Clean Energy Application Center Mission and Resources

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Tom Bourgeois

Northeast Clean Energy Application Center

NYSERDA's CHP Conference

CHP in New York State: The Next Generation

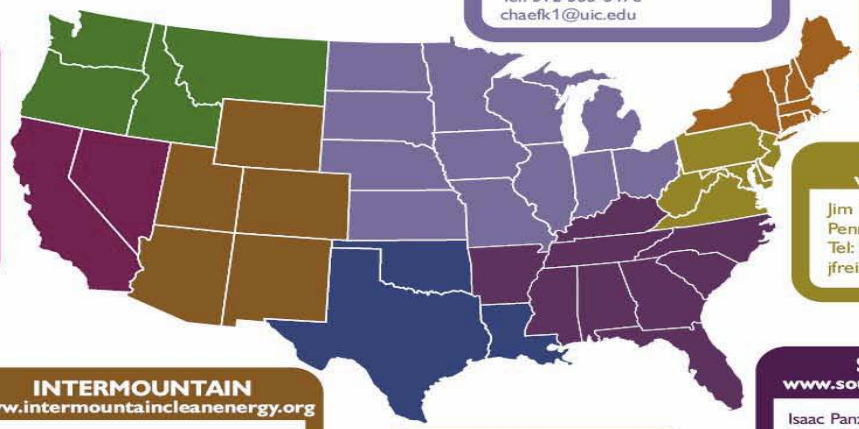
NYU Kimmel Center for University Life

New York, NY

June 20-22, 2012

Clean Energy Application Centers

DOE Clean Energy Application Centers: Locations, Contacts, and Web Sites



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CHP Is Used at the Point of Demand

