



COMBINED HEAT AND POWER (CHP) EN BANC HEARING OCTOBER 7, 2014, UNIVERSITY OF PITTSBURGH

Overview & Benefits

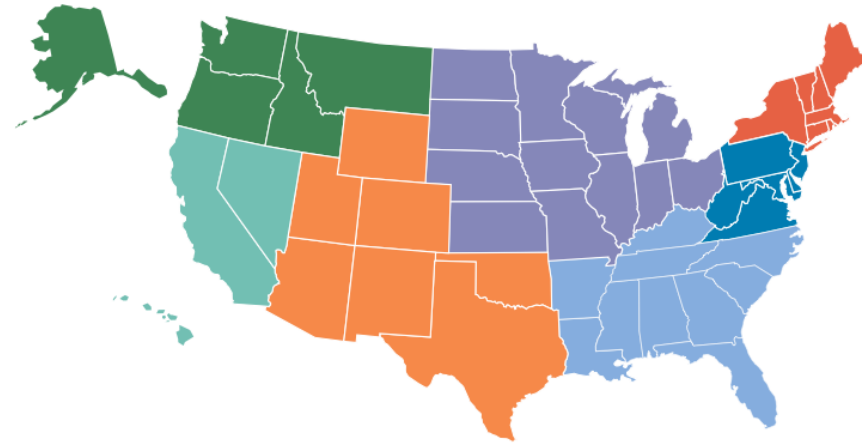
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October 7, 2014



U.S. DEPARTMENT OF ENERGY
CHP Technical Assistance Partnerships
MID-ATLANTIC

CHP Technical Assistance Partnerships

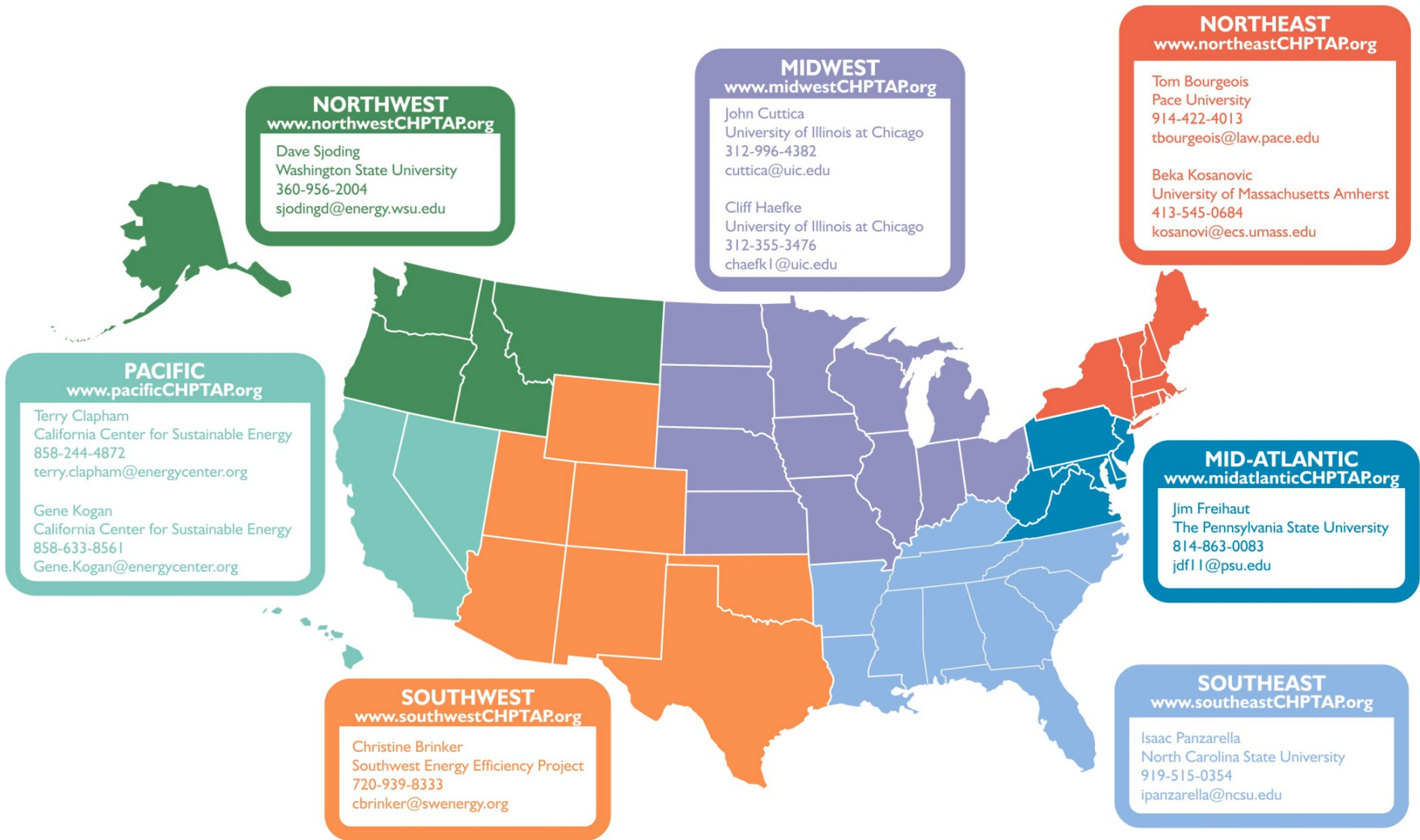
- Key Activities
- Market Opportunity Analysis.
Supporting analyses of CHP market opportunities in diverse markets including industrial, federal, institutional, and commercial sectors
- Education and Outreach.
Providing information on the energy and non-energy benefits and applications of CHP to state 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 with CHP in their facility and to help them through the development process from initial CHP screening to installation.



