CHP and Natural Gas for Resiliency and MACT Compliance

CIBO Annual Meeting

Joel Bluestein

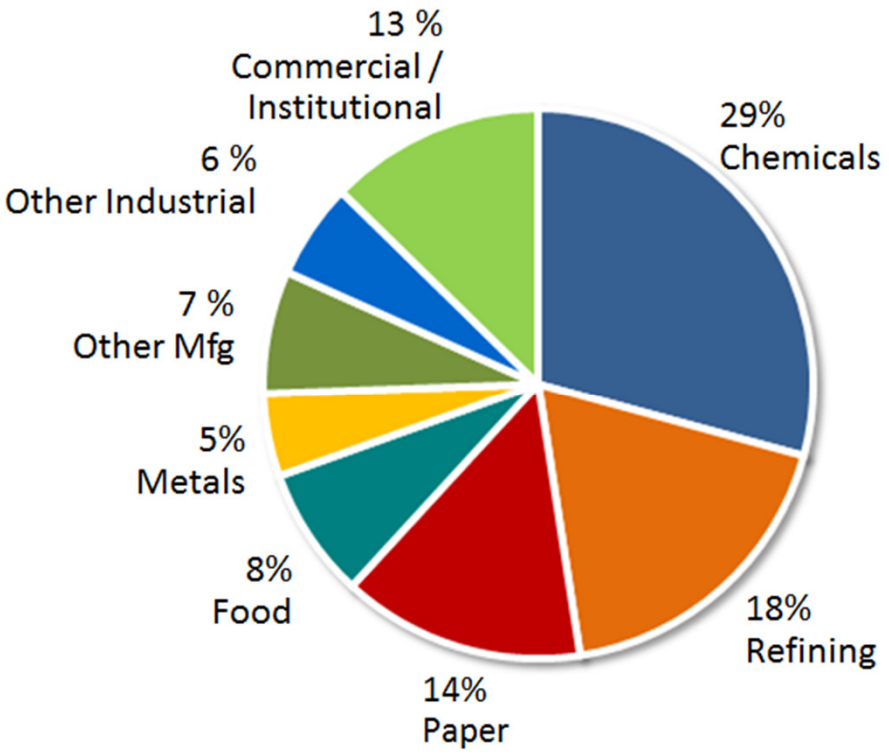
ICF International

October 17, 2013

ICF International

- Multi-sector consulting firm with a long-standing focus on energy and environment.
- Founded in 1969 – Over 40 years of experience.
- Diverse client base—73% U.S. federal, state, and local agencies; 22% U.S. commercial; and 5% Non-U.S.
- 2012 revenue of $937 million
- More than 4,500 employees
- Global presence with more than 60 offices, headquartered in the Washington, D.C., area
- Focus on gas and electricity markets, CHP/DG, energy and environmental policy, asset transactions, and litigation support.

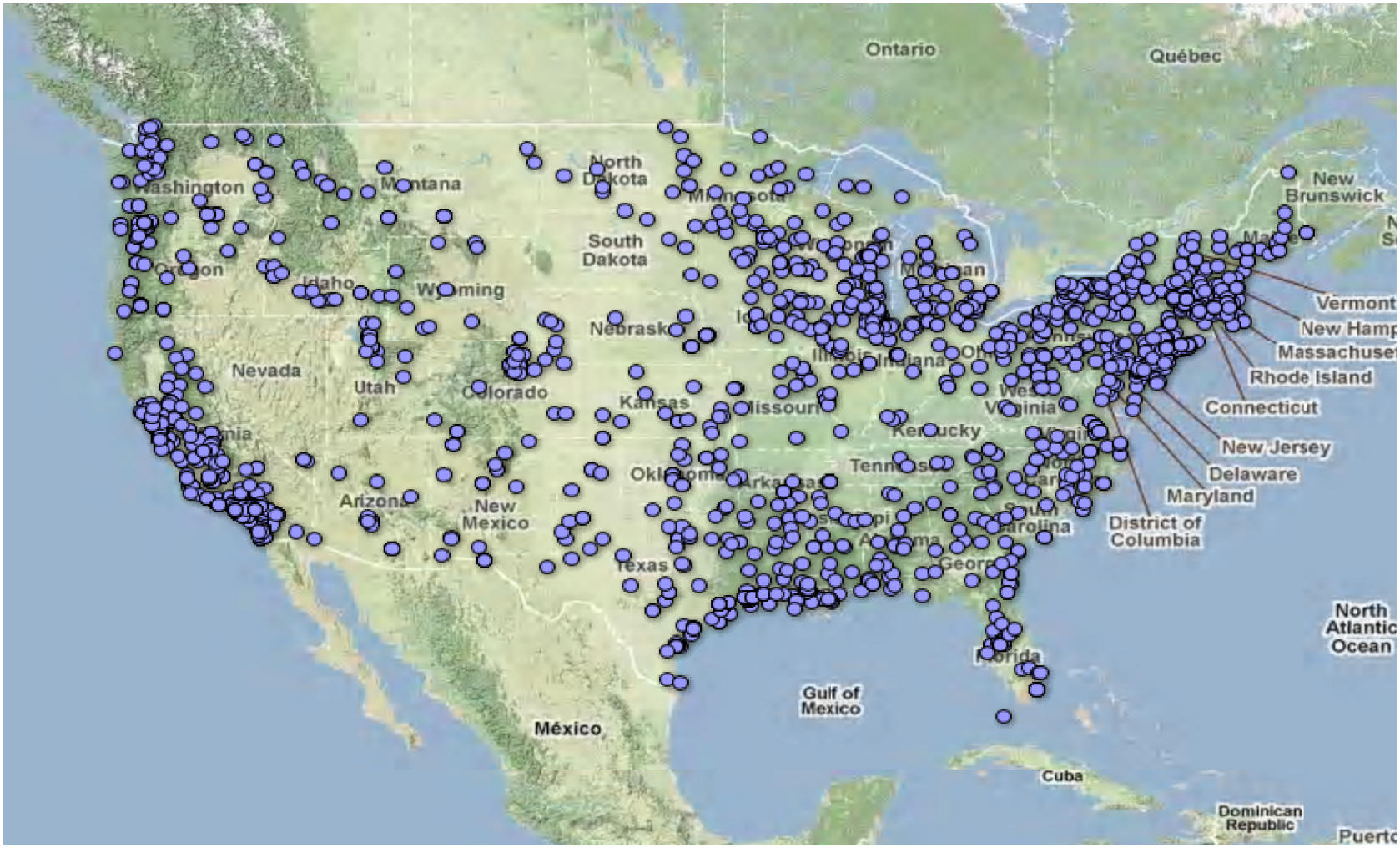
U.S. CHP Capacity Today



- **82.4 GW** of installed CHP over 4,200 industrial and commercial facilities (as of July 2013)
- 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 CO_2** compared to separate production

