



How Combined Heat and Power Saves Money, Reduces Emissions and Improves Energy Security

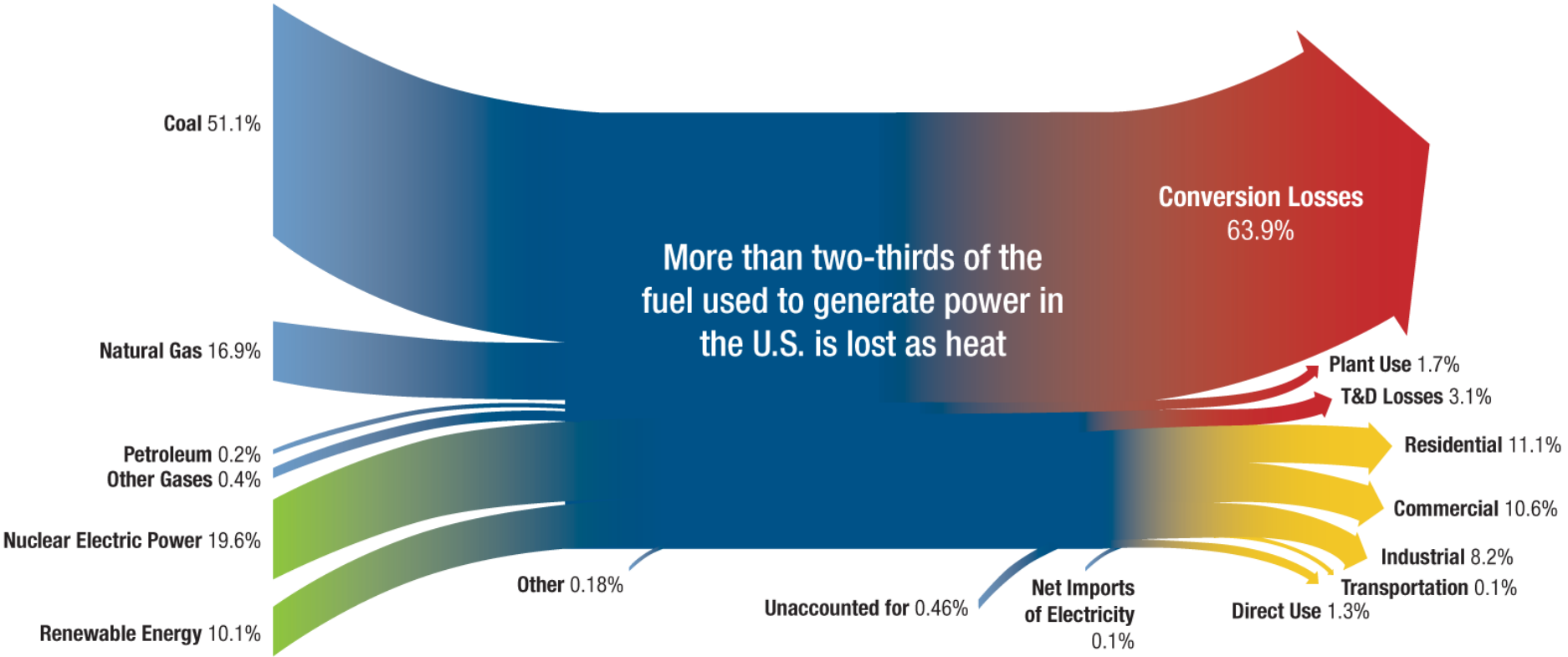
CHP Overview

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Over Two Thirds of the Fuel Used to Generate Electrical Power in the United States Is Lost as Heat



What Is Combined Heat and Power?

CHP is an *integrated energy system* that:

- Generates electrical and/or mechanical power
- Recovers waste heat for:
 - Space heating
 - Water heating
 - Space cooling
 - Dehumidification
- Is located at or near a factory or building that can use the energy output
- Can utilize a variety of technologies and fuels
- CHP is also known as *cogeneration*

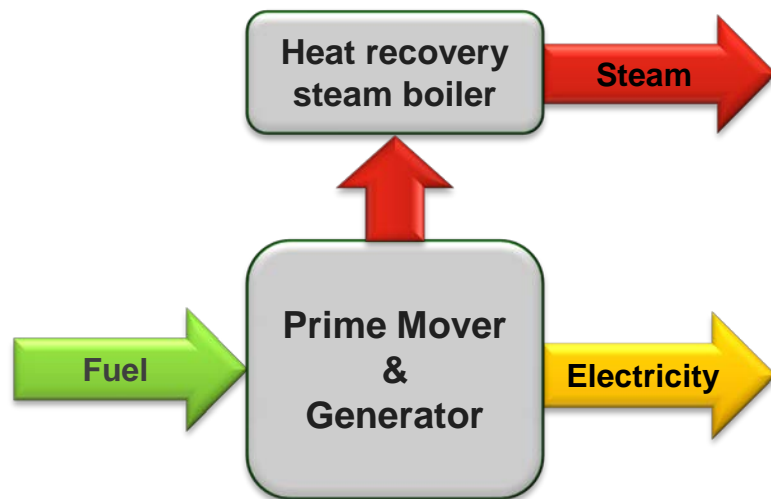


Defining Combined Heat & Power (CHP)