<http://eere.energy.gov/manufacturing/distributedenergy/chptaps.html>



DOE CHP Technical Assistance Partnerships (CHP TAPs)



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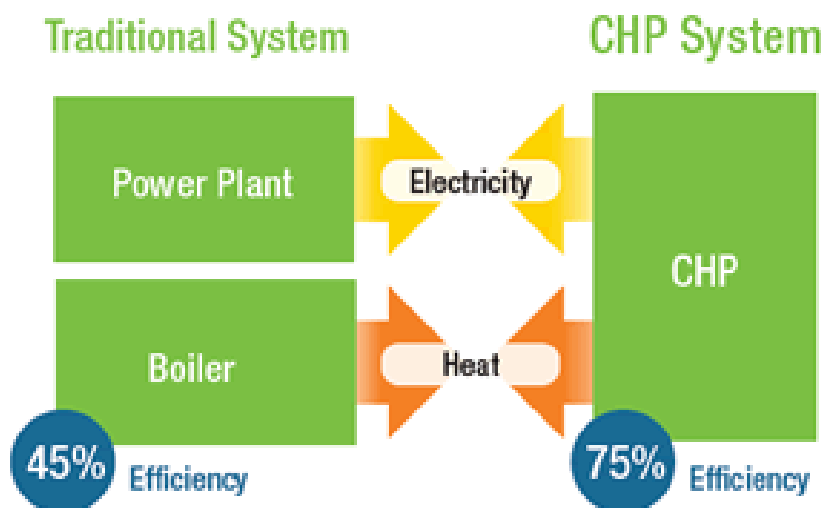
Agenda

- CHP Overview
- CHP Drivers & Benefits
- Relative Value of Benefits



What is 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
 - Refrigeration/Dehumidification