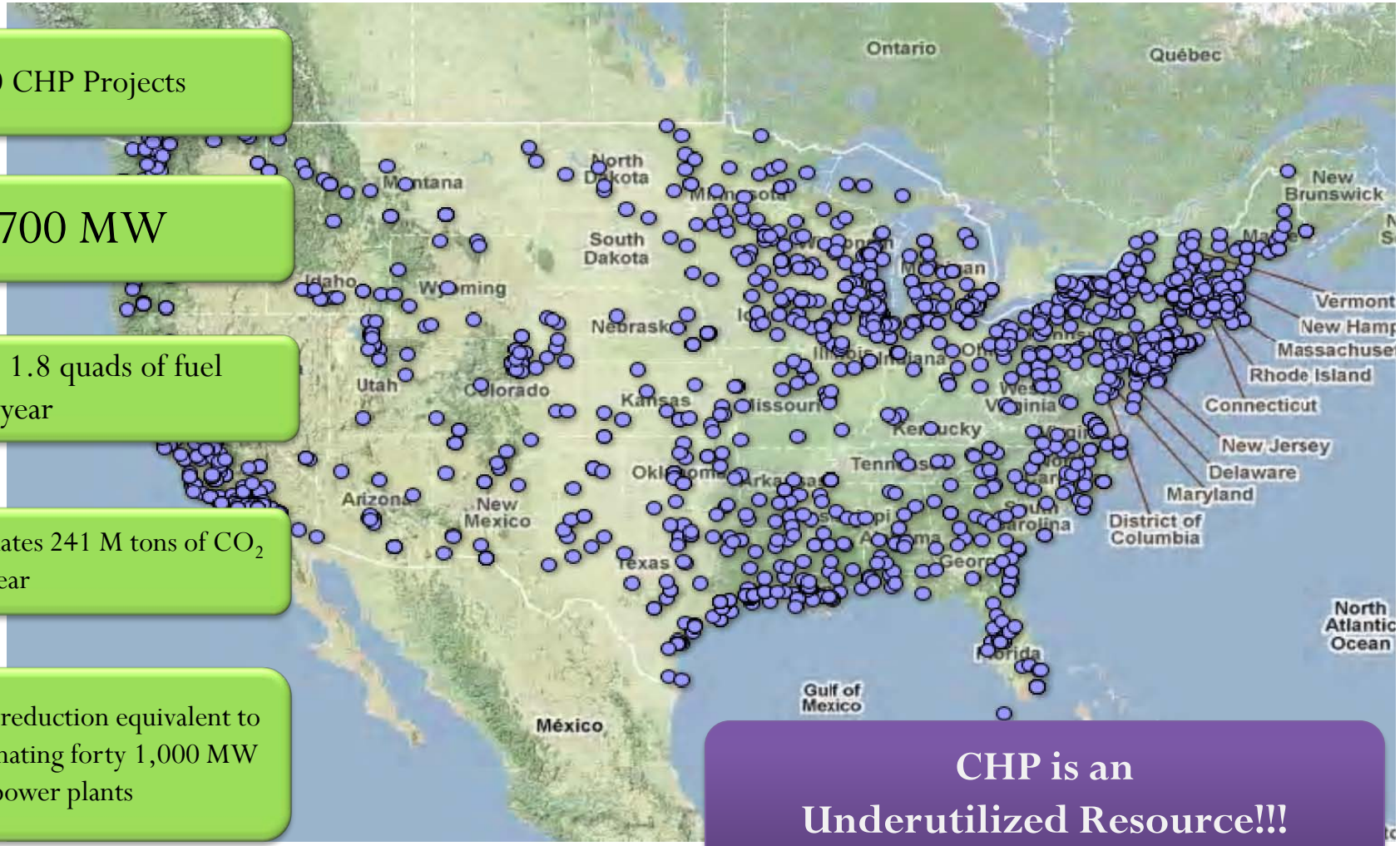
3,600 CHP Projects

81,700 MW

Saves 1.8 quads of fuel each year

Eliminates 241 M tons of CO_2 each year

CO2 reduction equivalent to eliminating forty 1,000 MW coal power plants

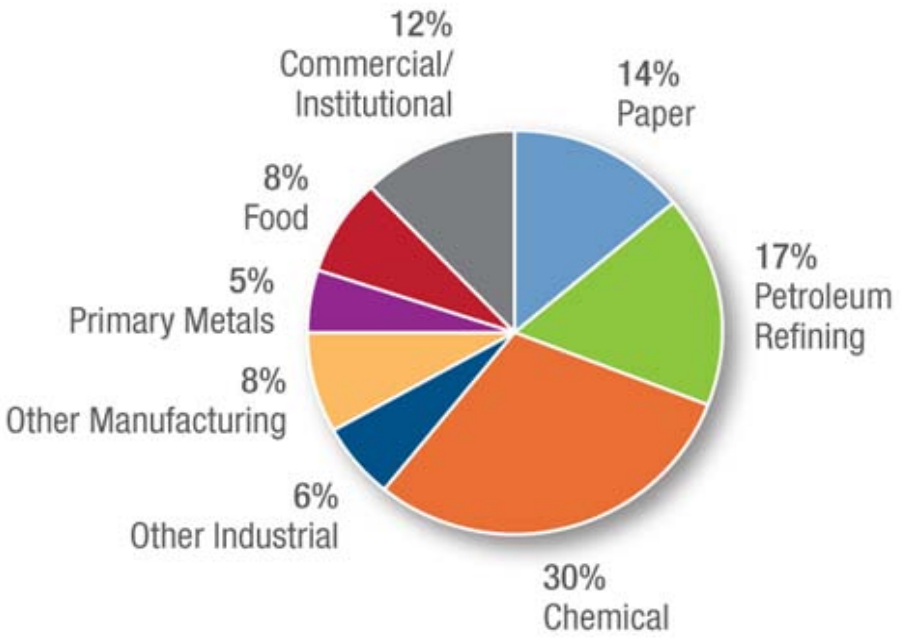


CHP is an Underutilized Resource!!!

Source: ICF International

Existing CHP Capacity

- ~ 8% US generating capacity
- ~ 12% total annual MWh generated
- Industrial applications represent 88% of existing capacity
- Commercial/institutional applications represent 12% of existing capacity:
  - Hospitals, Schools, University Campuses, Hotels, Nursing Homes, Office Buildings, Apartment Complexes, Data Centers, Fitness Centers



Source: ICF International

CEAC Mission and Focus

- **CEAC Mission: Develop technology application knowledge and the educational infrastructure necessary to promote "clean energy" technologies as viable energy options and reduce any perceived risks associated with their implementation.**

CEAC Focus: Assist in transforming the market for CHP, WHR, and DE technologies and concepts throughout the United States by providing:

- Market Analysis & Evaluation
- Education & Outreach
- Technical Assistance

Plans for 2012

- Technical Outreach
  - Continue CHP Technical Assessments across Northeast Region
  - Implementation support (contact past clients to see if it would be possible to support implementation of CHP project)
- Foster innovative new initiatives with utilities promoting incentives for "Strategically Sited CHP"
- State outreach across the Northeast, including;
  - NY – Con Edison CHP for targeted DSM zones in NYC
  - MA – Financing mechanisms for health care CHP projects
  - CT – Leveraging new incentives to promote CHP and assess opportunities for multi-building CHP, promoting "Big Projects / Big Results"