*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)



Recip. Engine

Gas Turbine

Micro-turbine

Fuel Cell

Boiler/Steam Turbine

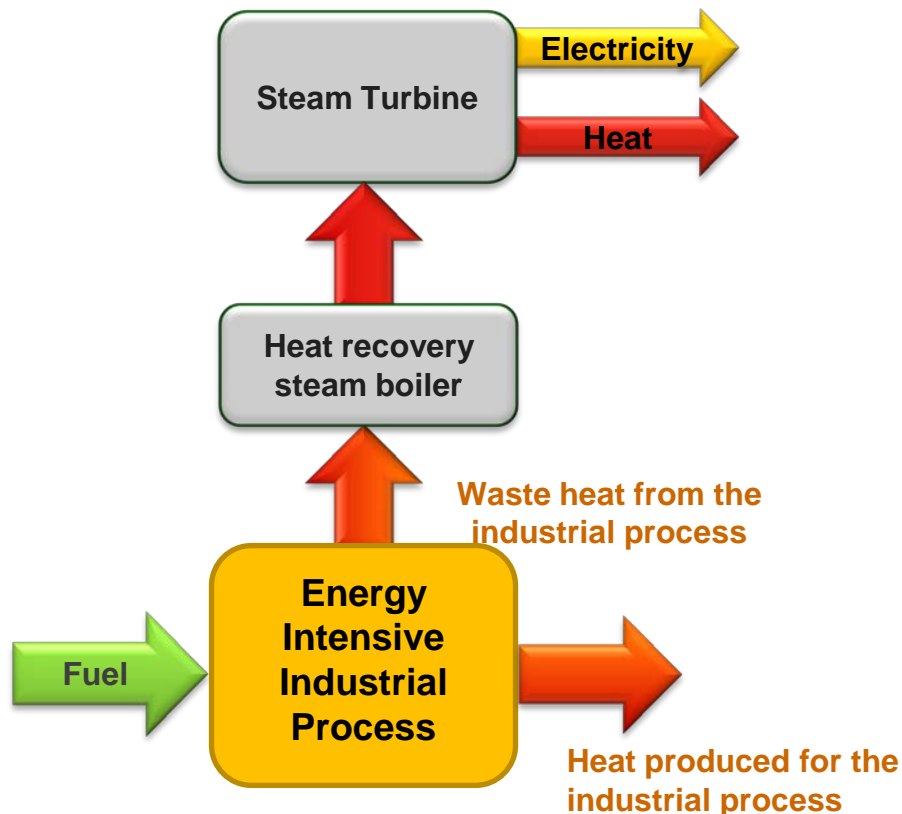
- Simultaneous generation of heat and electricity
- Fuel is combusted/burned for the purpose of generating heat and electricity
- Normally sized for thermal load to max. efficiency – 70% to 80%
- HRSG can be supplementary fired for larger steam loads
- Normally non export of electricity
- Low emissions – natural gas

Defining Combined Heat & Power (CHP)

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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 requires high temperature (> 800°F) (*low hanging fruit in industrial plants*)

CHP in the U.S. Represents a Variety of Fuels, Technologies, Sizes and Applications