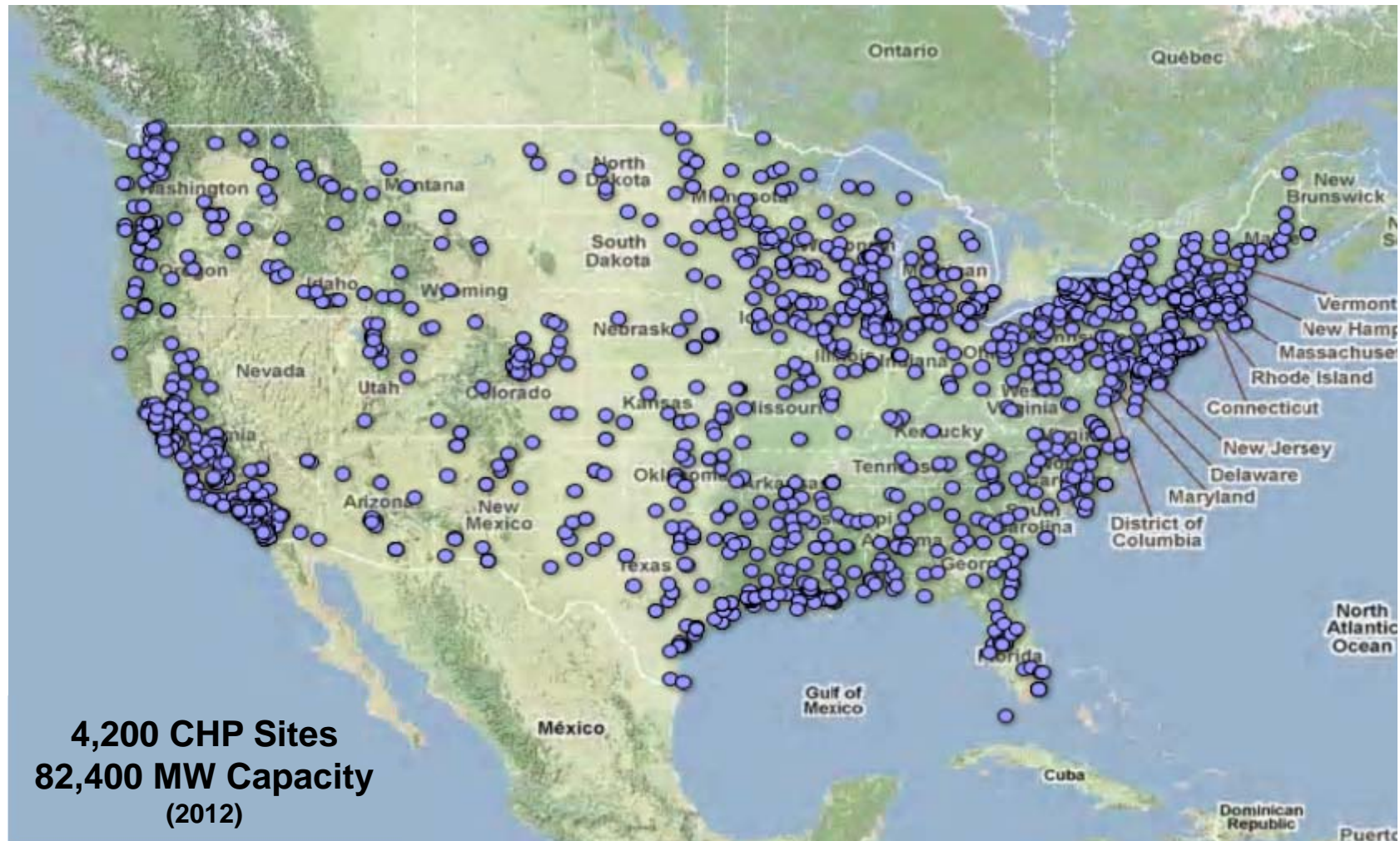


Source:
http://www1.eere.energy.gov/manufacturing/distributedenergy/chp_basics.html

*CHP provides cost-effective, clean and reliable energy –
today and for the future.*



