Waste Heat to Power III

Where Does Waste Heat to Power Fit? DOE Perspective

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Where Does Waste Heat to Power and CHP Fit at Department of Energy?

- Office of Electricity
- Office of Energy Efficiency and Renewable Energy
- National Themes

Renewable and Distributed Systems Integration

Increasing Levels of Integration

Equipment into Package CHP System

Package CHP System Into Building

Building-Integrated CHP into Community

Past Goals

Present Goals

Renewable and Distributed Systems Integration

- Involves development of advanced operational controls for greater interoperability and the seamless integration of distributed systems (generation and storage) with electric grid planning and operations
- Includes research, development, field testing, and demonstration of distributed systems for demand response and ancillary services
- Provides energy solutions for utilities, customers, and local energy systems such as district energy, power parks, and microgrids

Benefits

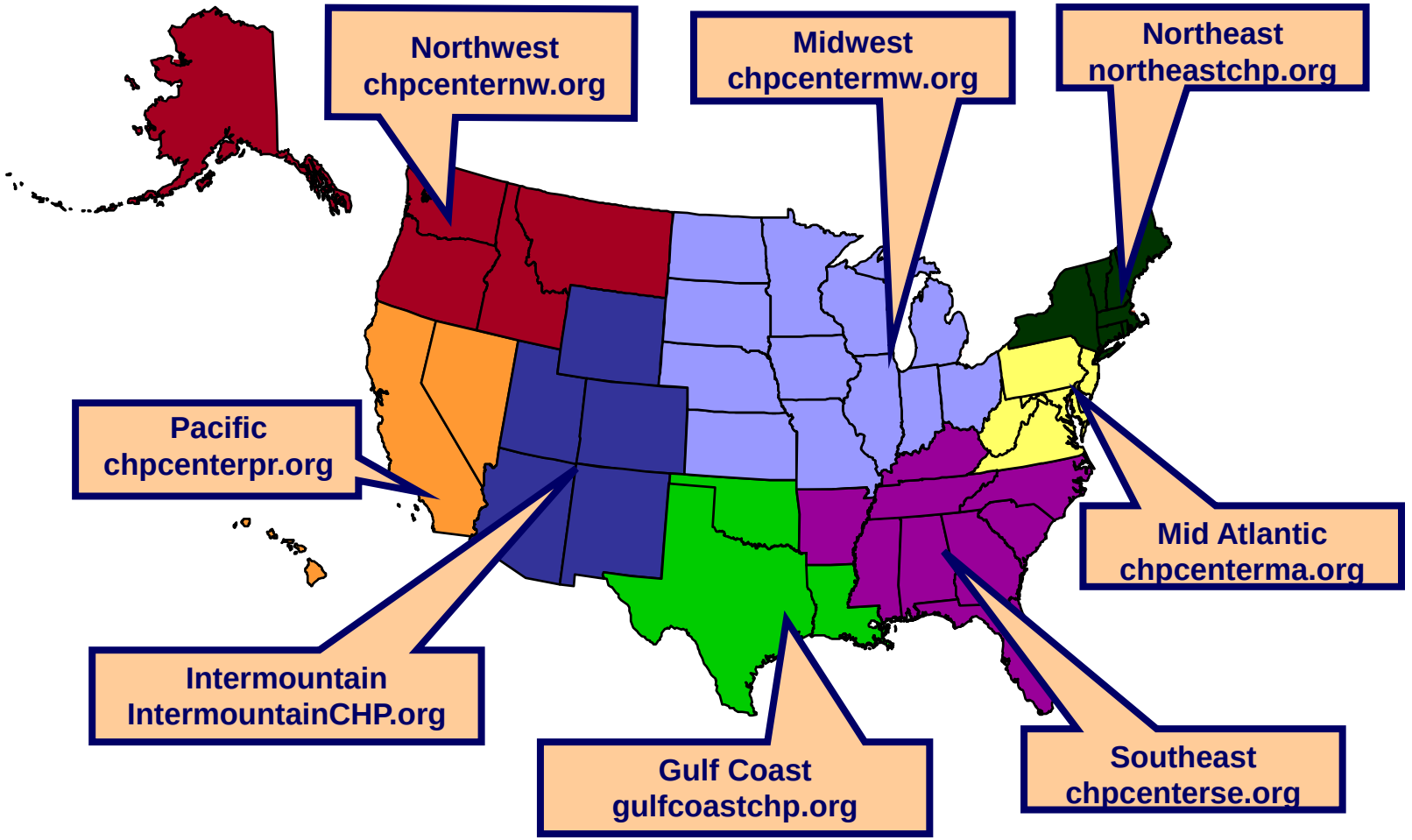
- ✓ Increases grid reliability
- ✓ Addresses vulnerability of critical infrastructure
- ✓ Helps manage peak loads and defers T&D investment
- ✓ Lowers emissions and utilizes fuel resources more efficiently
- ✓ Helps customers manage energy costs





Regional Application Centers

Provide information exchange, education, and technical assistance to regional stakeholders to promote CHP technology applications for energy efficiency and grid reliability.