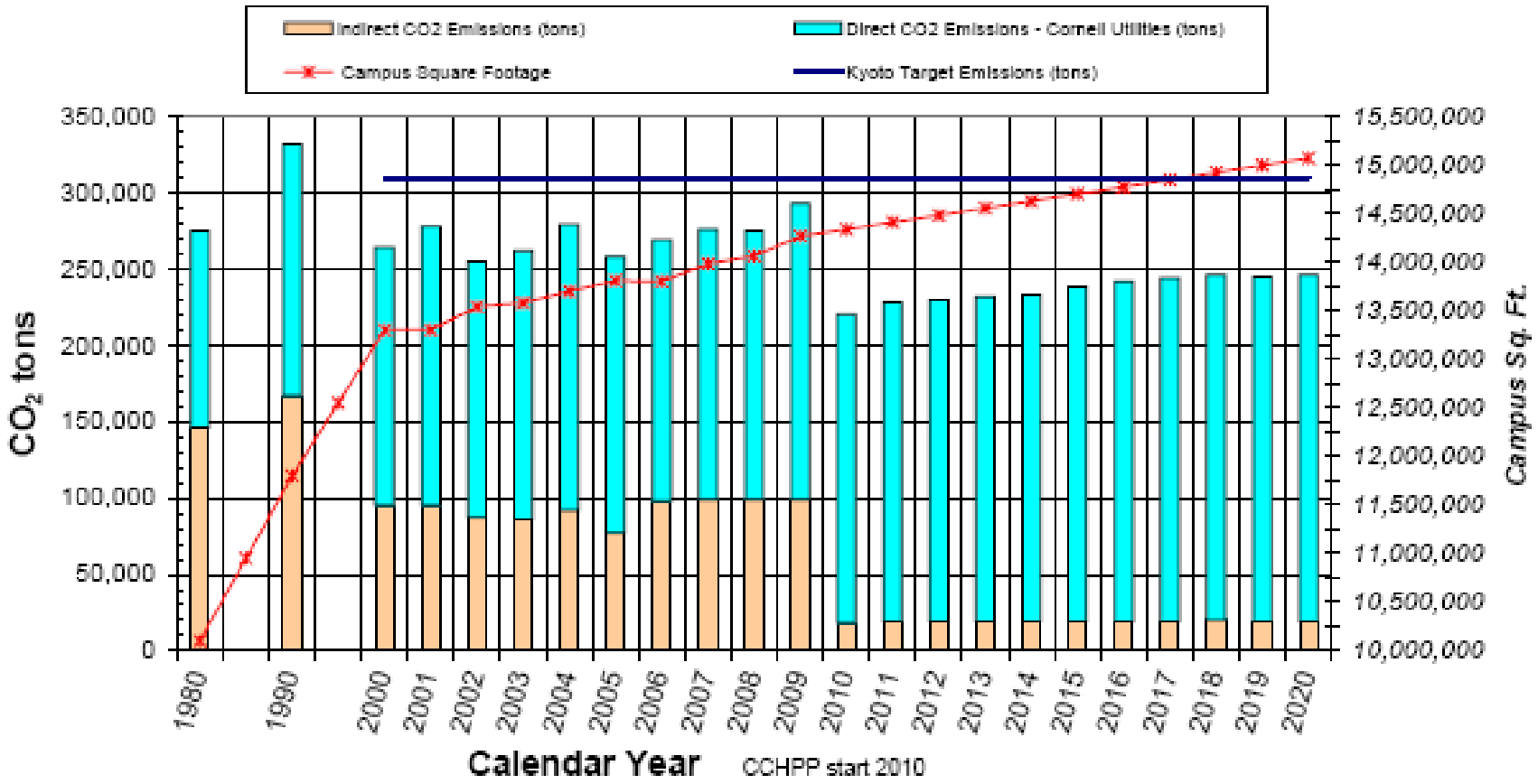
Focusing on Results

- Close collaboration with key market participants:
  - New York City Mayor's Office & NYC DEP Energy office on workshops to promote the 800 MW CHP goal in NY, meetings & work groups in progress since March 9 2012
  - Con Edison technical workshop on CHP in NYC
  - **Non-Wires Alternatives** Principles and potential Pilot with National Grid, Ongoing
  - A **"Solutions Summit"** in CT aimed at facilitating large scale, multi-building CHP