CHP Throughout the US



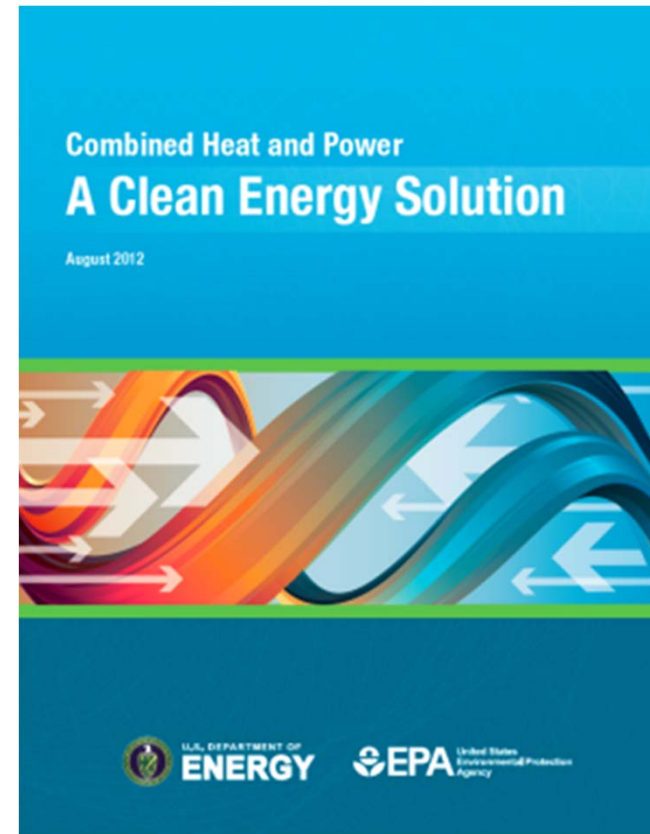
Source: ICF International

CHP Drivers

- Cost Savings **#1**
 - Offset Utility/3rd Party kWh's + Therms
- Emissions Reductions
 - Supported by US DOE & US EPA
- Reliability & Resiliency
 - Provides local grid support and improves power quality
 - CHP is emerging as a key tool in developing cost-effective Microgrids that improve energy resiliency and can provide emergency back-up power
- Economic Development
 - Reduced energy costs, job creation and job retention
- National Security
 - Reduced fossil fuel usage extends US resources and multiple points of power generation are less subject to catastrophic failure or attack

CHP Drivers

- 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
- Energy resiliency and critical infrastructure



DOE / EPA CHP Report (8/2012)

Benefits of Distributed Generation/CHP

Energy Reliability

1. Improved power quality
2. Business continuity
3. Reduced grid congestion
4. End-of-the-wire supply
5. Short lead-time, off-the-shelf, modular technology

Energy Security

6. Reduced system vulnerability
7. Disaster Mitigation
8. Disaster Recovery

Energy Efficiency

9. Improved fuel efficiency (fuel economy)
10. Optimized use of scarce natural gas resources
11. Eliminates line losses

Economic Development

12. Lower cost for new electricity than new central generation and T&D
13. Improved energy cost predictability
14. No ratepayer investment required (generation or T&D)
15. Creates new high-tech manufacturing sector, domestic and export
16. Creates local jobs for installation, operation and maintenance
17. Supports competitive electricity market structure

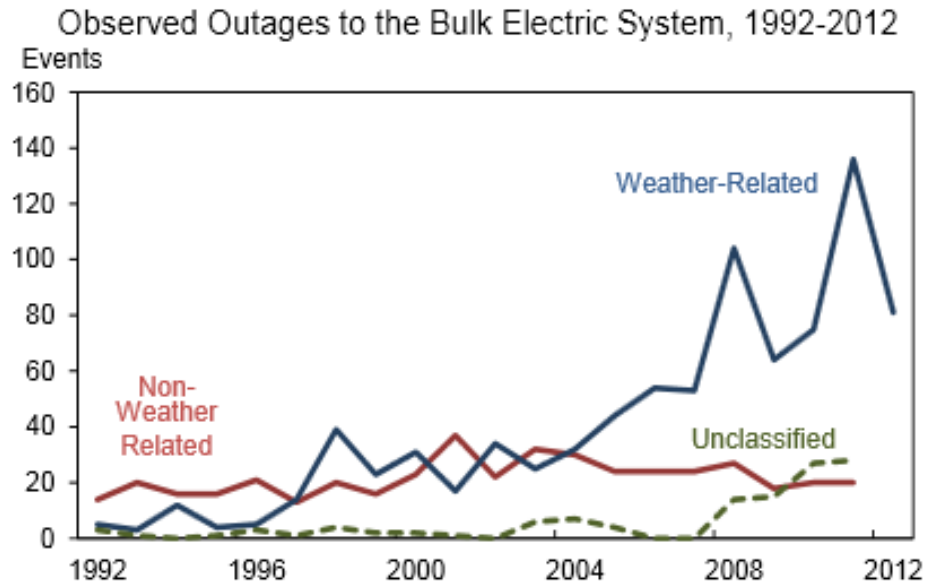
Environmental Stewardship

18. Reduced emissions per unit of useful output
19. Reduces land-use impacts and NIMBY objections
20. Reduces fresh water use