Industrial



Institutional



Residential



Utility Scale

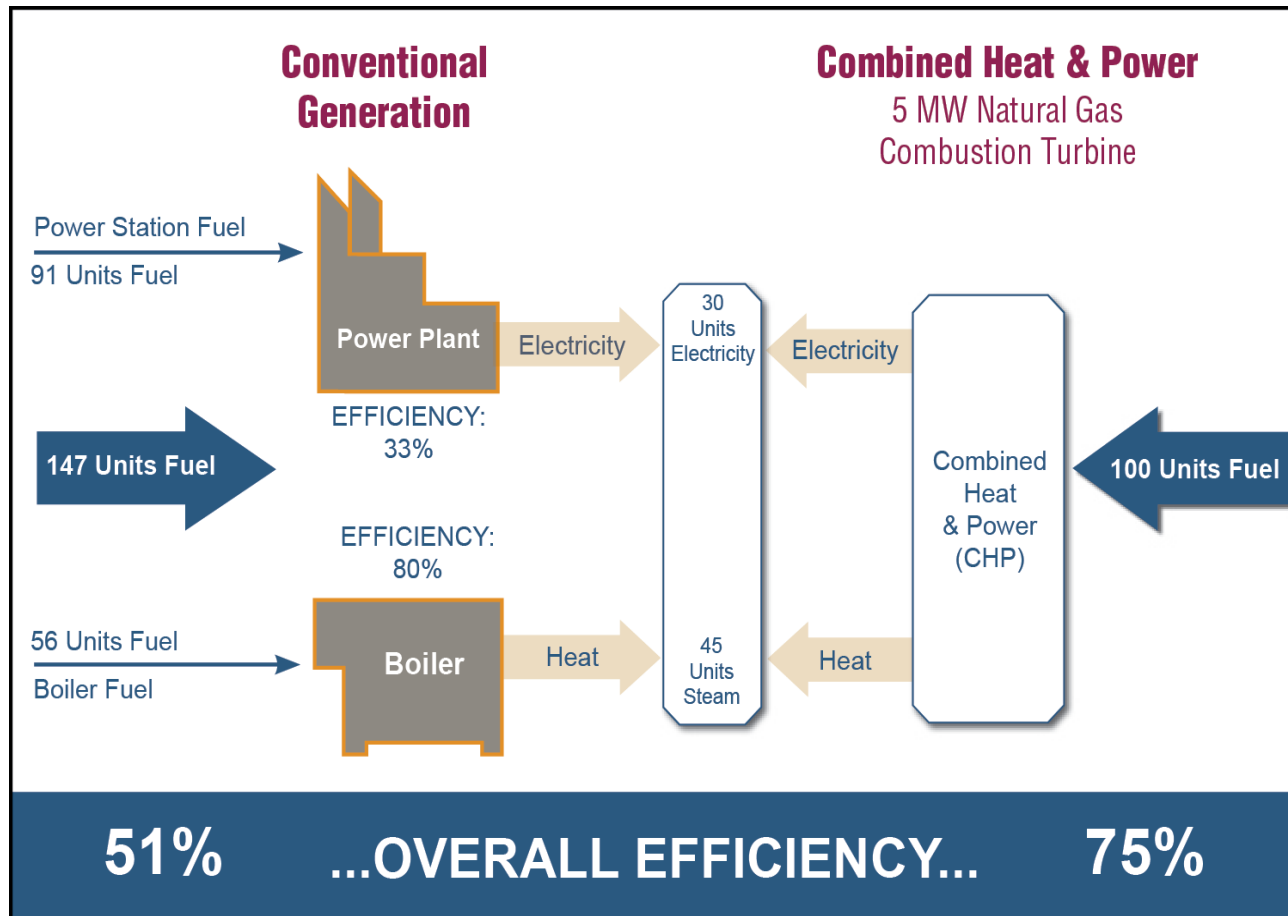


Commercial

What Are the Benefits of CHP?

