

# Combined Heat and Power (CHP) for Healthcare

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U.S. DEPARTMENT OF ENERGY

**CHP Technical Assistance Partnerships**

MIDWEST

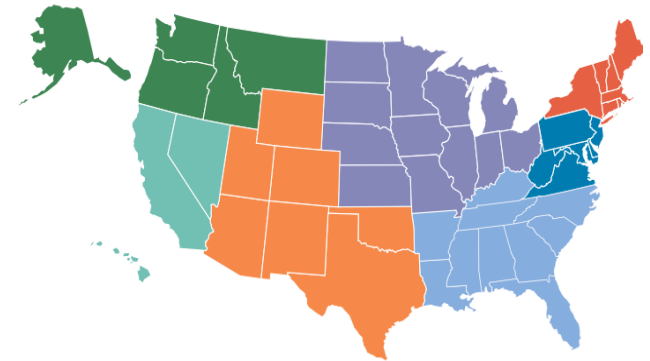
# Agenda

- DOE CHP Technical Assistance Partnerships (TAPs)
- CHP Overview
- CHP in Hospitals
- Available Resources and Next Steps

# DOE CHP Technical Assistance Partnerships (CHP TAPs) Key Activities

DOE's CHP TAPs promote and assist in transforming the market for CHP, waste heat to power, and district energy or microgrid with CHP throughout the United States. 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 or microgrid with CHP in their facility and to help them through the development process from initial CHP screening to installation.



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

# DOE CHP Technical Assistance Partnerships (CHP TAPs)

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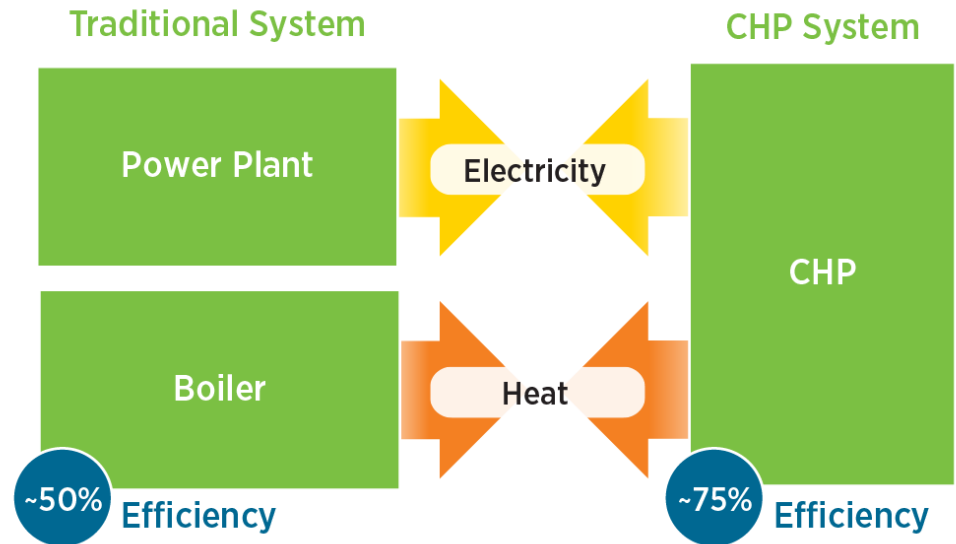
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# What is Combined Heat & Power (CHP)?