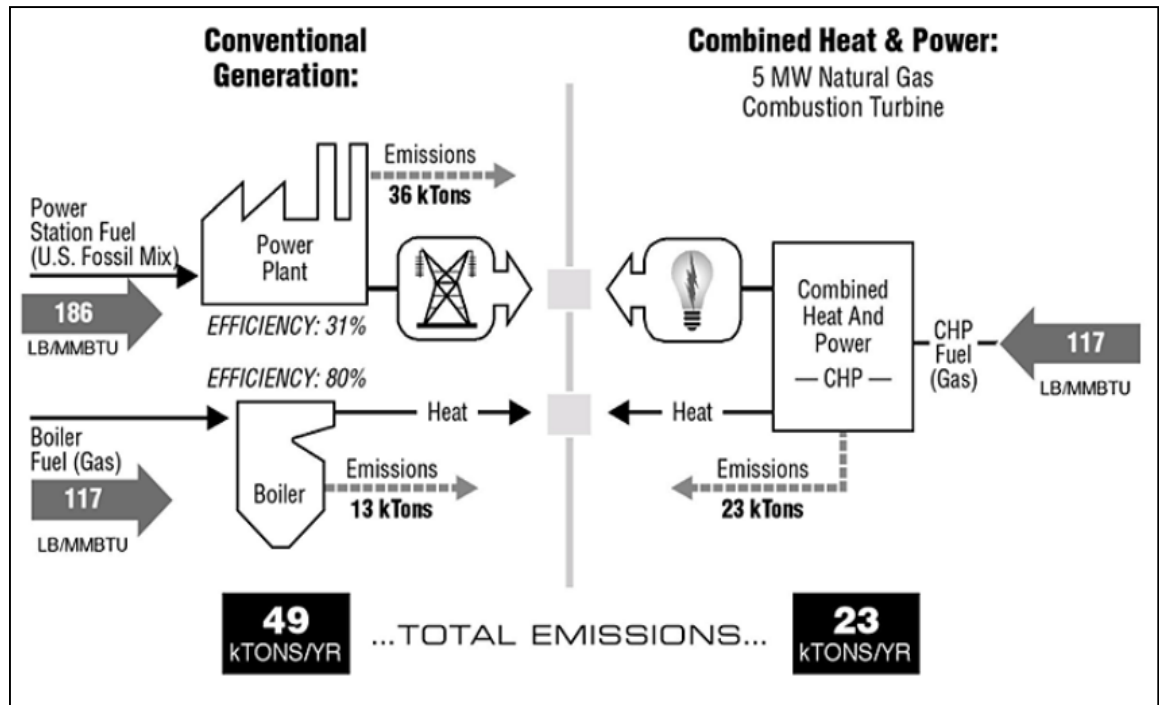
Reliability/Resiliency

- According to the EIA, Electric Grid outages have increased significantly over the past 20 years.
- Total losses due to Superstorm Sandy estimated between \$30 to \$50 billion including a two-day shutdown of the NY Stock Exchange, costing an estimated \$7 billion from halted trading.
- Rutgers estimates economic losses of \$11.7 billion for New Jersey GDP significantly impacting state tax income.
- CHP, when properly configured can work without the grid to provide power to critical facilities, government services and industrial facilities.



Emissions

- CHP provides highly efficient use of clean fossil or renewable fuel.
- CHP reduces carbon emissions by over 50% versus PA grid power and natural gas boilers.



Source: EPA's Handbook of CHP Technologies



Emissions

Category	10 MW CHP	10 MW PV	10 MW Wind	Combined Cycle (10 MW Portion)
Annual Capacity Factor	85%	22%	34%	70%
Annual Electricity	74,446 MWh	19,272 MWh	29,784 MWh	61,320 MWh
Annual Useful Heat	103,417 MWh _t	None	None	None
Footprint Required	6,000 sq ft	1,740,000 sq ft	76,000 sq ft	N/A
Capital Cost	\$20 million	\$60.5 million	\$24.4 million	\$10 million
Annual Energy Savings	308,100 MMBtu	196,462 MMBtu	303,623 MMBtu	154,649 MMBtu
Annual CO ₂ Savings	42,751 Tons	17,887 Tons	27,644 Tons	28,172 Tons
Annual NO _x Savings	59.4 Tons	16.2 Tons	24.9 Tons	39.3 Tons