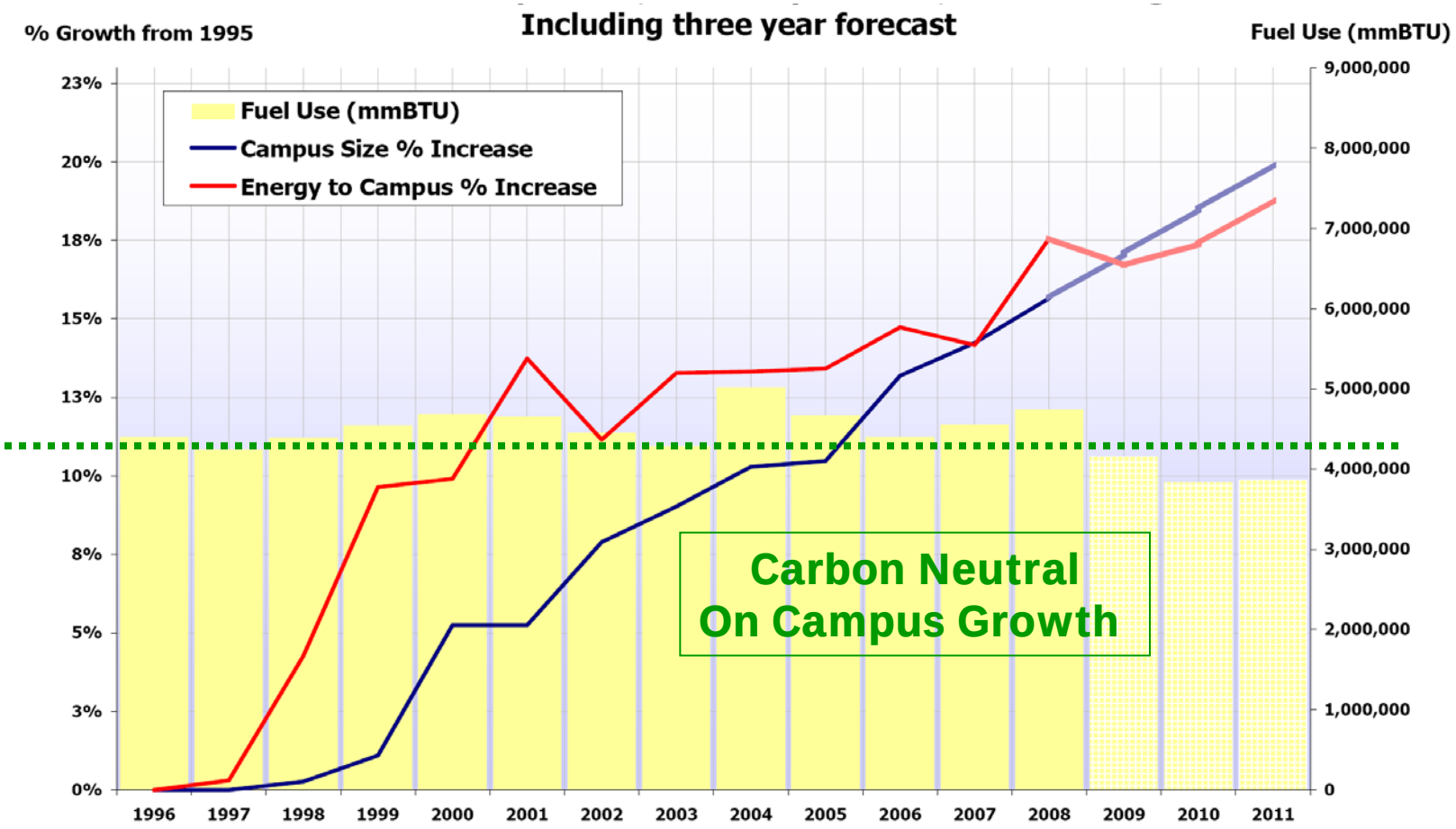
CHP as a Clean Energy Investment

- CHP represents a proven, economical and effective strategy for meeting environmental performance objectives:
  - For institutions that have signed the American College & University Presidents' Climate Commitment
  - For commercial, institutional business & municipalities with sustainability plans
  - For State greenhouse gas reduction goals

Cornell University
CO_2 Emissions since 1980



University of Texas - Austin
Campus Growth vs. Gas Consumption



A Continued Commitment to CHP

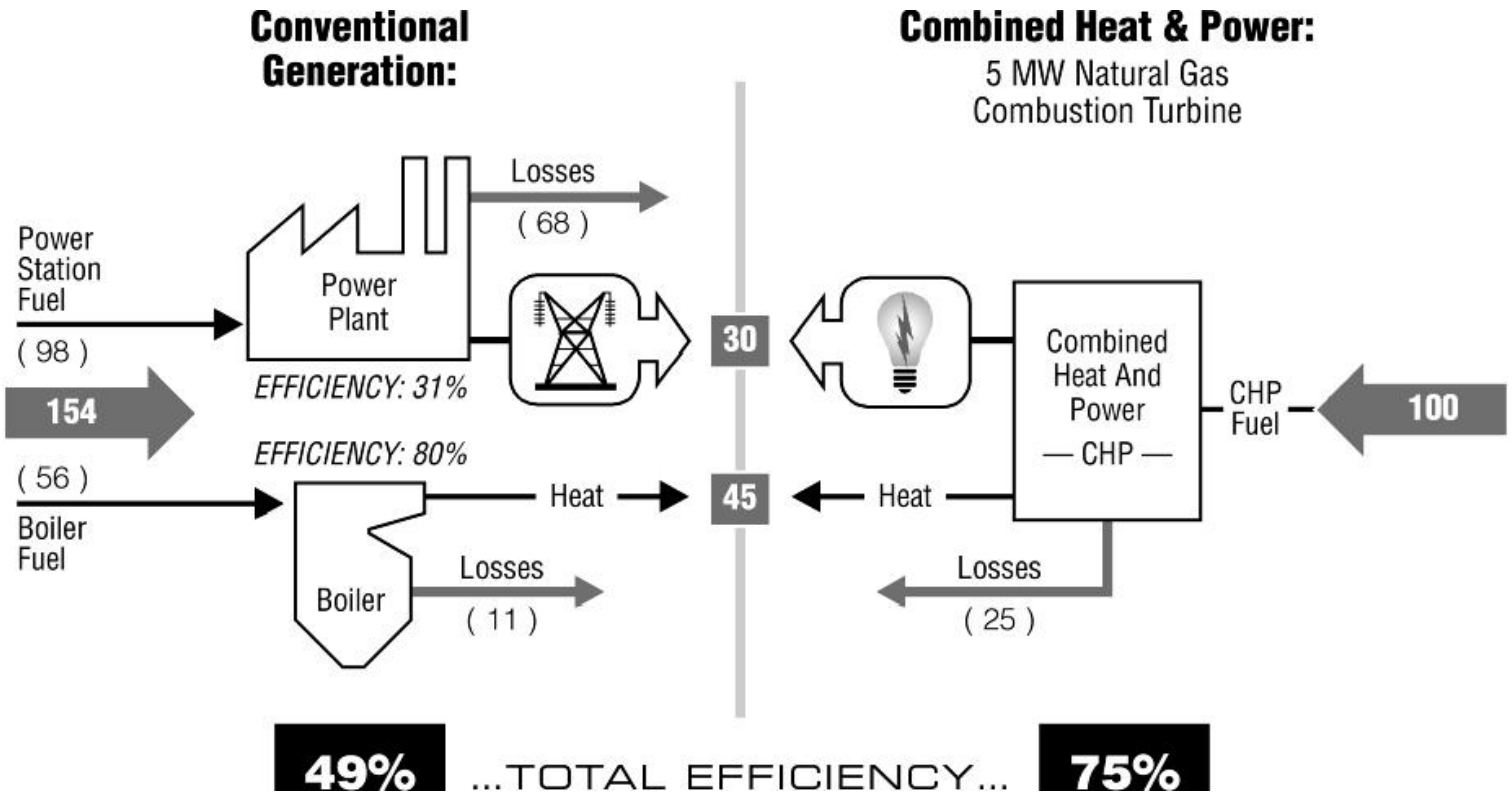
With our partners at NYSERDA and MA DOER, and key market participants in CT, ME, MA, NH, NY, RI, and VT:

- Foster a market environment to capture the economic, productivity enhancing, job creating & environmental benefits of CHP
- Assist in design/development execution of high quality CHP projects

NE-CEAC Services

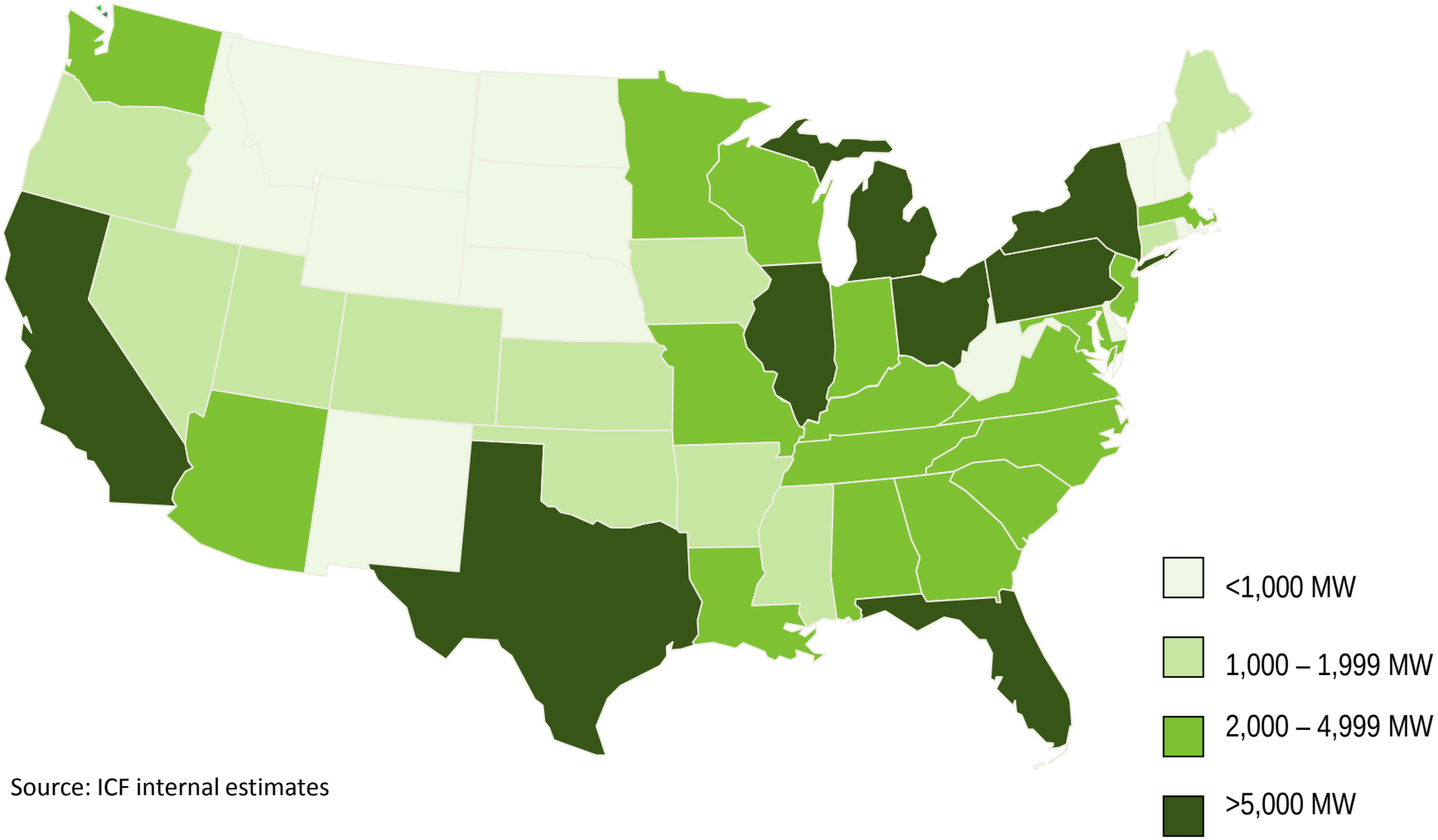
Market Assessments	Education and Outreach	Technical Assistance
Supporting analyses of CHP market potential in diverse sectors, such as health care, industrial sites, hotels, and new commercial and institutional buildings.	Providing information on the benefits and applications of CHP to state and local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