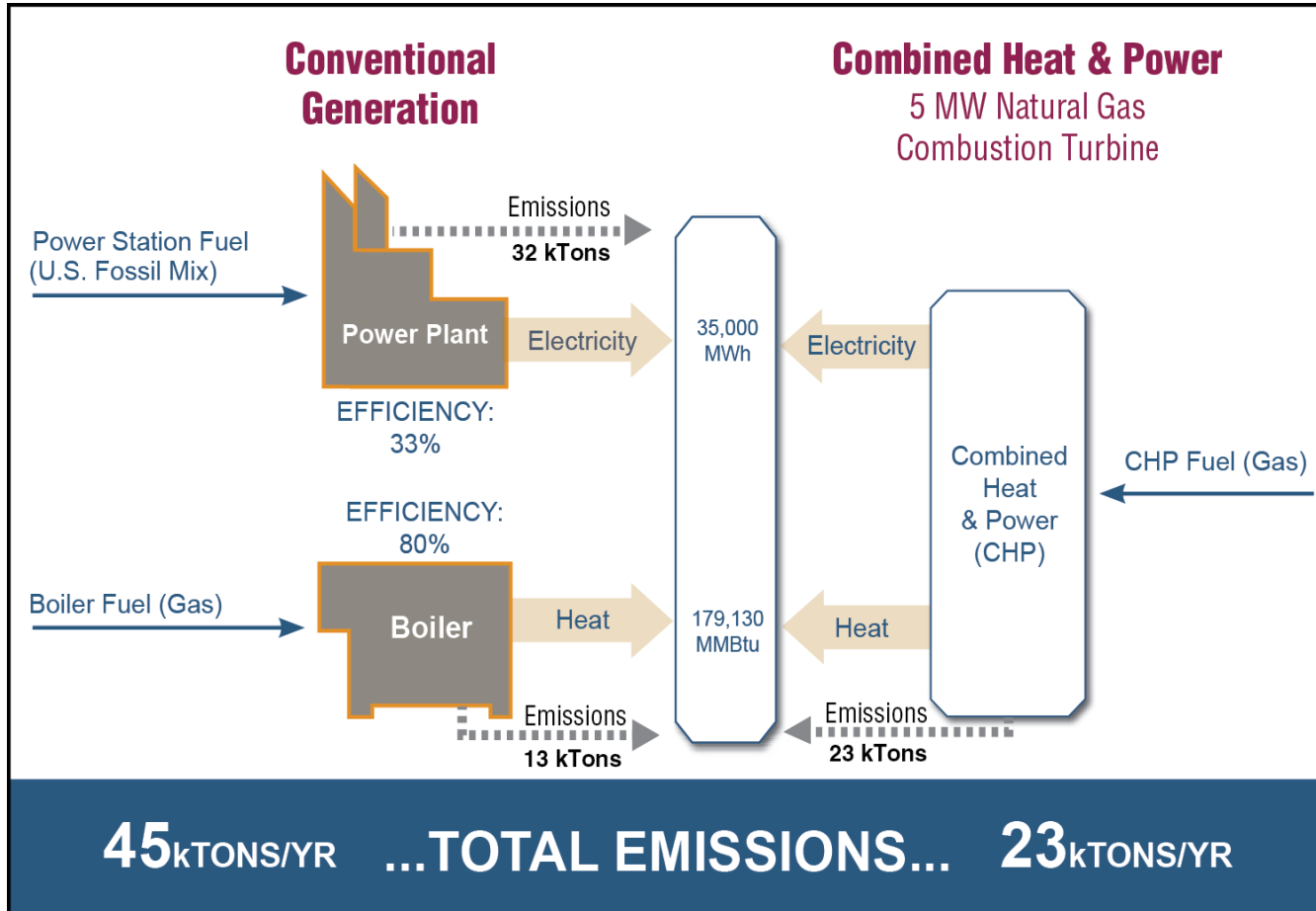
- CHP is more efficient than separate generation of electricity and thermal energy
- Higher efficiency translates to **lower operating cost**
- Higher efficiency **reduces emissions** of all pollutants, including CO₂, NO_x and SO₂
- CHP can **increase power reliability** and enhance power quality
- On-site electric generation **can help reduce grid congestion**

CHP is a Clean, Efficient Method of Providing Energy Services



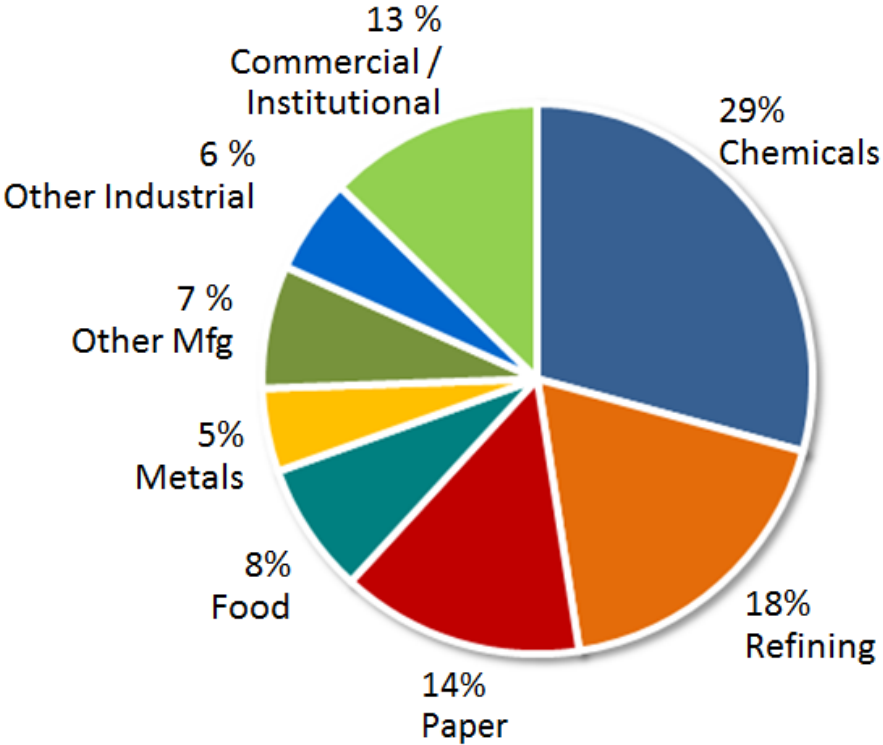
Source: EPA CHP Partnership - 2012

CHP's Increased Efficiency Generally Results in Lower Emissions



Source: EPA CHP Partnership - 2012

How Much CHP is Operating in the U.S. Today?