- 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.**

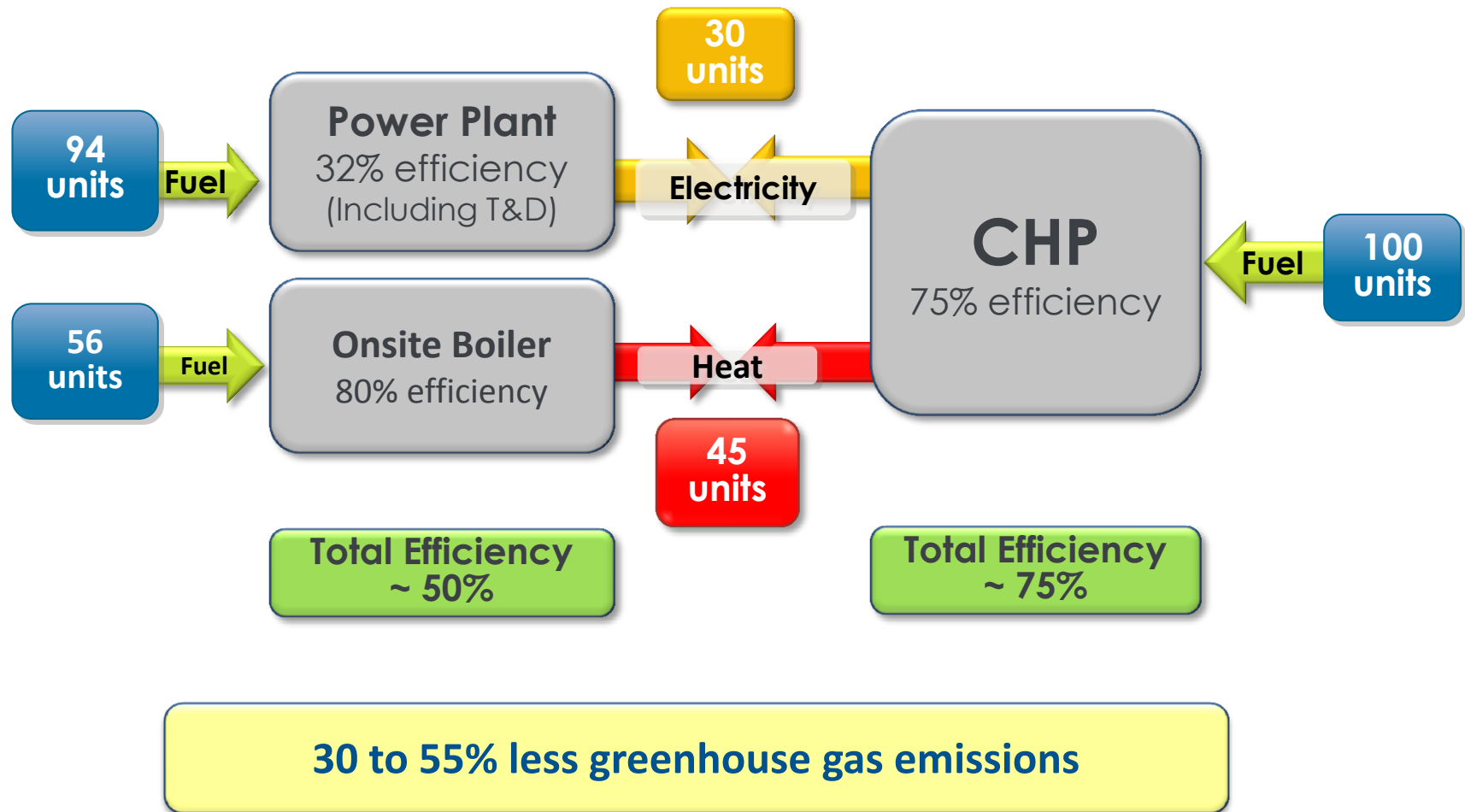
Source:

[http://www1.eere.energy.gov/manufacturing/distributedenergy/pdfs/chp\\_clean\\_energy\\_solution.pdf](http://www1.eere.energy.gov/manufacturing/distributedenergy/pdfs/chp_clean_energy_solution.pdf)



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# CHP Recaptures Heat of Generation, Increasing Energy Efficiency, and Reducing GHGs



# What Are the 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

# Critical Infrastructure and Resiliency

## Benefits of CHP

*“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

### CHP (if properly configured):

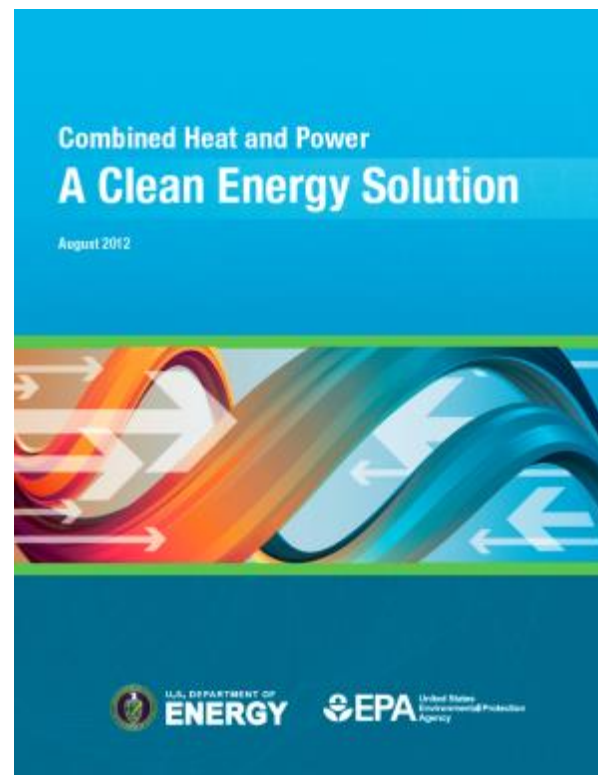
- Offers the opportunity to improve Critical Infrastructure (CI) resiliency
- Can continue to operate, providing uninterrupted supply of electricity and heating/cooling to the host facility