Outputs are based on:

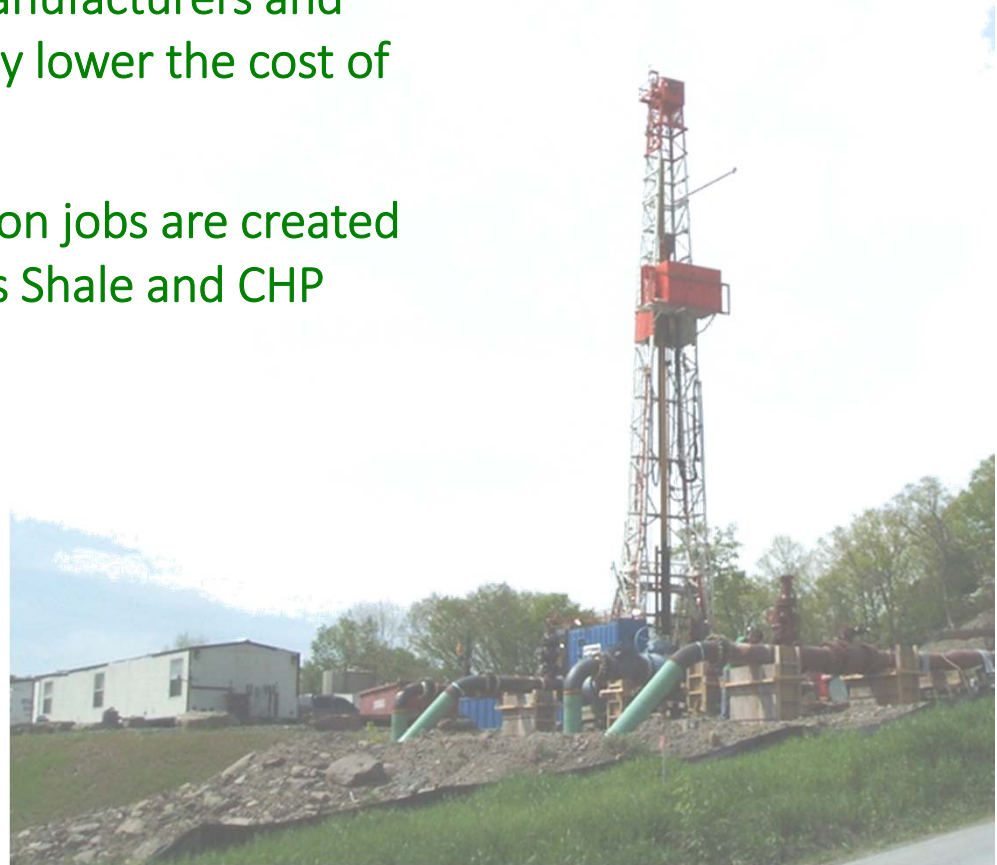
10 MW Gas Turbine CHP—28% electric efficiency, 68% total CHP efficiency, 15 ppm NO_x emissions

Capacity factors and capital costs for PV and Wind based on utility systems in DOE's Advanced Energy Outlook 2011 (AEO 2011)

Capital cost and efficiency for natural gas combined cycle system based on AEO 2011 (540MW system proportioned to 10 MW), NGCC 48% electric efficiency, NO_x emissions 9 ppm
 CHP, PV, Wind and NGCC electricity displaces National All Fossil Average Generation resources (eGRID 2012) - 9,572 Btu/kWh, 1,743 lbs CO₂/MWh, 1.5708 lbs NO_x/MWh, 6.5% T&D losses;
 CHP thermal output displaces 80% efficient on-site natural gas boiler with 0.1 lb/MMBtu NO_x emissions

Economic Development

- In-situ use of Marcellus Shale for combined heat and power generation allows manufacturers and large energy users to significantly lower the cost of energy
- New engineering and construction jobs are created in the development of Marcellus Shale and CHP plants
- Efficient use of Marcellus Shale Gas through CHP will provide a competitive advantage for existing and new energy intensive industries in Pennsylvania