- **82 GW** of installed CHP at 4,100 industrial and commercial facilities (2012)
 - 87% of capacity in industrial applications
 - 71% of capacity is natural gas fired
- Avoids more than **1.8 quadrillion Btus** of fuel consumption annually
- Avoids **241 million metric tons of CO₂** compared to separate production

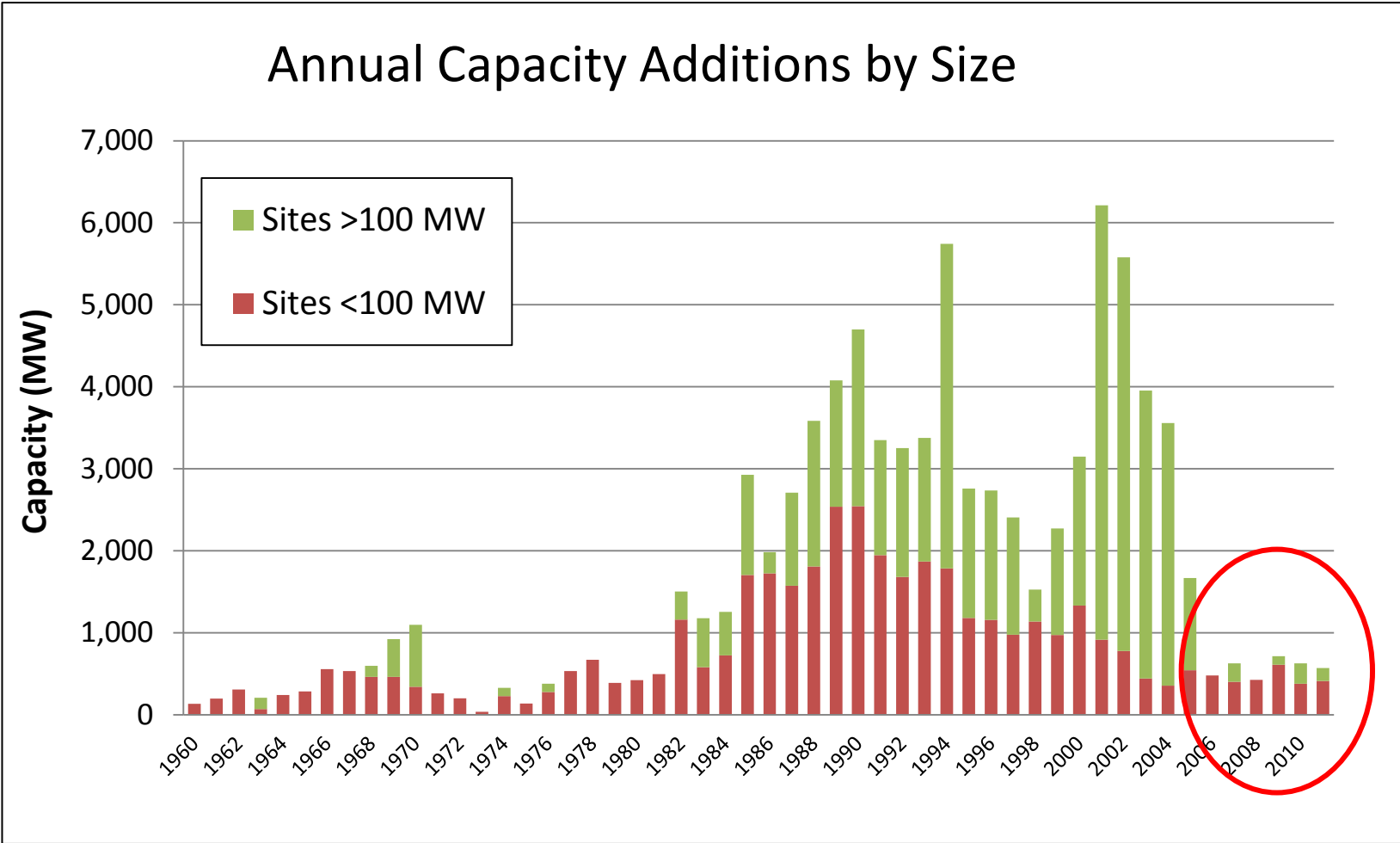
Source: ICF CHP Installation Database

CHP Is Used at the Point of Demand



Source: ICF CHP Installation Database

CHP Annual Additions since 1960