Efficiency Advantages of CHP



Source: Bruce Hedman, ICF Consulting - May 2007

CHP Onsite Technical Potential



Source: ICF internal estimates

CHP Trends in NY & New England: A Growing Market

- **NY ranked 2nd (CT and MA ranked 3rd and 4th) for CHP additions 2007 – 2011[1]**
- **CT, MA, RI and NY ranked 2,3,4 and 6 nationally for new CHP installations, normalized for number of economic establishments in the state**

Number of installations between (2006 – 2010) taken from ICF/CHP database. Number of business establishments (2006 – 2010) taken from the U.S. Bureau of Labor Statistics. Top 10 normalized by # of business establishments: AK, CT, MA, RI, ND, NY, SD, WI, NH, PA.

1. Source ICF/CHP database

Top 4 States for new CHP Installations: 2007-2011

New CHP Installations (#) (2007 - 2011)	
State	Installations
CA	95
NY	92
CT	64
MA	44

New CHP installations for remaining Northeast states:

- New Hampshire – 6 installations (Rank #16)
- Rhode Island – 4 installations (Rank #19)
- Vermont – 3 installations (Rank #27)
- Maine – 2 installations (Rank #35)

Source: ICF/CHP database

Top 4 States for New CHP Capacity 2007-2011

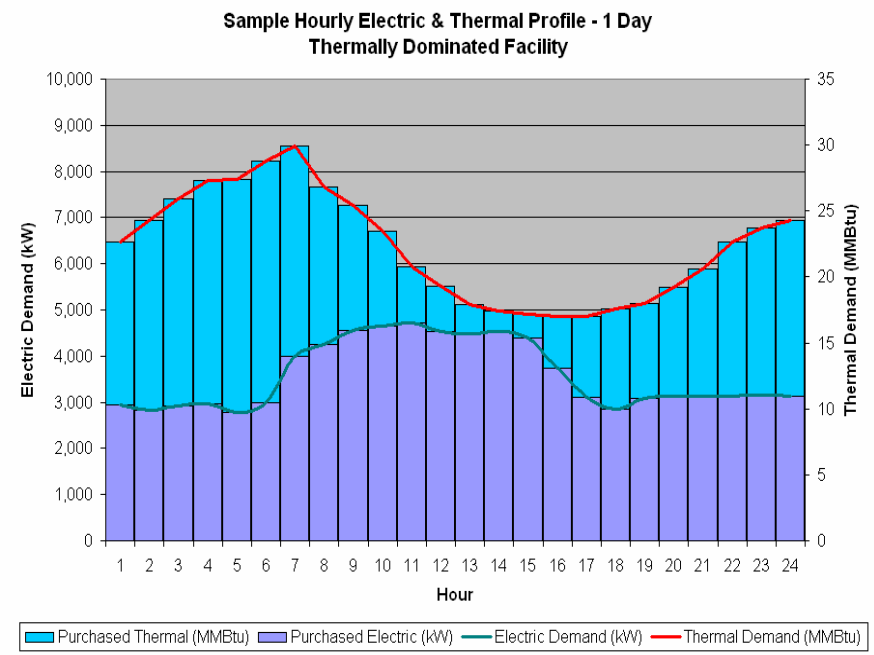
New CHP Capacity (MW's) (2007 - 2011)	
State	MW's
TX	301.1
CT	229.5
NY	147.5
OH	118.1

New CHP capacity for remaining Northeast states:

- Massachusetts – 25.8 MW (Rank #16)
- New Hampshire – 903 kW (Rank #38)
- Vermont – 565 kW (Rank #39)
- Maine – 490 kW (Rank #40)
- Rhode Island – 300 kW (Rank #44)

Source: ICF/CHP database

Important Design Considerations



- **Thermal and Electric Loads -Cooling, Heating, or Dehumidification (CHP is sized to meet *thermal* load)**
- **Cost of buying electric power from the grid relative to the cost of natural gas a.k.a "Spark Spread"**
- **Operating hours (>5000 hr/yr)**
- **Good Coincidence between electric & thermal loads (CHP is usually base loaded)**
- **Need for high power quality and reliability**
- **Access to Fuels (Natural Gas or Byproducts)**

CHP Keeps Critical Services Running!