# Emerging Drivers for CHP

- Benefits of CHP recognized by policymakers
  - President Obama signed an Executive Order to accelerate investments in industrial EE and CHP on 8/30/12 that sets national goal of 40 GW of new CHP installation over the next decade
  - 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

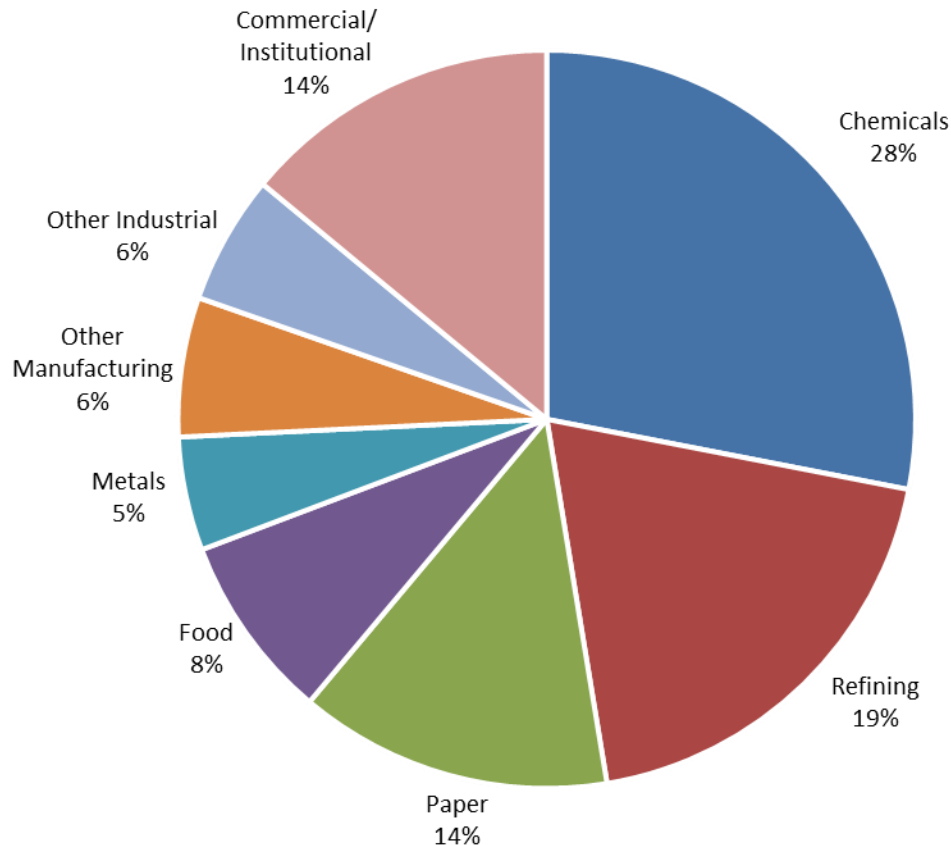
*DOE / EPA CHP Report (8/2012)*



Executive Order: <http://www.whitehouse.gov/the-press-office/2012/08/30/executive-order-accelerating-investment-industrial-energy-efficiency>  
Report: [http://www1.eere.energy.gov/manufacturing/distributedenergy/pdfs/chp\\_clean\\_energy\\_solution.pdf](http://www1.eere.energy.gov/manufacturing/distributedenergy/pdfs/chp_clean_energy_solution.pdf)

# CHP Today in the United States

## Existing CHP Capacity (MW)



- **82.7 GW** of installed CHP at over 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 CO<sub>2</sub>** compared to separate production

Source: DOE CHP Installation Database (U.S. installations as of December 31, 2014)

# Hospitals are Ideal Candidates for CHP

## 1. Practical

- Hospitals operate 24/7, and have significant needs for electric power, heating, and cooling
- Hospitals with installed CHP systems experience reduced operating costs and higher reliability of continued service

## 2. Proven

- 215 hospitals and medical campuses nationwide currently operate CHP systems
- CHP is a proven, well understood application that can be easily maintained with existing trained staff