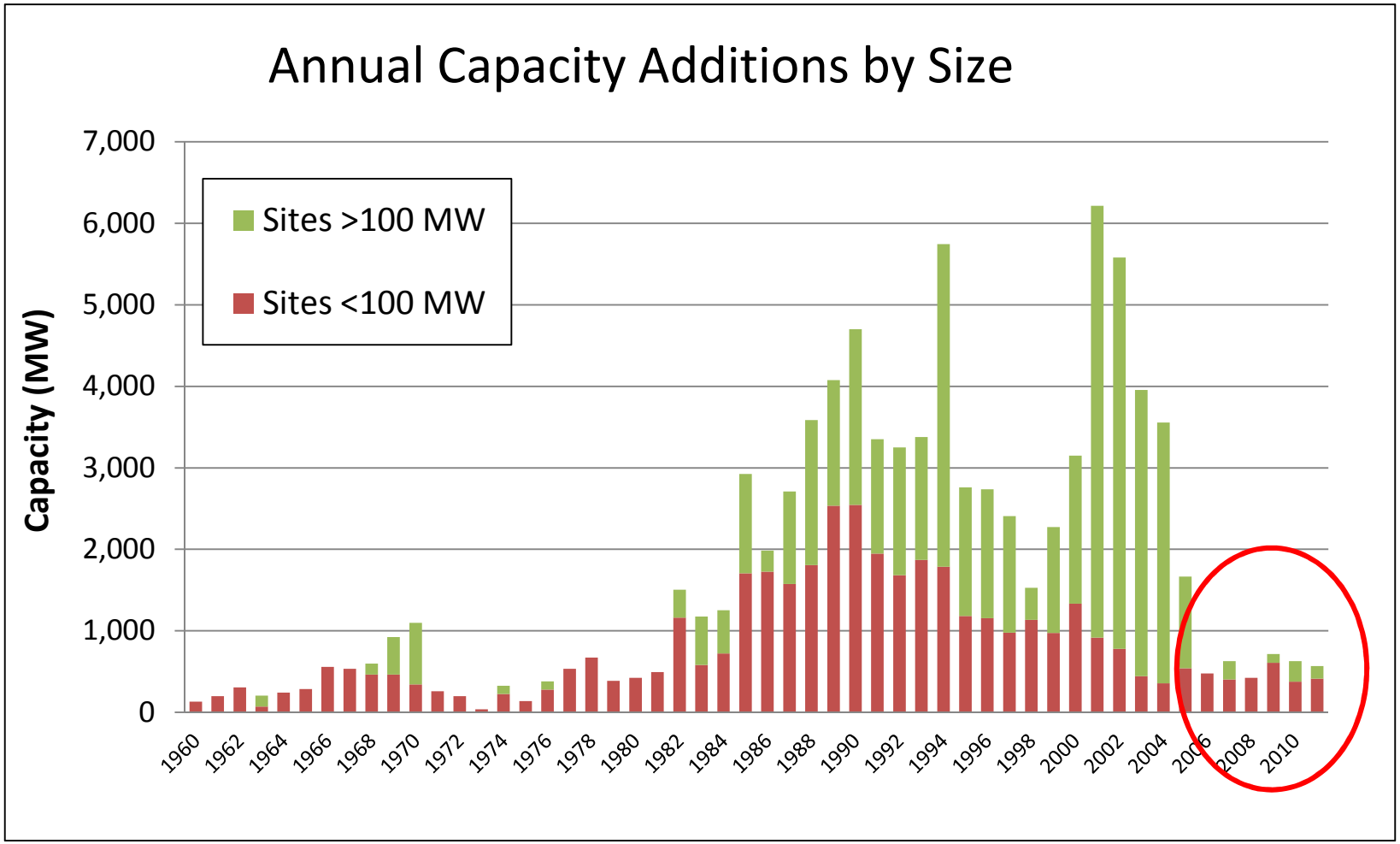
Source: ICF CHP Installation Database

CHP Is Widely Used



Source: ICF CHP Installation Database

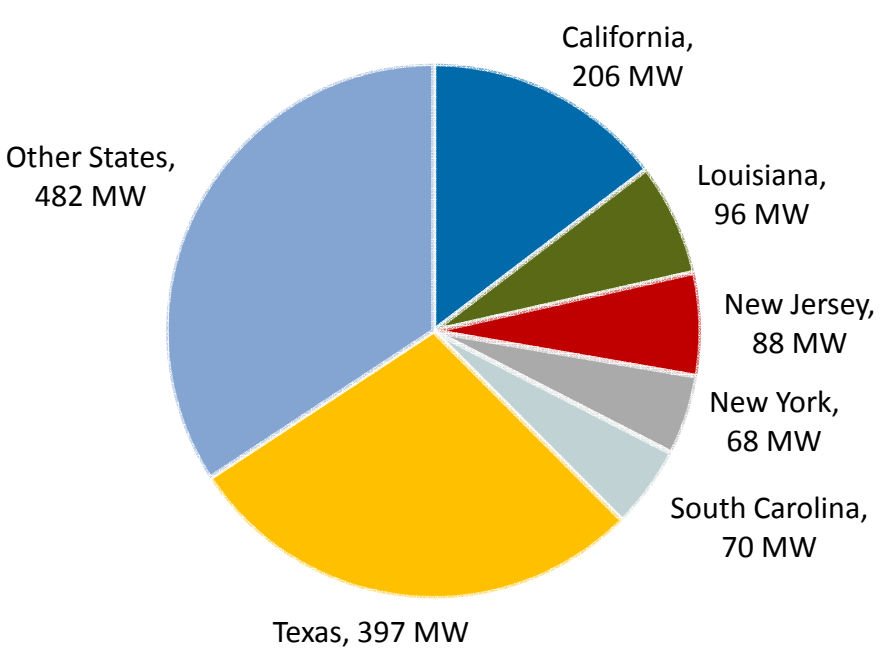
CHP Annual Additions since 1960



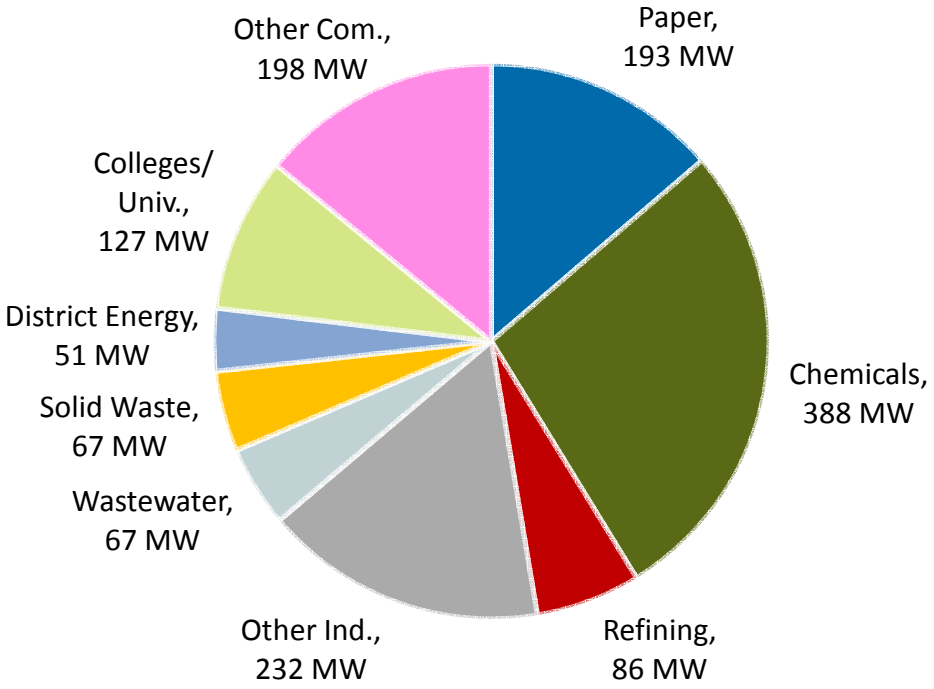
Source: ICF CHP Installation Database

CHP Additions 2011-2012 (1,407 MW)