Save Energy Now Program
Energy Savings Plant Assessments (ESA)

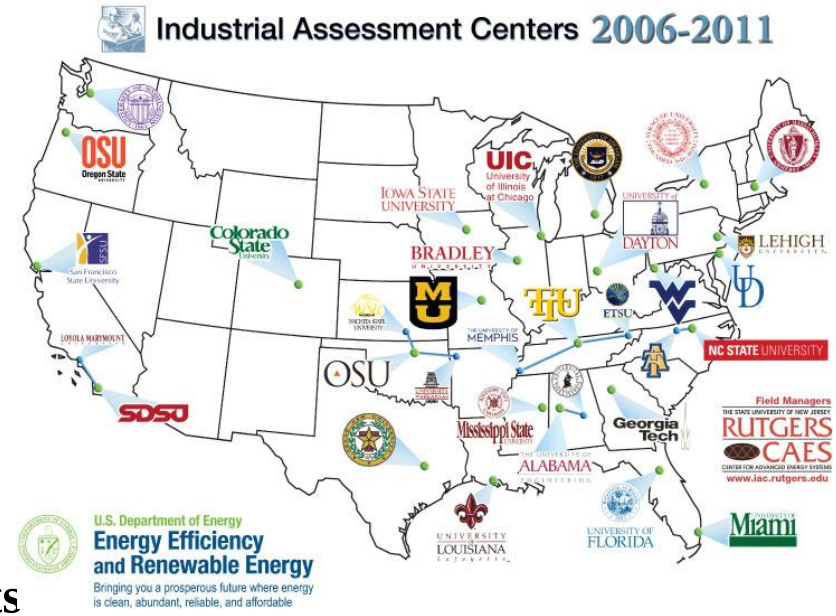
- In 2006, focused on natural gas savings in some of the nation's largest manufacturing plants (200 ESAs completed)
  - Specifically focused on process heating and steam systems
- Targeted those plants that consume 1 trillion Btus or more annually
- In 2007, 250 ESAs planned
- Extending focus beyond steam and process heating
- Assessments available to a wider range of facilities

Save Energy Now Resources

- Software Tools
  - Process Heating Assessment and Survey Tool (PHAST)
  - Steam System Assessment Tool (SSAT)
- ESA Experts
  - Trained in tools and protocols
  - Selected from pool of Qualified Specialists to conduct ESAs
- ITP Existing Resources
  - Software decision tools
  - Assessment protocols
  - Training curricula
  - Certified experts
  - Deployment partnerships