## 3. Economic

- Efficient CHP systems can lead to attractive investments with electric and thermal energy savings, especially in areas with high electric rates and lower natural gas costs
- When properly designed and operated, a CHP system will run reliably for up to 15 years, providing energy cost savings well after the initial investment has paid for itself

## 4. Reliable

- Recent extreme weather events have turned attention to energy reliability and business continuity, disrupting electric distribution systems and exposing fragilities in our back-up power systems
- Opposed to emergency generators that may not be able to operate as expected over the full duration of an outage, several facilities with CHP systems were able to maintain both power and heat during these storms and other events, providing a “dynamic asset” with an economic return running every day

## 5. Clean

- High efficiency, low emissions CHP systems have been recognized as the centerpiece of sustainability strategies at premier hospital and university campuses.
- A hospital can reduce its greenhouse gas impacts by almost 20% with a single investment in high efficiency CHP

# Energy Savings Impact in Hospitals

- Healthcare organizations spend > \$6.5B annually
- Every \$1 a non-profit healthcare organization saves on energy is equivalent to generating \$20 in new revenues for hospitals
- For-profit hospitals can raise their earnings per share 1¢ by reducing energy costs just 5%
- By being more energy efficiency and saving money, hospitals can reinvest savings from improved energy performance
- 7 of Top 16 U.S. hospitals use CHP according to US News

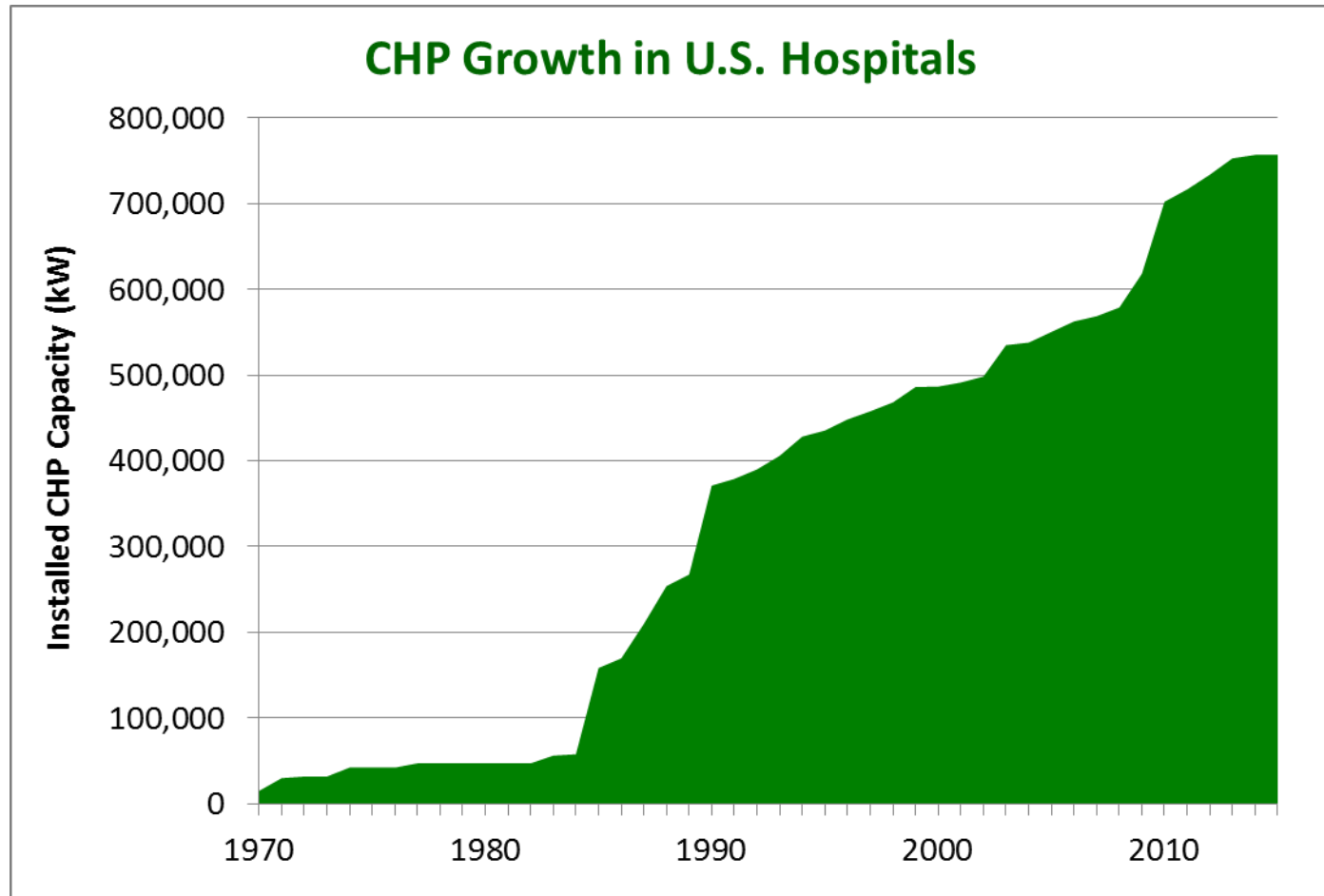
1) ENERGY STAR - <http://www.energystar.gov/ia/partners/publications/pubdocs/Healthcare.pdf>