By State



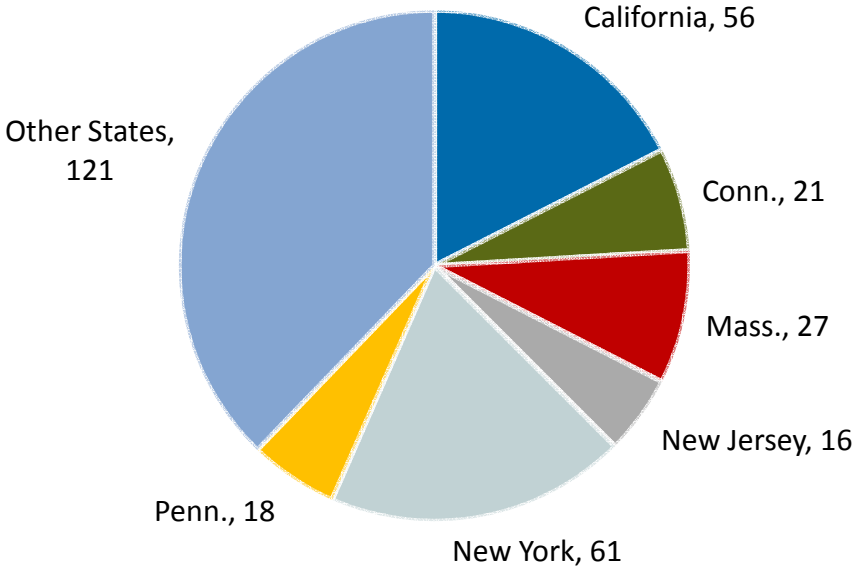
By Application



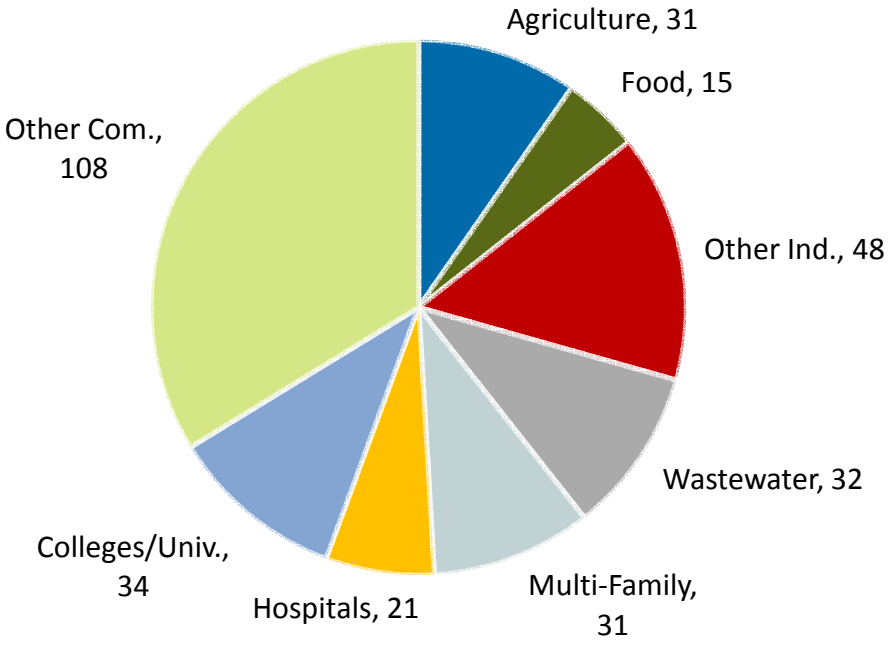
Source: ICF CHP Installation Database

CHP Additions 2011-2012 (320 Sites)

CHP Additions by State



CHP Additions by Application



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.)*
- Focus on energy reliability and resiliency
- Game changing outlook for natural gas supply and price in North America
  - *Returning industries (new chemical plant announcements)*
- Opportunities created by environmental drivers
  - *ICI Boiler MACT*
  - *Pressures on utility coal and oil capacity - NSPS*

Gas Supply is Abundant and Cost Effective

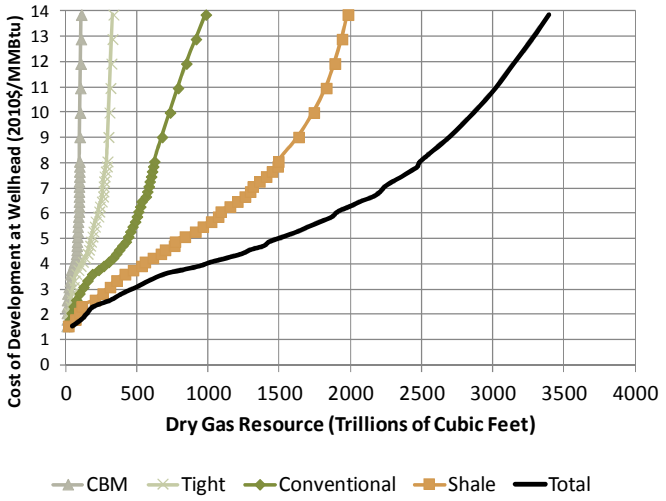
U.S. and Canada Natural Gas Resource Base

(Tcf of Economically Recoverable Resource, Assuming Current E&P Technologies)

	Proven Reserves	Unproved Plus Discovered Undeveloped	Total Remaining Resource	Shale Resource[2]
Alaska	9.4	153.6	163.0	0.0
West Coast Onshore	2.9	24.6	27.5	0.3
Rockies & Great Basin	81.8	388.3	470.1	37.9
West Texas	20.4	47.7	68.1	17.5
Gulf Coast Onshore	97.6	684.7	782.3	476.9
Mid-continent	65.3	205.0	270.3	133.9
Eastern Interior [3,4]	45.2	1,053.7	1,098.9	986.1
Gulf of Mexico	10.7	238.6	249.3	0.0
U.S. Atlantic Offshore	0.0	32.8	32.8	0.0
U.S. Pacific Offshore	0.8	31.7	32.5	0.0
WCSB	68.8	664.0	732.8	508.8
Arctic Canada	0.0	45.0	45.0	0.0
Eastern Canada Onshore	0.8	15.9	16.7	10.3
Eastern Canada Offshore	0.3	71.8	72.1	0.0
Western British Columbia	0.5	10.9	11.4	0.0
US Total	**334.1**	**2,860.6**	**3,194.7**	**1,652.5**
Canada Total	**70.4**	**807.6**	**878.0**	**519.1**
US and Canada Total	**404.5**	**3,668.1**	**4,072.6**	**2,171.6**

