AIChE® 12th SOUTHWEST PROCESS TECHNOLOGY CONFERENCE

OCTOBER 1–2, 2020
CHP, Energy Resilience and Grid Reliability

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DOE CHP Technical Assistance Partnerships

- **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 CHPTAPs 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.
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 System Schematic

**Fuel**
- Natural Gas
- Propane
- Biogas
- Landfill Gas
- Coal
- Steam
- Waste Products
- Others

**Prime Mover**
- Reciprocating Engines
- Combustion Turbines
- Microturbines
- Steam Turbines
- Fuel Cells
- ORC turbine

**Generator**

**Electricity**
- On-Site Consumption
- Sold to Utility

**Heat Recovery**

**Thermal**
- Steam
- Hot Water
- Space Heating
- Process Heating
- Space Cooling
- Process Cooling
- Refrigeration
- Dehumidification
CHP Technologies

- Microturbines
- Gas Turbines
- Reciprocating Engines
- Fuel Cells
- Steam Turbines
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 and enhance power quality

• On-site electric generation can reduce grid congestion and avoid distribution costs.
CHP Integration with Renewables and Storage

- CHP + Solar PV: solar seldom meets the entire electricity load, making room for CHP to supply thermal loads and electricity when PV electricity is insufficient or unavailable.
- CHP + Battery Storage: 1) dampen daily demand swings; 2) Shift power usage from off-peak to on-peak periods; 3) enhanced resiliency and availability; and 4) enhance grid value-stacking capabilities (voltage support, T&D deferral, reserve capacity, reliability, over-generation management).
- CHP in a Microgrid: 1) efficient measure to serve thermal load; 2) backup power during extended outages; 3) supplements generation from PV & storage.
- CHP is a Flexible Generation Resource: most CHP technologies can be powered down or off when renewable supply exceeds demand.
- CHP Powered by Renewable Gas: would enable CHP to partially or completely utilize renewable fuel either by piping non-pipeline quality biogas to the CHP site; using directed renewable gas; or purchasing pipeline gas that has been blended with renewable gas.
• **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 CO₂** compared to separate production

Source: DOE CHP Installation Database (U.S. installations as of December 31, 2018)
CHP Additions by Application (2014-2018)

By Installations – 866 Installs

- Other/Unknown: 15 installs
- Food Processing: 37 installs
- Other Industrial: 122 installs
- Colleges/Univ.: 53 installs
- Hotels: 44 installs
- Wastewater Treatment: 58 installs
- Other Comm./Inst.: 248 installs
- Multi-Family: 181 installs
- Schools (K-12): 50 installs

By Capacity – 3.3 GW

- Chemicals: 553 MW
- Food Processing: 285 MW
- Pulp & Paper: 367 MW
- Refining: 407 MW
- Utilities: 271 MW
- District Energy: 165 MW
- Colleges/Univ.: 162 MW
- Other Industrial: 494 MW
- Other Comm./Inst.: 563 MW

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

- Resilience: the ability of an entity—e.g., asset, organization, community, region—to anticipate, resist, absorb, respond to, adapt to, and recover from a disturbance
  - Reducing the magnitude and duration of energy service disruptions
- Reliability: the ability of the electric power system to deliver the required quantity and quality of electricity demanded by end-users

Electric System Disturbances

Electric system outages are increasingly frequent...

And outages are increasingly caused by natural disasters and storm events.