2) US News' 2013-2014 Honor Roll of the Nation's Top 18 Hospitals:(John Hopkins, Mass. General, Mayo Clinic, Cleveland Clinic, NY Presbyterian, NYU Langone, Indiana University)



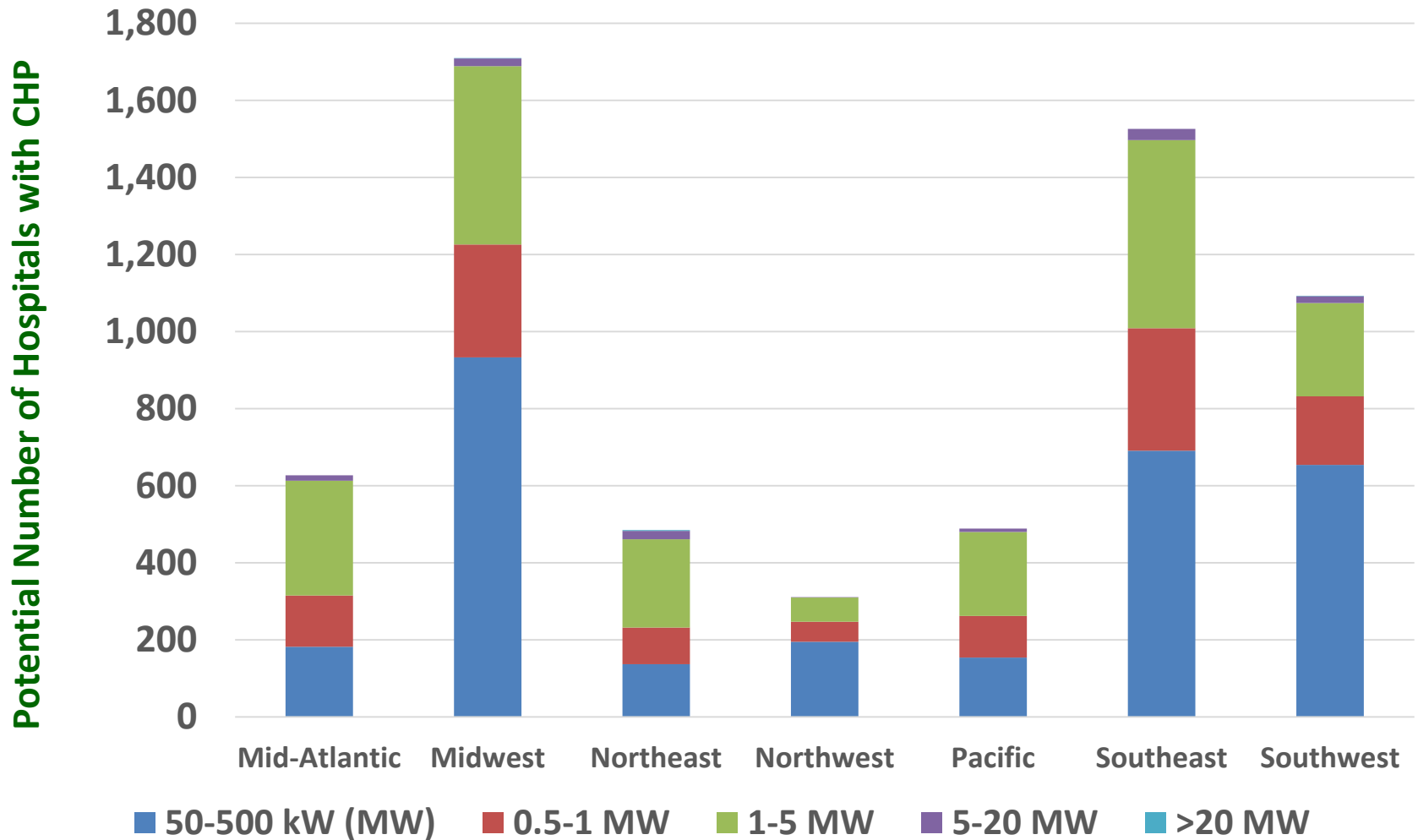
# CHP Growth in U.S. Hospitals

- 215 hospitals have CHP, totaling 756.8 MW of CHP generating capacity
- Further technical potential totaling 7,318 MW of CHP generating capacity at 5,614 sites