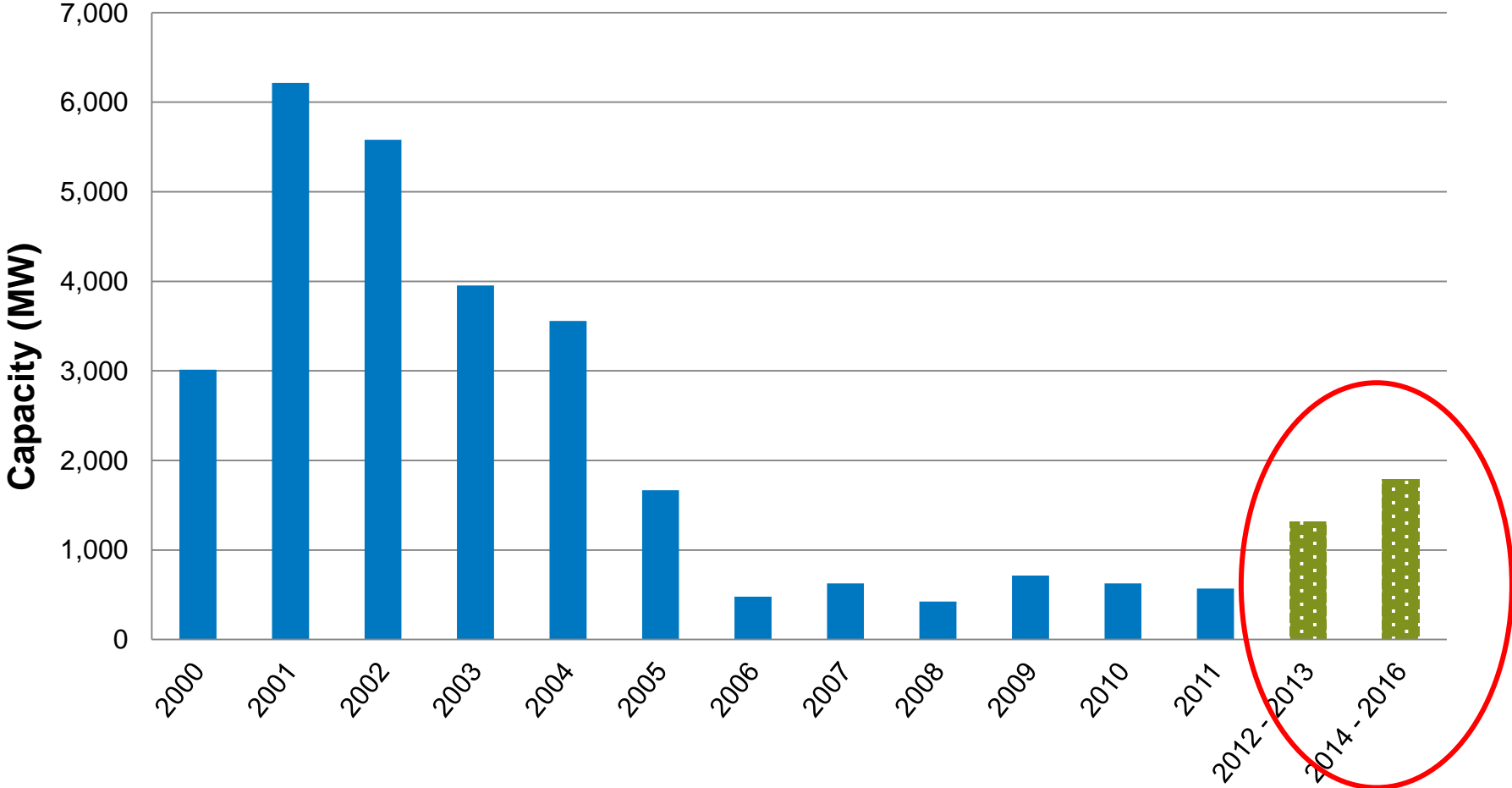


Source: ICF CHP Installation Database

Emerging Drivers for CHP

- Benefits of CHP recognized by Federal and State policymakers
 - *White House Executive Order: 40 GW by 2020*
 - *Increasing state interest (Ohio, Maryland, New Jersey, etc.)*
- Game changing outlook for natural gas supply and price in North America
- Opportunities created by environmental drivers
 - *ICI Boiler MACT*
 - *Pressures on utility coal and oil capacity*

