low engine-out emissions and require no cooling. A fuel gas compressor may be required to deliver the specified inlet gas pressure.		Fuel cells are quiet, have low emissions, and produce high quality power.	Steam turbines require a boiler or other steam source.