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

# How many hospitals could still benefit from CHP today?



Source: [energy.gov/chp-potential](https://energy.gov/chp-potential)

# Typical Hospital CHP System Configurations

- Sizes TYPICALLY range from 100s of kW to several MWs (depending on facility size and usually below 10 MW)
- Common CHP prime mover types in hospitals are reciprocating engines, combustion turbines, and/or steam turbines (mostly fueled by natural gas)
- Most hospital CHP systems are sized for the thermal load requirements with the resulting electric power generated used to first offset the power purchased from the utility grid (excess power can be sold to the utility)
- CHP systems do not replace the need for emergency generator sets to meet the “life critical loads” of a hospital
  - Can reduce the number and capacity of the emergency generators
  - Can increase the total electric reliability for the hospital

Source: Combined Heat & Power (CHP) Resource Guide for Hospital Applications

[http://www1.eere.energy.gov/manufacturing/distributedenergy/pdfs/chp\\_hospital\\_guidebook\\_2007.pdf](http://www1.eere.energy.gov/manufacturing/distributedenergy/pdfs/chp_hospital_guidebook_2007.pdf)

# Designing for Reliability

## Two Generator Types

- Induction
  - Requires external power source to operate
    - When grid goes down, generator goes down
  - Less Complicated and Costly to Interconnect
- Synchronous
  - Self Excited (Does not need grid to operate)
  - Generator can operate thru Grid outages
  - More Complicated and Costly to Interconnect

## Uninterrupted Operation Requirements

- Black start capability
  - Allows the system to start up independently from the grid
- Generators capable of grid-independent operation
  - The system must be able to operate without grid power signal
- Ample Carrying Capacity
  - System size must match critical loads
- Parallel utility interconnection and switch gear controls
  - The system must be able to disconnect from the grid, support critical loads, and reconnect after an event



# Emergency Generators vs CHP Systems

## Emergency Generators

- Minimum requirement, sized to meet “life critical loads
- Hospitals are installing larger generators to protect more and more hospital loads
- Diesel fueled – high emissions & limited amount of stored fuel (hours versus days of operation)
- Not designed or capable of continuous operation for long periods of time – rarely operates
- Financial payback only in times of emergency

## CHP Systems

- Sized to meet thermal or electric loads – operates continuously to meet those loads
- Natural gas fueled – low emissions
- Does not replace emergency generator set for “life critical” loads
- Reduces overall size and capacity of emergency generator sets
- Emergency generator sets become backup to the backup; much higher reliability
- Good financial return



# Project Snapshot:

## Resiliency and Disaster Relief

### South Oaks Hospital

Amityville, NY

**Application/Industry:** Healthcare

**Capacity (MW):** 1.25 MW

**Prime Mover:** Reciprocating Engines

**Fuel Type:** Natural Gas

**Thermal Use:** Steam, Cooling, Hot Water

**Installation Year:** 2007

**Testimonial:** South Oaks isolated itself from the Long Island Power Authority (LIPA) grid on the evening of October 28<sup>th</sup> and remained disconnected from the grid for approximately fifteen days. LIPA was able to restore power to the sub-station that services the facility about five days after the storm. However, the grid was still not stable at that time and LIPA requested that South Oaks remain disconnected from the grid due to continued loss of power and phases in the area. South Oaks was able to provide critical services for two weeks relying solely on their CHP system. They admitted patients from other sites that had been displaced by the storm. They offered refrigeration for vital medicines to those who had lost power and had no means of keeping medicines refrigerated. The staff and local community were welcome to come to the hospital to perform important tasks such as recharging phones and other electronic devices, and having a place to shower.