Recent CHP Market Activity



Source: ICF CHP Installation Database

CHP Provides Energy Reliability and Resiliency Benefits

- Traditional backup generators do not always perform during emergencies, a system operating on a daily basis (CHP) is more reliable
- CHP provides continuous benefits to host facilities, rather than just during emergencies
- CHP systems kept running during Sandy:
 - South Oaks Hospital - Amityville, NY, 1.25 MW
 - The College of New Jersey - Ewing, NJ, 5.2 MW
 - Public Interest Data Center - New York, NY, 65 kW
 - Bergen County Wastewater Plant – Little Ferry, NJ
 - New York University – New York, NY
 - Sikorsky Aircraft Corporation – Stratford, CT



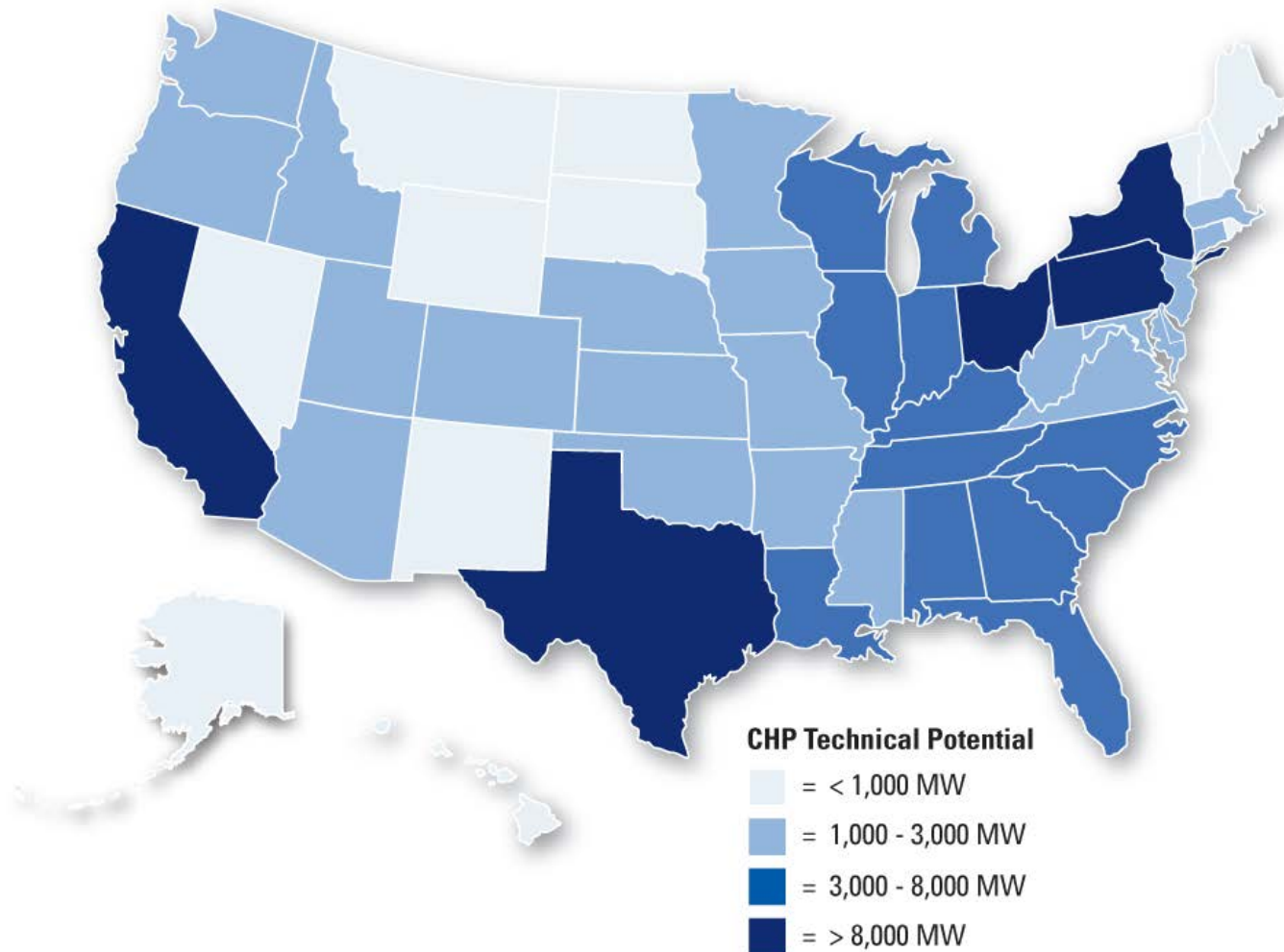
New Report on CHP in Critical Infrastructure

- **Combined Heat and Power: Enabling Resilient Energy Infrastructure for Critical Facilities**
- Provides context for CHP in critical infrastructure applications
- Contains 14 case studies of CHP operating through grid outages
- Policies promoting CHP in critical infrastructure
- Details how to design CHP for reliability