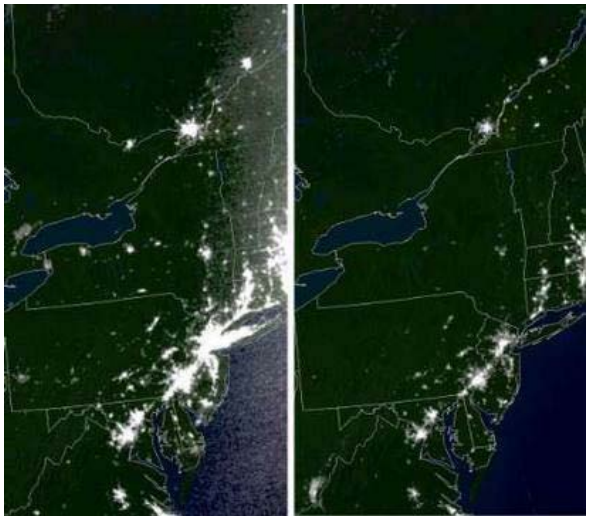
Northeast Blackout of 2003

While half of NYC's 58 hospitals suffered backup power failures, sites with CHP systems continued to be operational:

South Oaks Hospital - Amityville, NY

Montefiore Medical Center - NYC

Spring Creek Towers - NYC



Hurricane Katrina

Baptist Hospital, Jackson, Mississippi - 624 bed urban hospital with 3000 employees

Grid down – 52 hours starting August 29, 2005, Baptist Hospital's CHP system ran islanded and provided power, hot water, and air conditioning.

South Oaks Hospital
Long Island, NY

- South Oaks Hospital, Amityville, NY
- Operates a 1.3 MW CHP system, consisting of two dual-fuel reciprocating engines
- During the blackout in August 2003, South Oaks Hospital <u>never lost power.</u>
- Hospital employees were initially unaware of the blackout since they saw no interruption in their service.

Long Island Jewish Medical Center
New Hyde Park, NY

- 829 bed, non-profit teaching hospital located on a 48-acre campus
- NYSERDA CHP Funding:

  $1 million
- CHP system installed in 2009 with two 1,500 kW natural gas-fired reciprocating engines
- Heat recovered for domestic hot water and space heating.

Case Studies
UMASS Amherst

- 16 MW Power Plant
- Over 90% reduction in SOx, Nox and CO
- CHP plant: Provides 80% of electricity needs & 100% of the steam load
- Over 200 buildings and nearly 10 million gross square feet of building space
- Annual cost savings over $3,600,000
- No power interruption during October 2011 storm

U.S. DOE NORTHEAST CLEAN ENERGY APPLICATION CENTER

PROJECT PROFILE

University of Massachusetts
16 MW CHP Plant

Site Description

The new UMASS Central Heating Plant is housed in a 45,000 square foot building. Its power systems include a 10 MW Solar combustion gas turbine, 4 MW and 2 MW steam turbines, a heat recovery steam generator, three package boilers and various auxiliary equipment. A 100,000 lb/hr Heat Recovery Steam Generator (HRSG) uses the exhaust heat from the gas turbine to produce steam for campus heating and cooling year-round. Three package boilers, each rated up to 125,000 pounds per hour steam, provide additional steam capacity to meet campus demand in the spring, fall, and winter months. Two 20-inch main steam transmission lines connect the new plant to the campus. When the gas turbine is generating power at its full 10 MW capacity, the HRSG is capable of producing 37,000 lb/hr without any additional firing. Additional duct burners increase the capacity to the full 100,000 lbs/hr rating.

Quick Facts

LOCATION: Amherst, Massachusetts
FUEL: Natural Gas and Oil
MAX CAPACITY: 16 MW
POLLUTION CONTROL: Selective Catalytic Reduction (SCR)
ENVIRONMENTAL BENEFITS: 99.3% SOx Reduction, 93% NOx Reduction, 96% CO Reduction
AVERAGE CAPACITY FACTOR: ~ 75%
ENERGY OUTPUT: 100,000 MWh per year
IN OPERATION SINCE: April 2009
EQUIPMENT: 10 MW Solar Gas Turbine; 4 MW and 2 MW Steam Turbines
USE OF ELECTRICAL ENERGY: Displaces campus loads previously supplied by the local utility

Reasons for Installing CHP

The old coal fired central heating plant, built in the early 1900's and expanded over the years, could no longer obtain operating permits from the state due to emissions issues. The only fuel that could get an operating permit in the state was now natural gas. This meant a new natural gas fired central heating plant was going to have to be built. Faced with the prospect of transitioning from a relatively inexpensive fuel (coal) to a more expensive fuel (natural gas) the University decided it would be best to get the maximum value from this new fuel and the way to do that was through a combustion turbine based CHP system.

New Central Heating Plant

Heat Recovery Steam Generator

U.S. Department of Energy
Northeast Clean Energy Application Center

EPA ICI Boiler MACT

- * Date finalized *
- Standards for hazardous air pollutants from major sources: industrial, commercial and industrial boilers and process heaters (excludes any unit combusting *solid waste*)
- Major source is a facility that emits:
  - 10 tpy or more of any single Hazardous Air Pollutant, or 25 tpy or more of total Hazardous Air Pollutants (HAPs)
- Emissions limits applicable to new and existing units > 10 MMBtu/hr
  - Mercury (Hg)
  - Particulate Matter (PM) as a surrogate for non-mercury metals (alternative limits for total selective metals (TSM))
  - Hydrogen Chloride (HCl) as a surrogate for acid gases
  - Carbon Monoxide (CO) as a surrogate for non-dioxin organics