Source: <http://energy.gov/eere/amo/downloads/chp-enabling-resilient-energy-infrastructure-critical-facilities-report-march>



# Project Snapshot:

## Resiliency and Disaster Relief

### Mississippi Baptist Medical Center

Jackson, Mississippi

**Application/Industry:** Healthcare

**Capacity (MW):** 4.2 MW

**Prime Mover:** Solar Centaur Gas Turbine

**Fuel Type:** Natural Gas

**Thermal Use:** Hot water

**Installation Year:** 1991

**Testimonial:** For more than four days after Hurricane Katrina hit the region, MBMC 's CHP system provided power and thermal energy to the hospital. MBMC was the only hospital in the Jackson metro area to remain nearly 100% operational following the storm. MBMC was able to receive displaced patients from other hospitals and serve as an operations center for emergency responders.

Source: [http://southeastchptap.rlmartin.com/Data/Sites/4/documents/profiles/Mississippi\\_Baptist\\_Medical\\_Center-CHP\\_Project\\_Profile.pdf](http://southeastchptap.rlmartin.com/Data/Sites/4/documents/profiles/Mississippi_Baptist_Medical_Center-CHP_Project_Profile.pdf)



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# Project Snapshot:

100% Energy Independence

## Gundersen Health System

La Crosse, WI

**Application/Industry:** Hospital

**Capacity (MW):** 500 kW

**Prime Mover:** Boiler/Steam Turbine

**Fuel Type:** Biomass

**Thermal Use:** Heating, Hot Water, Sterilizing Needs

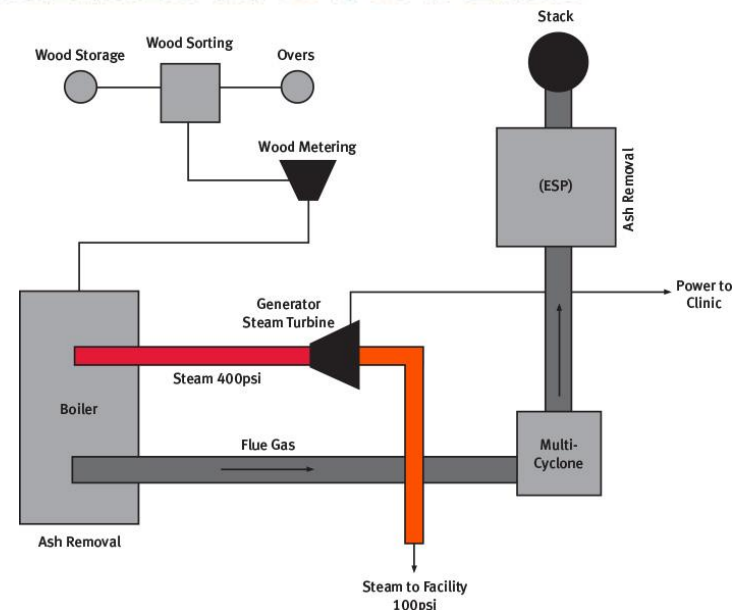
**Installation Year:** 2013

**Energy Savings:** \$500,000/year

**Testimonial:** Gundersen Health System received a \$225,000 grant from the U.S. Forest Service through the Wisconsin Dept. of Administration for the biomass CHP system at their La Crosse campus. Gundersen Health system reached 100% energy independence in 2014 thanks to their 4 CHP systems at their campuses.

Source: <http://www.gundersenhealth.org/news/gundersen-powers-up-biomass-boiler>,  
[http://lacrossetribune.com/news/local/gundersen-s-new-wood-chip-boiler-taps-region-s-resources/article\\_79024da6-b2c7-11e2-8d3a-0019bb2963f4.html](http://lacrossetribune.com/news/local/gundersen-s-new-wood-chip-boiler-taps-region-s-resources/article_79024da6-b2c7-11e2-8d3a-0019bb2963f4.html)

# GUNDERSEN HEALTH SYSTEM®



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# Emerging Utility CHP Programs

- Contact one of the DOE CHP TAPs to find information about state and local CHP policies and incentives. Example CHP utility programs include:



## **Ohio – Dayton Power & Light CHP Rebates**

- Up to \$10,000 towards CHP feasibility study
- Generation incentive: \$100 per kW capacity and \$0.08 per kWh generated over 12 months (capped at 50% of total installed cost and capped at \$500,000 per project)

<https://www.dpandl.com/save-money/business-government/custom-rebates/chp-rebates/>