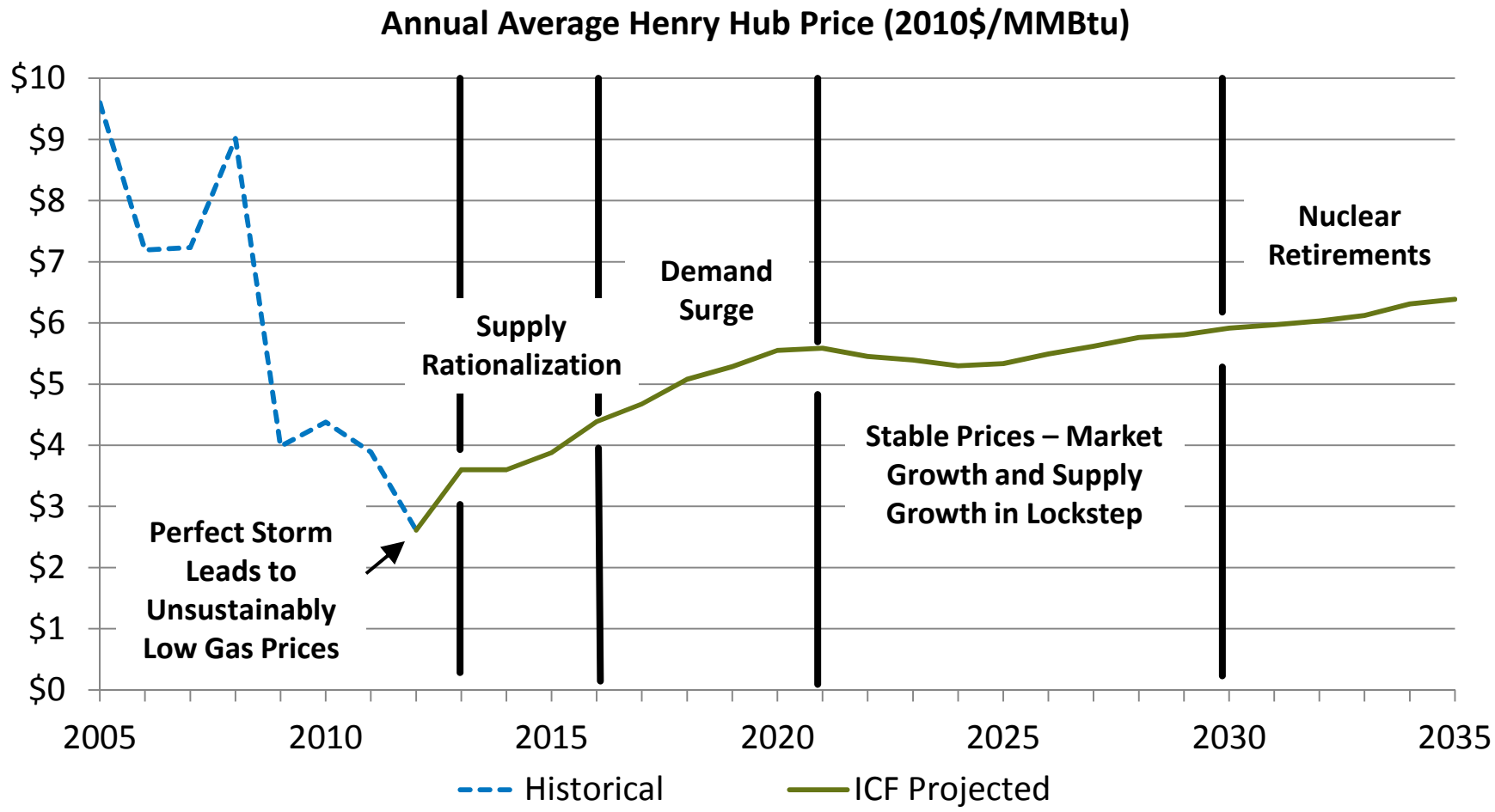
Source: U.S. Energy Information Administration based on data from various published studies. Canada and Mexico plays from ARI.
Updated: May 9, 2011

North American Gas Supply Curves

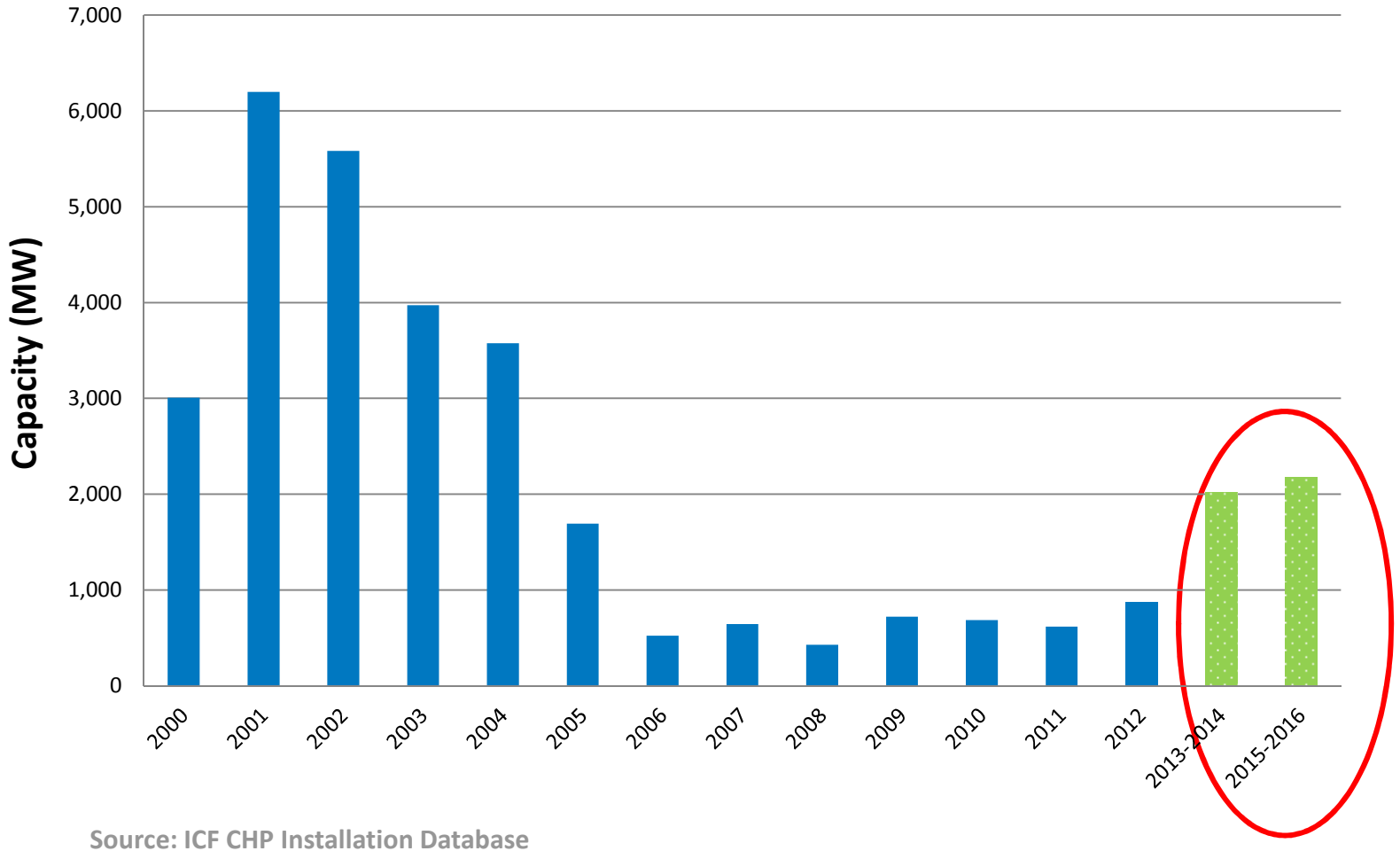


- **Over 4,000 Tcf of economically recoverable gas resource with current technologies – roughly 140 years of production at current consumption levels**
- **Roughly 1,500 Tcf recoverable at less than $5 per MMBtu – roughly 50 years of production at current consumption levels**

Gas Prices Remain Relatively Low in the Near Term, and Increase Moderately as the Market Grows