Affected Facilities by Technical Assistance CEAC Region

CEAC Region for Technical Assistance	Number of Facilities	Number of Coal Units	Number of Heavy Oil Units	Number of Light Oil Units
Mid-Atlantic	109	150	67	43
Midwest	232	377	100	82
Northeast	58	22	88	26
Southeast	168	202	112	90
Total	**567**	**751**	**367**	**241**

The data in this chart is still being refined

- Facilities are categorized by the CEAC region conducting their technical assistance, not their actual location
- This table includes only industrial/commercial/institutional boilers

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Coal and Oil Units by Application

	Coal		Oil		Total	
Description	# Units	Capacity (MMBtu/hr)	# Units	Capacity (MMBtu/hr)	# Units	Capacity (MMBtu/hr)
Food	115	26,445	56	6,107	171	32,553
Beverage/Tobacco	13	1,641	7	445	20	2,086
Textile Mills	36	2,993	14	698	50	3,691
Wood Products	14	4,121	12	646	26	4,767
Paper Manufacturing	114	38,718	89	18,349	203	57,067
Petroleum and Coal	28	7,992	37	5,154	65	13,146
Chemicals	138	36,622	130	12,661	268	49,284
Plastics and Rubber	12	1,670	57	4,150	69	5,820
Primary Metals	25	18,509	17	4,448	42	22,957
Fabricated Metals	5	1,290	5	152	10	1,442
Machinery	12	5,192	2	84	14	5,276
Transportation Equip.	73	11,435	62	5,901	135	17,336
Furniture	15	784	3	72	18	856
Other Industrial	26	8,764	26	3,107	52	11,871
Professional Services	1	112	12	1,101	13	1,213
Educational Services	72	9,663	12	1,884	84	11,547
Hospitals	12	889	2	139	14	1,027
National Security	22	2,718	48	2,039	70	4,758
Other Commercial	18	967	17	3,293	35	4,260
Total	**751**	**180,525**	**608**	**70,430**	**1,359**	**250,955**

The data in this chart is still being refined

Affected Boilers in the Northeast

Fuel Type	Number of Units	Capacity (MMBtu/hr)
Coal	22	3,957
Heavy Liquid	88	7,525
Light Liquid	26	3,145
Biomass	5	39
Process Gas	6	277
Total	**147**	**14,943**

The data in this chart is still being refined

Includes industrial, commercial and institutional boilers only

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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	332	751	180,525	18,055	114.2
Heavy Liquid	170	367	48,296	4,830	22.9
Light Liquid	109	241	22,133	2,214	10.5
Total	**611***	**1,359**	**250,954**	**25,099**	**147.6**

The data on this chart is still being refined

*Some facilities are listed in multiple categories due to multiple fuel types; there are 567 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

Impacts of the Boiler MACT Reconsidered Proposal

- Compliance straight forward for natural gas fired units (tune-ups in lieu of more rigorous control options)
  - Refinery and blast furnace gases are treated as natural gas
- Rule significantly impacts oil and coal boilers
  - Emissions limits must be met at all times except for start-up and shutdown periods
  - Controls are potentially required for Hg, PM, HCl and CO
  - Also includes monitoring and reporting requirements
  - Limits are difficult (technically and economically) for oil and coal boilers (especially older units)

Standard Compliance Measures

- Mercury (Hg): Fabric filters and activated carbon injection are the primary control devices
- Particulate Matter (PM): Electrostatic precipitators may be required for units to meet emission levels
- Hydrogen Chloride (HCl): Wet scrubbers or fabric filters with dry injection are the primary control technologies
- Carbon Monoxide (CO): Tune-ups, replacement burners, combustion controls and oxidation catalysts are the preferred control technologies

Required compliance measures for any unit depend on current emissions levels from the units and the control equipment already in place

CHP as a Compliance Strategy

- Compliance with MACT limits may be expensive for many coal and oil boilers
- May consider converting to natural gas
  - Conversion for most oil units
  - New boilers for some coal units?
- May consider moving to natural gas fueled "Conventional CHP" (trade off of benefits versus additional costs)
  - 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

NE-CEAC Support

- **DOE, through the CEACs, is supplementing the standard CEAC services by 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 is being piloted in Ohio now, and will be rolled out nationally when the EPA rule reconsideration process is complete (Spring 2012)**

For more information on DOE Boiler MACT Technical assistance visit:

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

DOE Boiler MACT Technical Assistance Program

The U.S. DOE Northeast CEAC will supplement its normal CHP services by:

- **Providing site specific technical and cost information to the 85+ major source facilities (~ 215 boilers) 163 currently burning coal or oil**
- **Meeting with willing individual facility management to discuss "Clean Energy Compliance Strategies" such as CHP, including potential funding and financial opportunities.**
- **Assisting interested facilities in the implementation of CHP as a compliance strategy**

DOE Boiler MACT Technical Assistance Program

- **Site specific "Decision Trees" will include:**
  - **Facility Info**
  - **Site Financial Data**
  - **Contact Info**
  - **Boiler Unit Data**
  - **Compliance Control Requirements**
  - **CHP as an Alternative Compliance Option**
  - **Comparative Cost of Compliance Options**
  - **CHP Payback**
  - **Available Financial Options**

Questions ?

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