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
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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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%
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)

- 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*)
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.

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
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 Is Used Nationwide In Several Types of Buildings/Facilities

82.6 GW installed at nearly 4,400 sites

Saves 1.8 quads of fuel each year

Avoids 241 M metric tons of CO₂ each year

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
## West Virginia Commercial CHP Potential

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

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### U.S. Department of Energy

**CHP Technical Assistance Partnerships**

**MID-ATLANTIC**
West Virginia Industrial CHP Potential

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

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<th>50-500 kW (MW) Sites</th>
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**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

SnapProject shot: University District Energy CHP System

University of Illinois at Chicago
Chicago, Illinois

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
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
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
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
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
“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
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
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:
- Screening and Preliminary Analysis: Quick screening questions with spreadsheet payback calculator.
- Investment Grade Analysis: 3rd Party review of Engineering Analysis. Review equipment sizing and choices.
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.
MA CHP TAP Contact Information

Dr James Freihaut
Director
jdf@psu.edu
814-863-0083

Bill Valentine,
Program Manager
wjv3@psu.edu
(215) 353 3319

www.midatlanticchptap.org
Appendix
How to Implement a CHP Project with the Help of the CHP TAP
CHP TAP Technical Assistance

**US DOE CHP TAP Services:**

**Screening and Preliminary Analysis:**
Quick screening questions with spreadsheet payback calculator.

**Feasibility Analysis:**
Uses available site information. Estimate: savings, installation costs, simple paybacks, equipment sizing and type.

**Investment Grade Analysis:**

**Procurement, Operations, Maintenance, Commissioning:**
Review specifications and bids. Limited operational analysis.
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

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<tr>
<th>Annual Energy Consumption</th>
<th>Base Case</th>
<th>CHP Case</th>
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<tbody>
<tr>
<td>Purchased Electricity, kWh</td>
<td>88,250,160</td>
<td>5,534,150</td>
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<tr>
<td>Generated Electricity, kWh</td>
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<td>On-site Thermal, MMBtu</td>
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<td>CHP Thermal, MMBtu</td>
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<td>Boiler Fuel, MMBtu</td>
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<td>CHP Fuel, MMBtu</td>
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<tr>
<td>Total Fuel, MMBtu</td>
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<table>
<thead>
<tr>
<th>Annual Operating Costs</th>
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<tr>
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<td>$1,104,460</td>
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<td>Standby Power, $</td>
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<td>On-site Thermal Fuel, $</td>
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<td>CHP Fuel, $</td>
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<td>Incremental O&amp;M, $</td>
<td>50</td>
<td>$744,444</td>
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<tr>
<td>Total Operating Costs, $</td>
<td>$10,255,013</td>
<td>$7,809,514</td>
</tr>
</tbody>
</table>

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                                         | $0.099    |
- 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
CHP Project Resources

DOE Project Profile Database
(100+ case studies)

DOE Database of Incentives & Policies (DSIRE)

energy.gov/chp-projects

www.dsireusa.org
C H P P r o j e c t R e s o u r c e s

D O E C H P I n s t a l l a t i o n D a t a b a s e
(L i s t o f a l l k n o w n
C H P s y s t e m s i n U . S .)

L o w - C o s t C H P S c r e e n i n g a n d
O t h e r T e c h n i c a l A s s i s t a n c e f r o m
t h e C H P T A P

energy.gov/chp-installs

energy.gov/chp-contacts