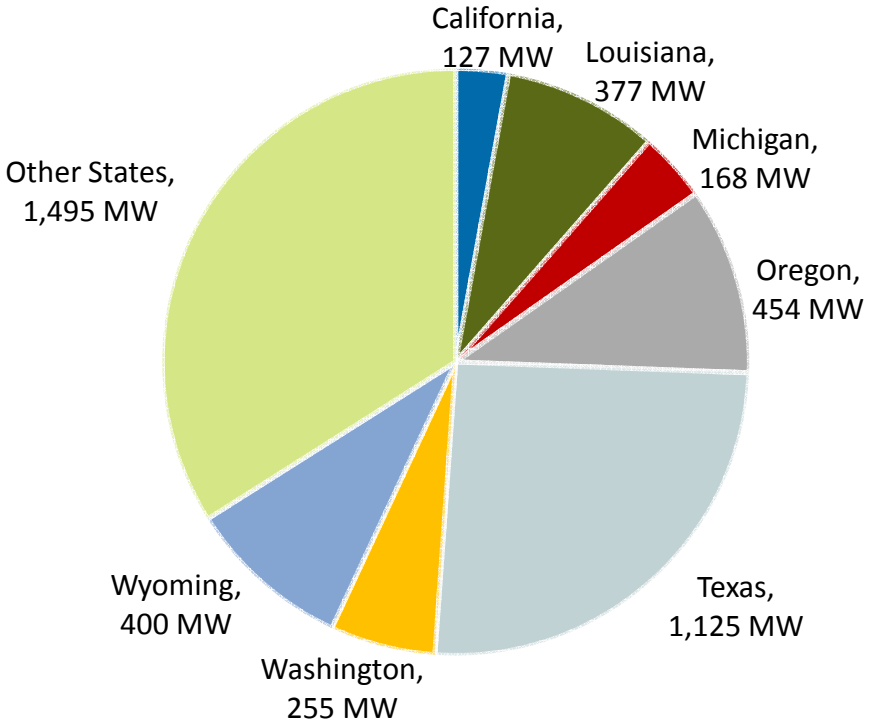
CHP Market Activity



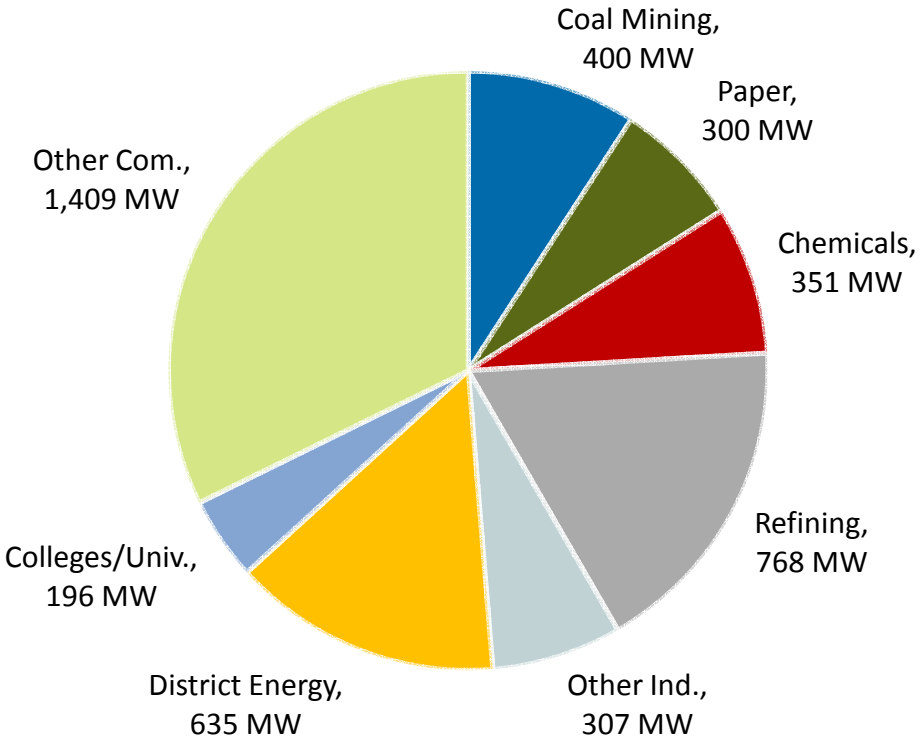
Source: ICF CHP Installation Database

CHP in Development or Under Construction (4,400 MW)

CHP by State

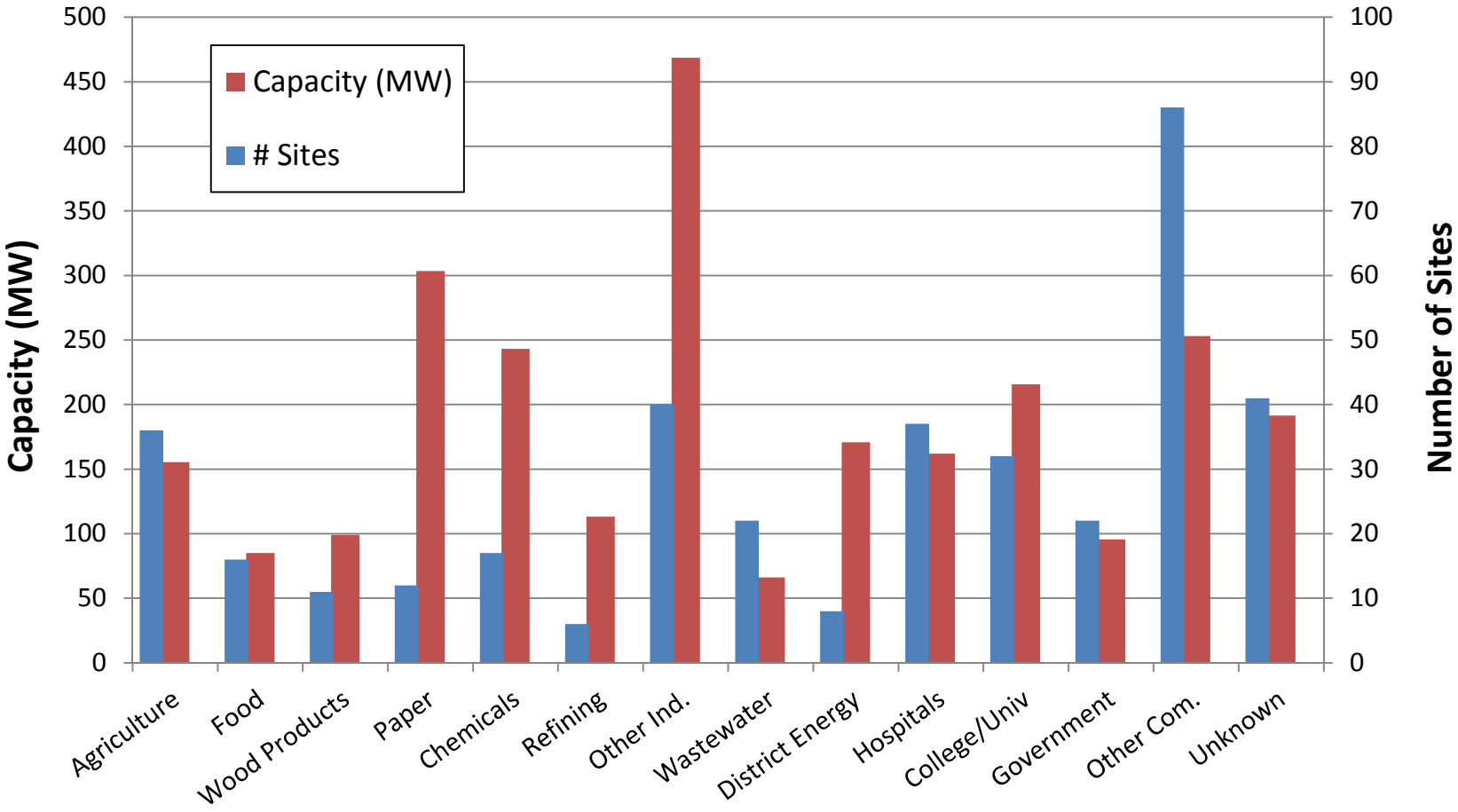


CHP by Application



Source: ICF CHP Installation Database

CHP in Development or Under Construction – <100 MW sites (386 sites, 2,622 MW)