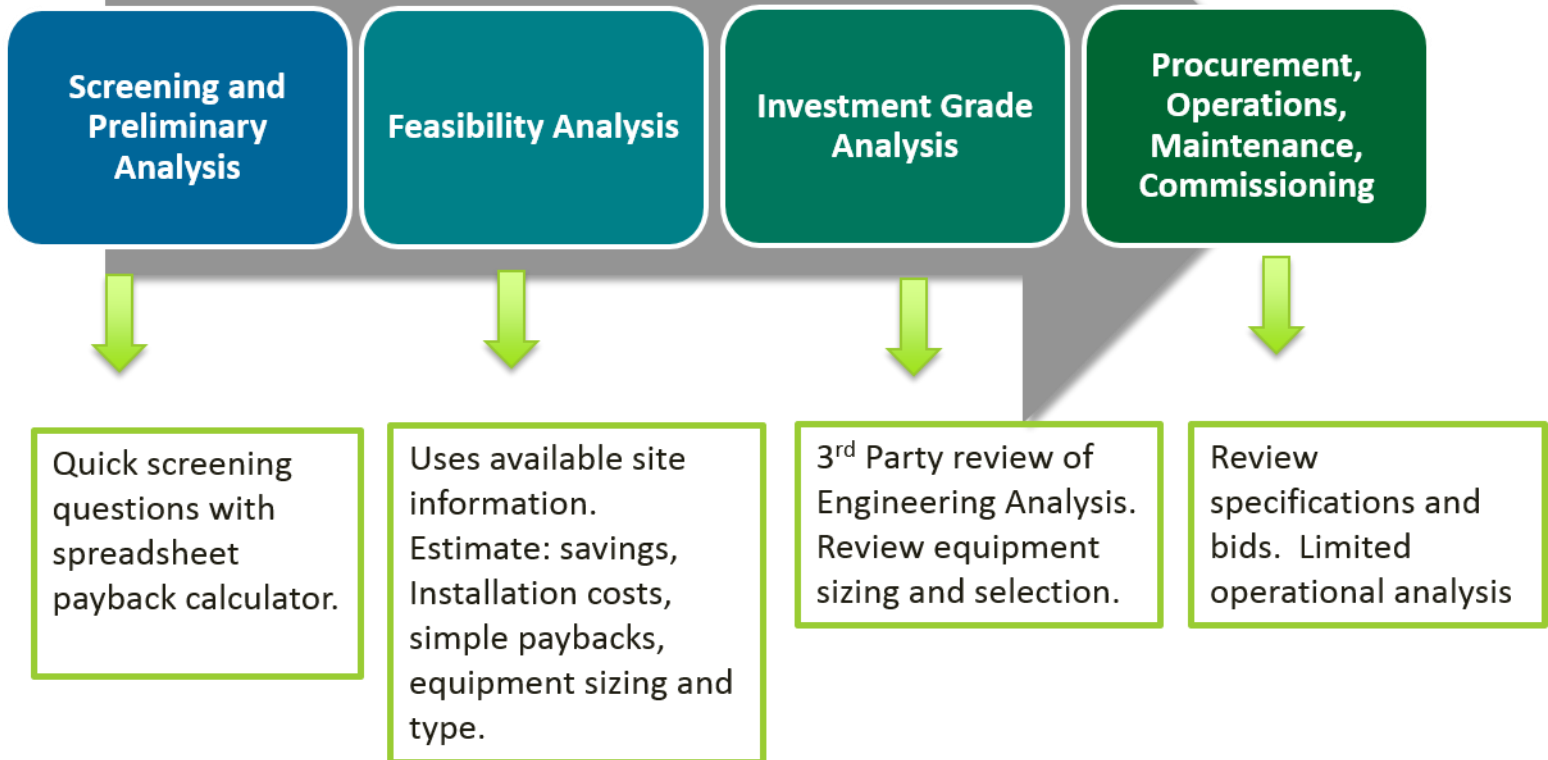
## **Illinois – ComEd Smart Ideas CHP Pilot**

- 50% of feasibility assessment cost up to \$25,000
- 50% of interconnection fee up to \$25,000
- Production Incentive: \$0.07 per eligible kWh based on review of 12 months of metered data and capped at \$2,000,000 per project

[http://www.cogeneration.org/assets/2016/PDF/ComEd CHP Flyer.pdf](http://www.cogeneration.org/assets/2016/PDF/ComEd_CHP_Flyer.pdf)

# CHP TAP Project Development Technical Assistance

**US DOE  
CHP TAP  
Services:**



# Finding the Best CHP Candidates

Some or All of These Characteristics

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

# Summary

- CHP in hospitals is Practical, Proven, Economic, Reliable, and Clean
- 215 hospitals today experience the benefits of CHP and your hospital could be next
- Resources are available to assist in developing CHP Projects



# Next Steps and Questions

Contact DOE 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

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