Industrial Assessment Centers

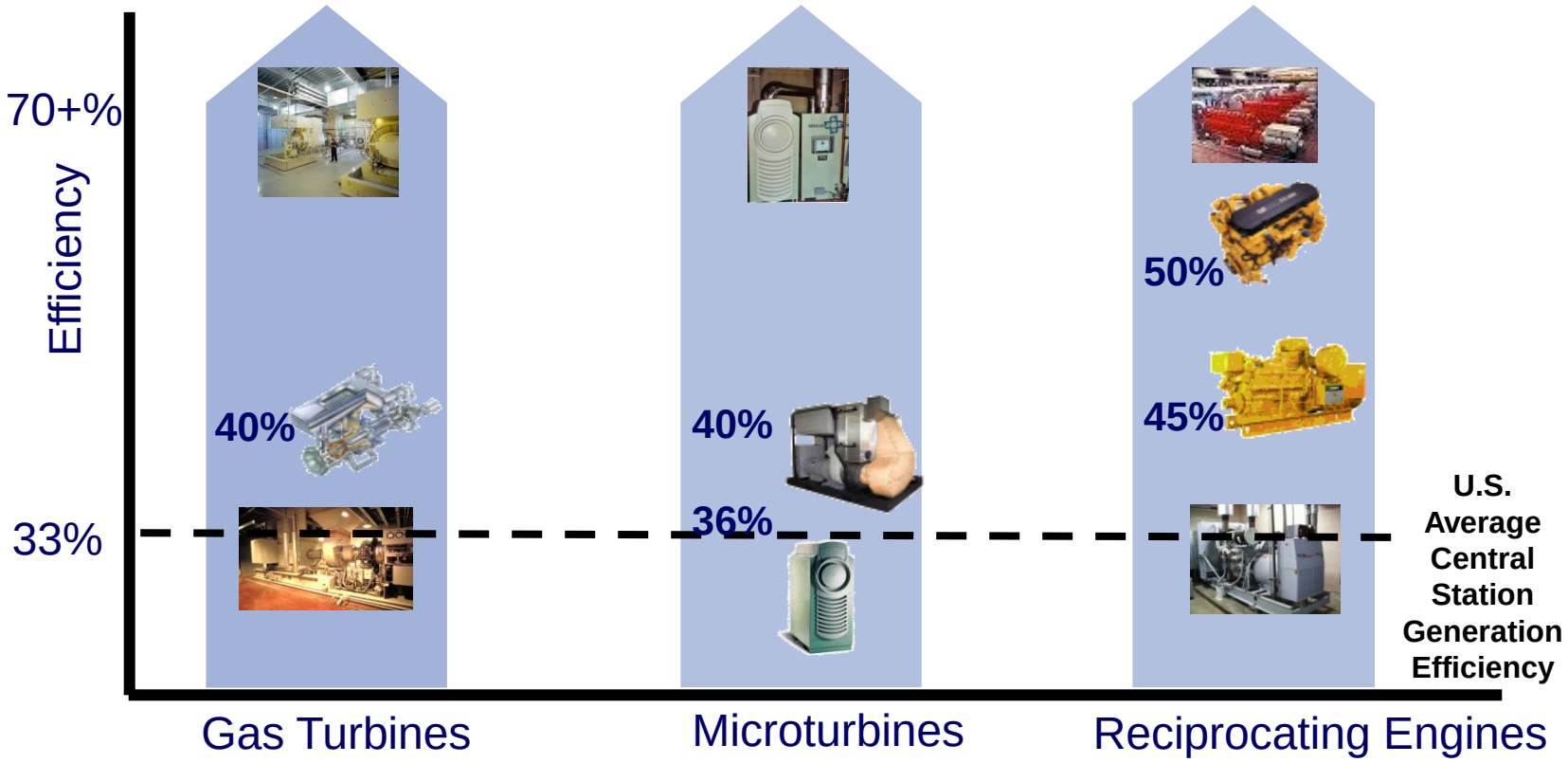
- Engineering faculty and students at 26 university engineering schools
- Assessment teams include faculty and students
- Provide free energy, waste and productivity assessments to small and mid-sized manufacturers in their regions
- Assessments entail a one-day site visit
- Integrated approach considers energy, waste, and productivity
- Good training ground for students
- Performed 113 assessments in 2006, and have identified an average of $117,000 per plant in annual energy savings since 2001



National Themes and Opportunities Where Waste Heat to Power Technologies Fit

- **Energy Efficiency**
- **Climate Change**

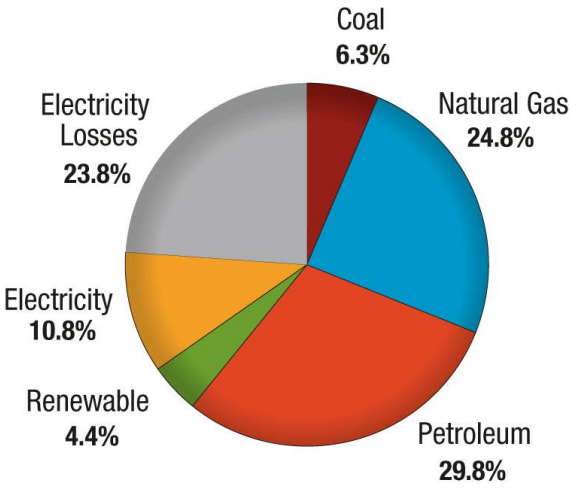
Improved Generation, Heat Utilization and Integrated CHP Systems



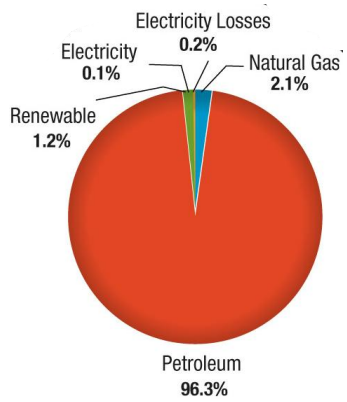
Industrial Sector Offers Greatest Opportunity to Achieve National Energy and Emissions Goals