*86 sites on Watch List with no capacity data

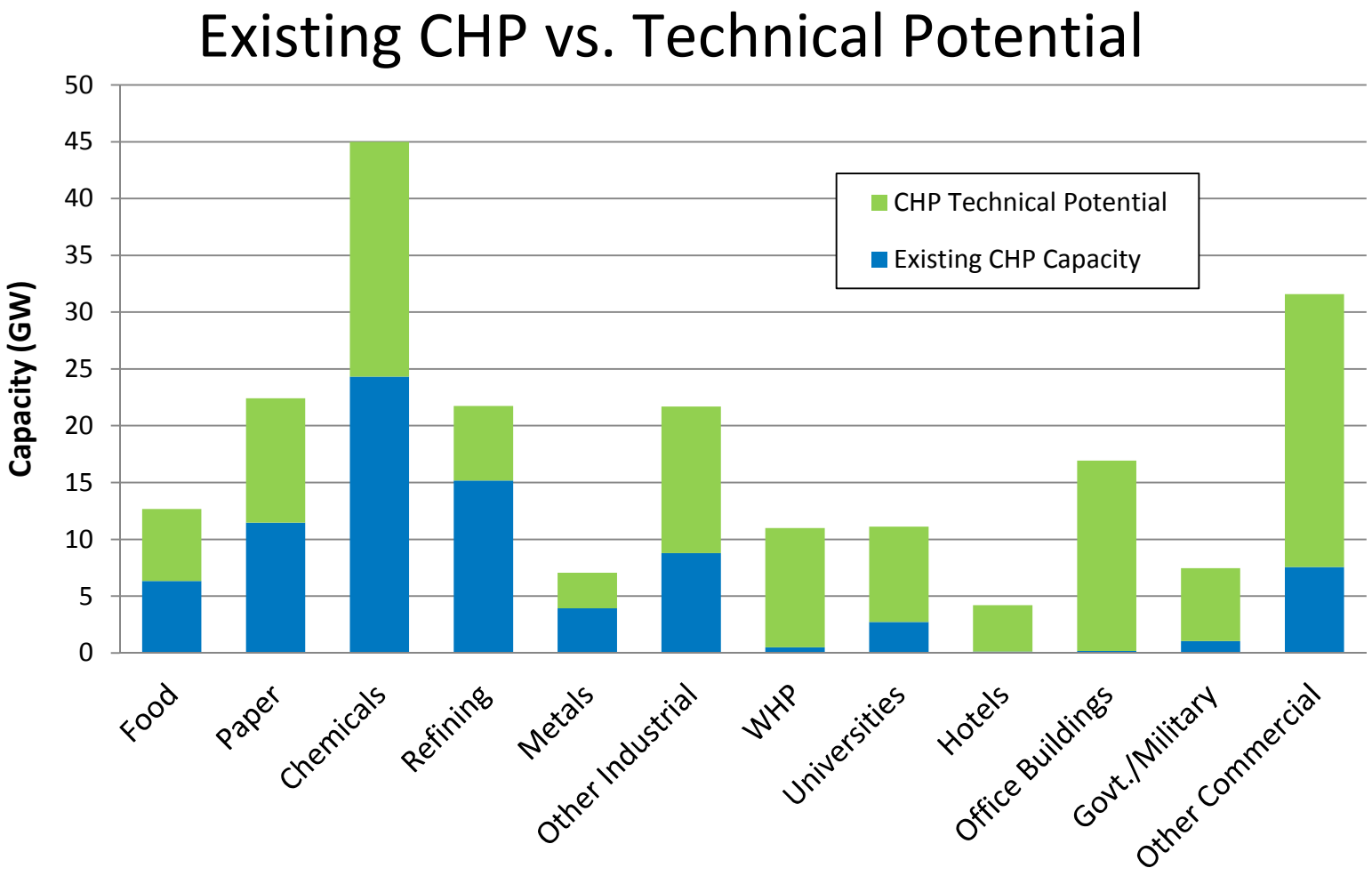
CHP Technical Potential

- Based on improvements in ICF potential site data and energy load estimates
  - Additional applications (military, natural gas processing)
  - Inclusion of weather factors on commercial sites

Application	50-500 kW (MW)	500 - 1 MW (MW)	1 - 5 MW (MW)	5 - 20 MW (MW)	>20 MW (MW)	Total MW
Industrial - Onsite Use	6,211	4,431	14,748	14,118	21,082	60,590
Commercial - Onsite Use	20,293	17,290	18,820	7,052	2,665	66,119
Total - Onsite Use	**26,504**	**21,721**	**33,567**	**21,170**	**23,747**	**126,709**
Incremental Export - Industrial Only	0	0	1,113	9,810	97,325	108,248
Total - Onsite and Export	**26,504**	**21,721**	**34,680**	**30,980**	**121,072**	**234,957**