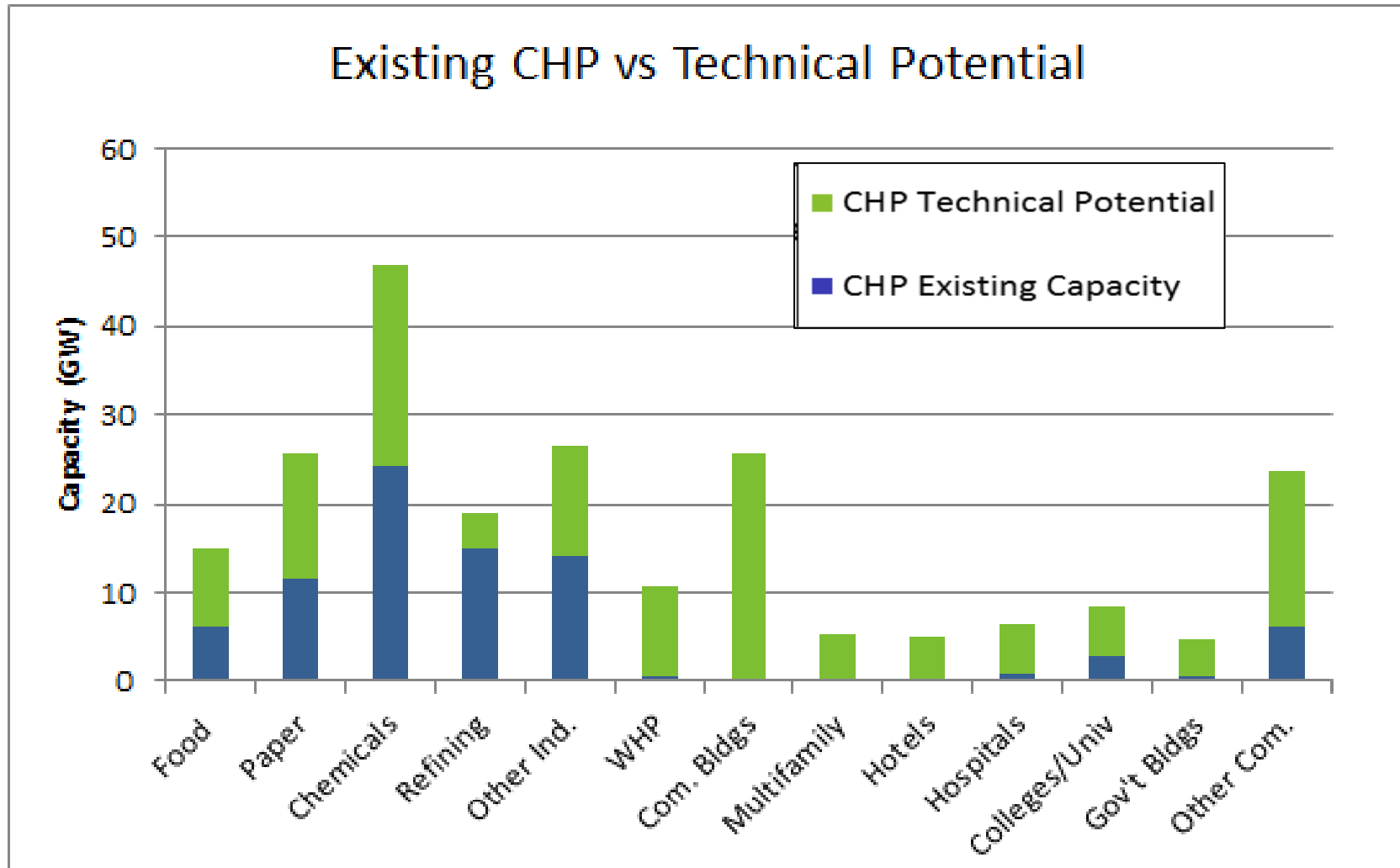
http://www.eere.energy.gov/manufacturing/distributedenergy/pdfs/chp_critical_facilities.pdf



The Potential for Additional CHP Is Nationwide



Where is the Remaining Potential for CHP



Source: ICF internal estimates

CHP Supports Industrial and National Goals

Benefits for U.S. Industry

- Reduces energy costs for the user
- Reduces risk of electric grid disruptions
- Provides stability in the face of uncertain electricity prices

Benefits for the Nation

- Provides an immediate path to increased energy efficiency and reduced GHG emissions
- Offers a low-cost approach to new electricity generation capacity and lessens need for new T&D infrastructure
- Uses abundant, domestic energy sources
- Uses American highly skilled local labor and technology

Questions?

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