## Valuing Resiliency and Reliability

<table>
<thead>
<tr>
<th>Study author</th>
<th>Parameters</th>
<th>Annual cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Galvin Electricity Initiative (Rouse and Kelly 2011)</td>
<td>Cost of losses due to power outages</td>
<td>$150 billion (about 4 cents for every kWh consumed nationwide)</td>
</tr>
<tr>
<td>Lawrence Berkeley National Laboratory (LaCommare and Eto 2006)</td>
<td>Cost of poor energy reliability and poor power quality</td>
<td>$79 billion</td>
</tr>
<tr>
<td>Hartford Steam Boiler and Atmospheric and Environmental Research (AER and HSB 2013)</td>
<td>Cost of power outages</td>
<td>$100 billion</td>
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<tr>
<td>Executive Office of the President (2013)</td>
<td>Cost of weather-related outages over five minutes</td>
<td>$18–33 billion</td>
</tr>
<tr>
<td>Institute of Electrical and Electronics Engineers (Bhattacharya and Cobb 2011)</td>
<td>Cost of poor power quality</td>
<td>$119–188 billion</td>
</tr>
<tr>
<td>Electric Power Research Institute (EPRI) (Hampson et al. 2013)</td>
<td>Cost of outages to “industrial and digital economy” businesses</td>
<td>$45.7 billion</td>
</tr>
<tr>
<td>EPRI (Hampson et al. 2013)</td>
<td>Cost of outages to entire US economy</td>
<td>$120–190 billion</td>
</tr>
<tr>
<td>US Congressional Research Service (Campbell 2012)</td>
<td>Cost of weather-related outages longer than five minutes</td>
<td>$25–70 billion</td>
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Reliability and Resilience: C&I Outage Costs by Sector

Manufacturing facilities generally experience higher outage costs than other Large C&I customer segments.
How Does CHP Increase 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
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

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<th>Requirement</th>
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<tr>
<td>Black-start capability</td>
<td>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.</td>
</tr>
<tr>
<td>Generator capable of operating independently of the grid</td>
<td>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.</td>
</tr>
<tr>
<td>Ample carrying capacity</td>
<td>The facility must match the size of the critical loads to the CHP generator.</td>
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<td>Parallel utility interconnection and switchgear controls</td>
<td>The CHP system must be able to properly disconnect itself from the utility grid and switch over to providing electricity to critical facility loads.</td>
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</table>
How to Implement a CHP Project with the Help of the CHP TAP
CHP TAP Role: Technical Assistance

- **Screening and Preliminary Analysis**: Quick screening questions with spreadsheet payback calculator; Advanced technical assistance to explore equipment or operational scenarios.
- **Feasibility Analysis**: Perform 3rd Party reviews of site feasibility assessments: Estimates on savings, installation costs, simple paybacks, equipment sizing, and type.
- **Investment Grade Analysis**: Perform 3rd Party reviews of Engineering Analysis: Review equipment sizing and choices.
- **Procurement, Operations, Maintenance, Commissioning**: Review specifications and bids.

**Virtual**

**OCTOBER 1–2, 2020**
Resilience Planning with DOE Resiliency Accelerator

• The **DOE CHP for Resiliency Accelerator** includes resources and tools designed to assist with resilience planning efforts
  • Distributed Generation for Resiliency Planning Guide
  • CHP for Resilience Screening Tool
  • Issue Brief on Performance of DERs in Disaster Events
  • Partner Profiles

https://betterbuildingsinitiative.energy.gov/accelerators/combined-heat-and-power-resiliency
CHP in Resilience Resources

DG for Resilience Planning Guide

[Image of DG for Resilience Planning Guide]

- Chp in Resilience Resources
- CHP: Enabling Resilient Infrastructure for Critical Facilities

[Images of CHP resources]

https://dg.resilienceguide.lbl.gov/

CHP Databases

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

[Link to DOE CHP Installation Database](https://energy.gov/chp-installs)

**EPA dCHPP (CHP Policies and Incentives Database)**

[Link to EPA dCHPP Database](https://www.epa.gov/chpdchpp-chp-policies-and-incentives-database)

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**VIRTUAL**

OCTOBER 1–2, 2020
In Summation

- CHP is a proven technology providing energy savings, reduced emissions, and opportunities for resiliency.
- Emerging drivers are creating new opportunities to evaluate CHP and numerous example exist to learn more how health care systems have incorporated CHP.
- Engage with the US DOE Southcentral CHP TAP to learn more about the technical assistance offerings in evaluating CHP in your health care facility.
Thank you

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