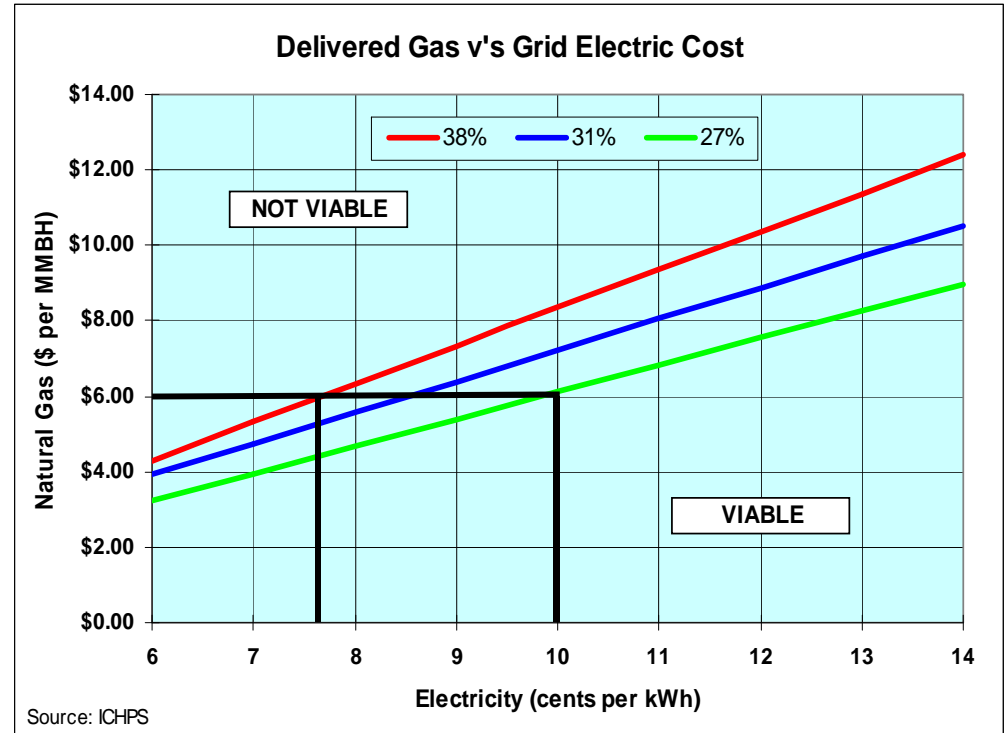
EPA 111(d)

- Section 111, 42 U.S.C. §7411, of the Clean Air Act requires EPA to develop regulations for categories of sources which cause or significantly contribute to air pollution which may endanger public health or welfare. Section 111(d) of the Act requires states to develop plans for existing sources of noncriteria pollutants (i.e., a pollutant for which there is no national ambient air quality standard) whenever EPA promulgates a standard for a new source. These are called Section 111(d) plans and are subject to EPA review and approval.
- Should the proposed EPA 111 (d) rule as it is currently written become law, CHP provides States with an important compliance tool.
- Apart from the significant greenhouse gas reductions obtainable through the deployment of CHP, the non air quality benefits offered by CHP include:
 - Increased Energy Efficiency
 - Increased Grid Resiliency
 - Economic Development
 - Cost Effectiveness



Cost to Generate Power with CHP

- At a natural gas cost of \$6/MMBH, on-site generators will produce power at between 7½ and 10 cents/kWh*
- With high thermal load factor, CHP produces power at an effective 5½ to 7½ cents/kWh*
- Spark spread is required to overcome capital cost, load risks and make investment 'worthwhile' to owner



* Includes maintenance



Only 4 of the 20 Benefits Accrue to the User

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Relative Value of Benefits

- Owner/Host Site Benefits
 - Cost Savings
 - Environmental Stewardship/Good PR
 - Power Quality/Availability
- Societal Benefits
 - Lower Energy & Infrastructure Costs
 - Emissions Reductions/Health Care Benefits
 - Increased Grid Reliability/Tax Income
 - Resource Extension/National Security
 - Job Creation/Retention
 - Underpin Expansion of NG Distribution Network