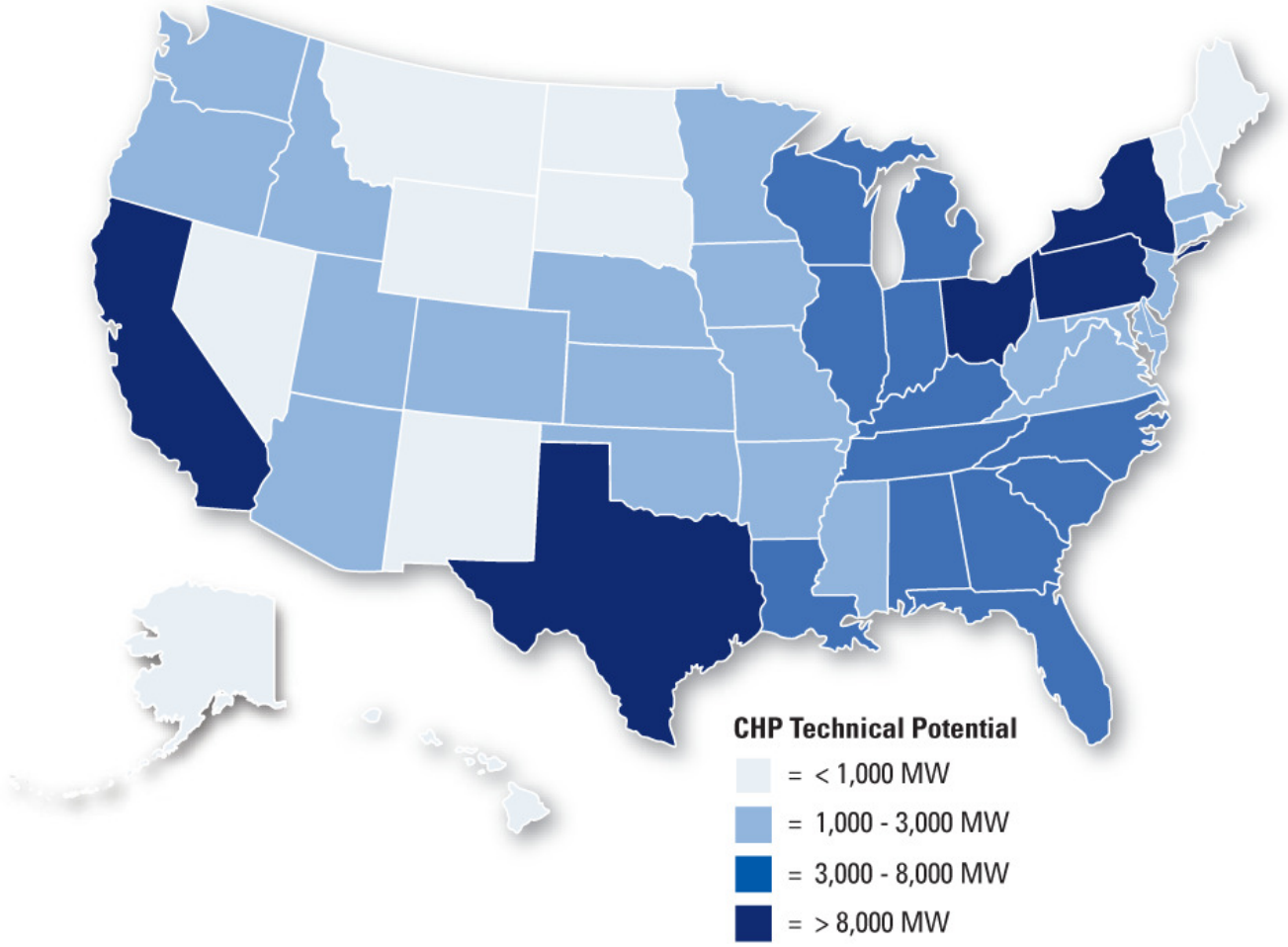
Source: ICF internal estimates

Where is the Remaining Potential for CHP?



Source: ICF internal estimates

The Potential for Additional CHP Is Nationwide



Source: ICF Internal Estimates

HAP Standards for Boilers and Incinerators

- On December 20, 2012, EPA finalized a specific set of adjustments to the March 2011 hazardous air pollutant standards for boilers and certain solid waste incinerators
  - Area Source Boiler Rule
  - Major Source Boiler Rule (ICI Boiler MACT)
  - Commercial and Industrial Solid Waste Incinerators MACT
- Address public health impacts of toxic air pollution, including mercury and other HAPs

CHP as a MACT Compliance Strategy

- Compliance with limits will be expensive for many coal and oil users
- May consider converting to natural gas
  - Conversion for most oil units?
  - Boiler replacements for coal units?
- May consider moving to natural gas CHP
  - Represents a productive investment
  - Potential for lower steam costs due to generating own power
  - Higher overall efficiency and reduced emissions
  - Higher capital costs, but partially offset by required compliance costs or new gas boiler costs
  - State / local / utility incentives can help

CHP as MACT Compliance

- Output-based compliance alternative can ease compliance with standard under CHP.
- Incremental cost for CHP may be low if alternative compliance cost is considered.
- Maximize overall efficiency if switching to gas.
- Operators may be able to better match facility power-to-heat profile.
- CHP may allow for additional compliance time with MACT.

MACT Affected Coal/Oil Boilers by Region

CEAC Region	# Coal Boilers	Coal Capacity (MMBtu/hr)	# Oil Boilers	Oil Capacity (MMBtu/hr)	Total Affected Boilers	Total Capacity (MMBtu/hr)
Gulf Coast	16	4,772.0	11	2,694.4	27	7,466.4
Intermountain	29	12,596.0	6	898.5	35	13,494.5
Mid-Atlantic	153	30,747.5	88	9,875.5	241	40,623.0
Midwest	360	84,197.1	122	15,311.3	482	99,508.4
Northeast	19	4,612.0	107	10,391.5	126	15,003.5
Northwest	23	3,238.0	23	5,066.7	46	8,304.7
Pacific	5	746.0	13	1,393.2	18	2,139.2
Southeast	186	39,710.1	164	16,981.4	350	56,691.5
Total	**791**	**180,618.7**	**534**	**62,612.5**	**1,325**	**243,231.1**

Data Source: DOE

ICI Boiler MACT - Potential CHP Capacity

Fuel Type	Number of Facilities	Number of Affected Units	Boiler Capacity (MMBtu/hr)	CHP Potential (MW)	CO_2 Emissions Savings (MMT)
Coal	351	791	180,619	18,064	114.3
Heavy Liquid	151	319	41,821	4,182	19.8
Light Liquid	215	215	20,791	2,080	9.9
Total	**717***	**1,325**	**243,231**	**24,326**	**144.0**

*Some facilities are listed in multiple categories due to multiple fuel types; there are 556 ICI affected facilities

- CHP potential based on average efficiency of affected boilers of 75%; Average annual load factor of 65%, and simple cycle gas turbine CHP performance (power to heat ratio = 0.7)
- GHG emissions savings based on 8000 operating hours for coal and 6000 hours for oil, with a CHP electric efficiency of 32%, and displacing average fossil fuel central station generation

Data Source: DOE

DOE Boiler MACT Technical Assistance

- DOE is providing site-specific technical and cost information on clean energy compliance strategies to those major source facilities affected by the Boiler MACT rule currently burning coal or oil.
  - These facilities may have opportunities to develop compliance strategies, such as CHP, that are cleaner, more energy efficient, and that can have a positive economic return for the plant over time

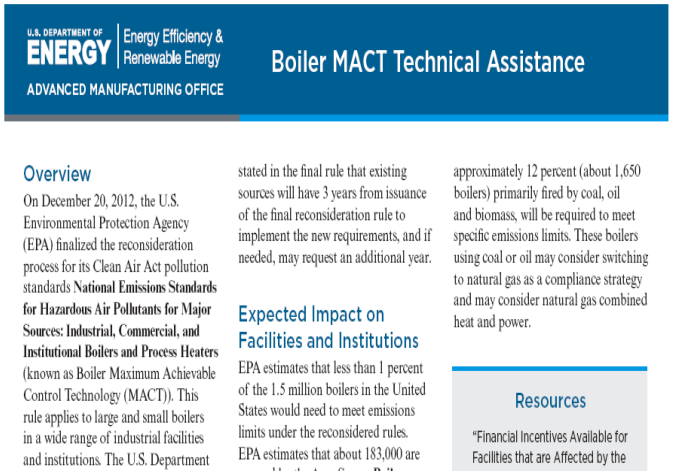
- DOE Boiler MACT Technical Assistance program was piloted in Ohio starting in Feb. 2012 and is being offered nationally

John Cuttica
cuttica@uic.edu

Beka Kosanovic
kosanovi@ecs.umass.edu

Jim Freihaut
jdf11@psu.edu

Isaac Panzarella
ipanzarella@southeastcleanenergy.org



U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy
ADVANCED MANUFACTURING OFFICE

Boiler MACT Technical Assistance

Overview

On December 20, 2012, the U.S. Environmental Protection Agency (EPA) finalized the reconsideration process for its Clean Air Act pollution standards **National Emissions Standards for Hazardous Air Pollutants for Major Sources: Industrial, Commercial, and Institutional Boilers and Process Heaters** (known as Boiler Maximum Achievable Control Technology (MACT)). This rule applies to large and small boilers in a wide range of industrial facilities and institutions. The U.S. Department stated in the final rule that existing sources will have 3 years from issuance of the final reconsideration rule to implement the new requirements, and if needed, may request an additional year.

Expected Impact on Facilities and Institutions

EPA estimates that less than 1 percent of the 1.5 million boilers in the United States would need to meet emissions limits under the reconsidered rules. EPA estimates that about 183,000 are approximately 12 percent (about 1,650 boilers) primarily fired by coal, oil and biomass, will be required to meet specific emissions limits. These boilers using coal or oil may consider switching to natural gas as a compliance strategy and may consider natural gas combined heat and power.

Resources

"Financial Incentives Available for Facilities that are Affected by the

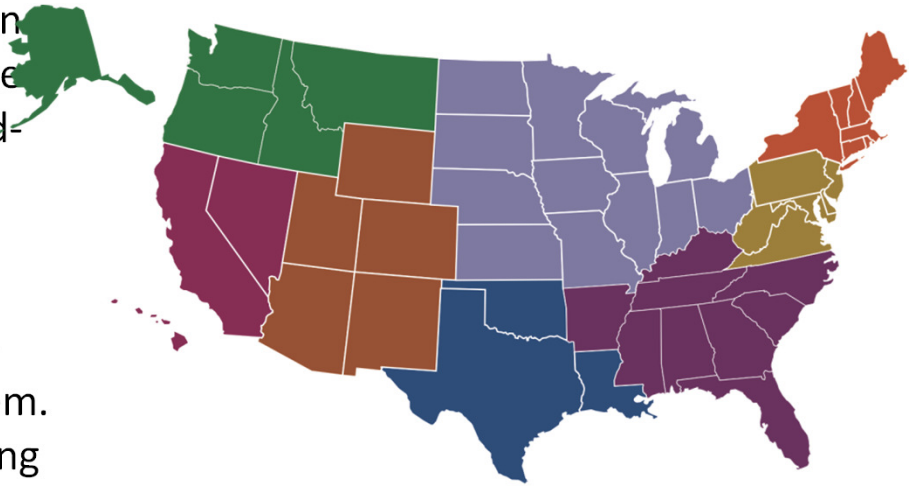
Regional Clean Energy Application Centers (CEACs)

CEAC Services:

- **Market Assessments:** Analyses of CHP market potential in diverse sectors, such as health care, industrial sites, hotels, & new commercial and institutional buildings.
- **Education and Outreach:** Providing information on the benefits and applications of CHP to state and local policy makers, regulators, energy end-users, trade associations and others.
- **Technical Assistance:** Providing technical information to energy end-users and others to help them consider if CHP makes sense for them. Includes performing site assessments, producing project feasibility studies, and providing technical and financial analyses.

FY13 FOA closed 3/8/13 for next generation CEACs – CHP Technical Assistance Partnerships (CHP TAPs)

Eight Regional CEACs & International District Energy Association



http://www1.eere.energy.gov/manufacturing/distributedenergy/ceacs.html

National Technical Assistance

- Preliminary Findings Reported (as of September 10, 2013):
  - Over 482 companies contacted
  - 197 feel they are already in compliance
  - 67 no longer in business
  - Technical Assistance for 61 in various stages (discussions underway or analyses considering CHP)
  - All companies are now aware of how CHP can assist in a compliance strategy
  - DOE will continue to track results of results of technical assistance

The Guide provides state policy makers with actionable information regarding:

- Design of standby rates
- Interconnection standards for CHP with no electricity export
- Excess power sales
- Clean energy portfolio standards
- Emerging market opportunities: CHP in critical infrastructure and utility participation in CHP markets

In development: State workshops w/ PUCs on the Guide & how to refine policy implementation to achieve greater CHP.

Guide to the Successful Implementation of State Combined Heat and Power Policies

Industrial Energy Efficiency and Combined Heat and Power Working Group

Driving Ratepayer-Funded Efficiency through Regulatory Policies Working Group

March 2013

The State and Local Energy Efficiency Action Network is a state and local effort facilitated by the federal government that helps states, utilities, and other local stakeholders take energy efficiency to scale and achieve all cost-effective energy efficiency by 2020.

Learn more at www.seeaction.energy.gov

New Interest in Resiliency Incentives

- CHP increasingly recognized as an important tool to support critical infrastructure, emergency preparedness and provide for business continuity
- Appropriately designed, configured and operated CHP can offer significant social benefits, but with added costs to the site
- Policymakers are responding with a new commitment to CHP that recognizes the societal value of high reliability for important services

Why CHP for Business Continuity and Resiliency?

- CHP is a proven and effective energy option for facilities/buildings that can enhance electric reliability and provide for energy services before, during, and after an emergency situation.

- CHP provides users with financial benefits through energy savings **every day** rather than only during a grid outage, as with a standby generator.

- CHP is more reliable than a standby generator because it is typically better maintained and continuously operated.

CHP Design for Reliability

- Estimates of costs to U.S. industries due to electric network reliability problems range from $40 billion to over $150 billion per year
- CHP systems designed for reliability will incur additional costs on the order of 10% of installation costs ($45 - $170/kW depending on complexity of system)
- These additional costs however provide important reliability benefits to the site, and to the community at large

Requirements for Uninterrupted Operation

- **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 the grid power signal
- **Ample carrying capacity**
  - System size must match critical loads
- **Parallel utility interconnection and switchgear controls**
  - The system must be able to disconnect from the grid, support critical loads, and reconnect after an event

CHP versus Backup Generation

	Backup Generator	CHP
System Performance	• Only used during emergencies	• Designed and maintained to run continuously • Improved performance reliability
Fuel Supply	• Limited by on-site storage	• Natural gas infrastructure typically not impacted by severe weather
Transition from Grid Power	• Lag time may impact critical system performance	• May be configured for “flicker-free” transfer from grid connection to “island mode”
Energy Supply	• Electricity	• Electricity • Thermal (heating, cooling, hot/chilled water)
Emissions	• Commonly burn diesel fuel	• Typically natural gas fueled • Achieve greater system efficiencies (up to 80%) • Lower emissions

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:
  - Sikorsky Aircraft Corporation – Stratford, CT
  - 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

CHP Kept Critical Facilities Running During Sandy

Application	# Sites	Capacity (MW)
Hospitals	7	19.31
Universities	6	84.5
Multi-family	6	44.5
District Energy	3	79.9
Data Center	1	0.065
Assisted Living	1	0.075
Manufacturing	1	10.7
WWTP	1	2.8
Government	1	19.3
Total	27	268.6

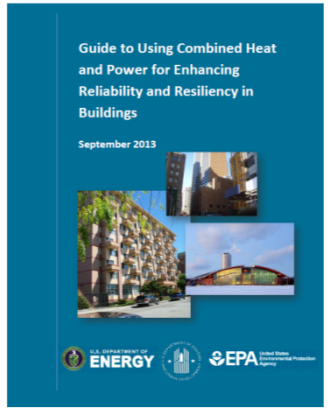
Additional Information

- **Combined Heat and Power: Enabling Resilient Energy Infrastructure for Critical Facilities (March 2013)**

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

- **Guide to Using Combined Heat and Power for Enhancing Reliability and Resiliency in Buildings (September 2013)**

http://www1.eere.energy.gov/manufacturing/distributedenergy/pdfs/chp_for_reliability_guidance.pdf



Conclusions

- CHP is a commercially available technology with demonstrated economic and environmental benefits.
- It is widespread and growing, driven by:
  - New industrial growth
  - Stable natural gas supply and prices
  - Increasing value of energy reliability
  - Federal and State policy support.
- CHP can assist boiler owners in cost-effective MACT compliance and improved reliability/resiliency.

Questions?

Joel Bluestein
703-934-3381
Joel.Bluestein@icfi.com