Industrial Sector

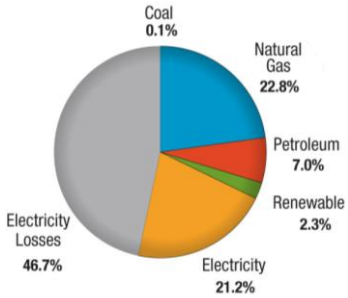
- >200,000 sites
- 14.3 million jobs
- $5,900 billion in shipments
- $980 billion in exports



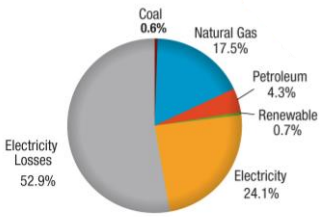
Industrial Sector Energy Consumption
32.0



Transportation Sector Energy Consumption
28.1



Residential Sector Energy Consumption
21.9



Commercial Sector Energy Consumption
18.0

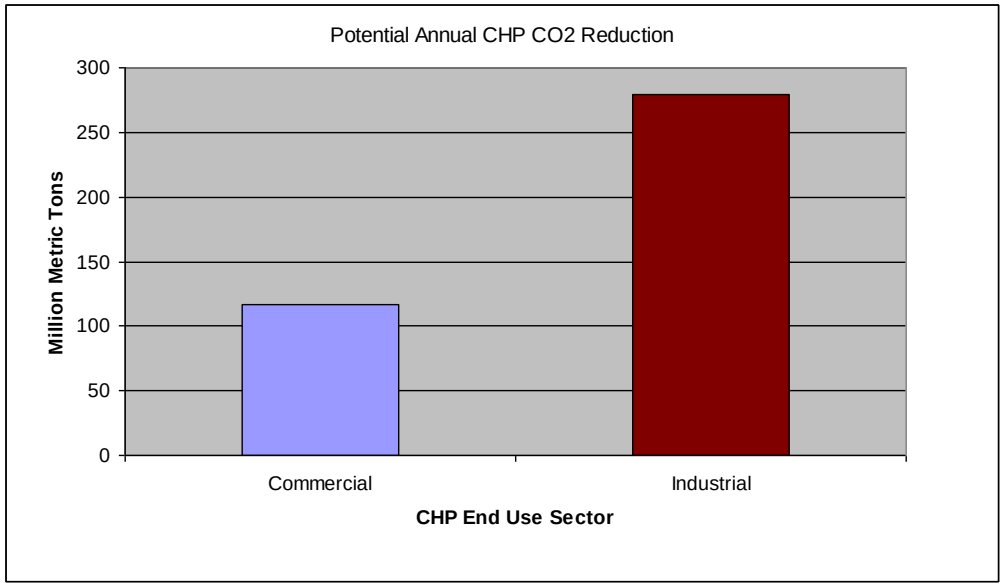
Largest Energy Consumer

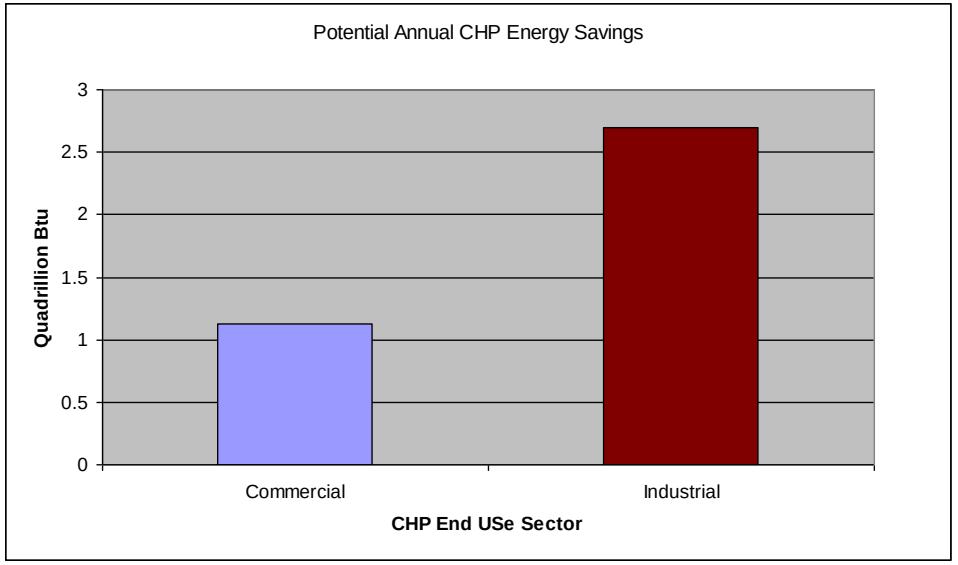
Most Diverse Energy Demand

Largest Opportunities for:

- **Energy Reduction**
- **Emission Reductions**
- **Fuel Flexibility**
- **Enhanced Energy Security**
- **Reduction of Imported Energy**

Greenhouse Gas and Energy Savings Reduction (Technical) Potential





Adapted from Analyses and Data from ORNL, DOE, EPA, EEA, RDC, and Discovery Insights

Energy Savings Opportunities Industrial Sector

Table 11-3 Opportunity Energy Savings Summarized by Broad Categories	
Category	Combined Savings (Trillion Btu)
Waste Heat and Energy Recovery (Opportunities 1,4,10,16-19)	1831
Improvements to Boilers, Fired Systems, Process Heaters and Cooling (Opportunities 3,8,13,20)	907
Energy System Integration and Best Practices (Opportunities 5-7,9,14-15)	1438
Energy Source Flexibility and Combined Heat and Power (Opportunities 2, 11)	828
Sensors, Controls, Automation (Opportunity 12)	191
Total	5195

Energy Use, Loss and Opportunities Analysis: U.S. Manufacturing and Mining (December 2004)

Top Twenty Opportunities

Energy Loss Reduction and Recovery in Industrial Energy Systems Technology Roadmap (Nov 2004)

A list of top opportunities was developed based on inputs obtained at the Energy Loss and Reduction Workshop and previous studies conducted [EI 2003, EI 2004, USCHPA 2001]. These opportunities are illustrated along with the associated energy savings in Table 4.

Table 4 Top Twenty R&D Opportunities (Trillion Btu)

#	Opportunity Area	Industries Analyzed	Pre-Process Energy Savings	Post-Process Energy Savings	Total Energy & Cost (million $) Savings
1	**Waste heat recovery** from gases and liquids in chemicals, petroleum, and forest products, including hot gas cleanup and dehydration of liquid waste streams	chemicals, petroleum, forest products	0	828	828 ($2210 MM)
2	**Combined heat and power systems**	forest products, chemicals, food, metals, machinery	634	0	634 ($2000 MM)
3	**Advanced industrial boilers**	chemicals, forest products, petroleum, steel and food processing	400	0	400 ($1090 MM)
4	**Heat recovery from drying processes**	chemicals, forest products, food processing	160	217	377 ($1240 MM)
5	**Steam best practices** (improved generation, distribution and recovery), not including advanced boilers	all manufacturing	310	0	310 ($850 MM)
6	**Pump system optimization** in electric motor-driven systems	All manufacturing	*302 (98)	0	*302 (98) ($1370 MM)
7	**Energy system integration**	chemicals, petroleum, forest products, iron and steel, food, aluminum	110	150	260 ($860 MM)
8	**Improved process heating/heat transfer systems for chemicals and petroleum industries** (improved heat exchangers, new materials, improved heat transport)	petroleum, chemicals	121	139	260 ($860 MM)
9	**Energy efficient motors and improved rewind practices**	all manufacturing	*258 (84)	0	*258 (84) ($1175 MM)
10	**Waste heat recovery** from gases in metals and non-metallic minerals manufacture (excluding calcining), including hot gas cleanup	iron and steel, cement	0	235	235 ($1133 MM)
11	**Energy source flexibility** (heat-activated power generation, waste steam for mechanical drives, indirect vs direct heat vs steam)	chemicals, petroleum, forest products, iron and steel	119	75	194 ($1100 MM)
12	**Improved sensors, controls, automation, robotics**	chemicals, petroleum, forest products, iron and steel, food, cement, aluminum	39	152	191 ($630 MM)
13	**Improved process heating/heat transfer for metals melting, heating, annealing** (cascade heating, batch to continuous, better heat channeling, modular systems)	iron and steel, metal casting, aluminum	63	127	190 ($915 MM)
14	**Compressed air system optimization** in motor-driven systems	all manufacturing	*163 (53)	0	*163 (53) ($740 MM)
15	**Optimized materials processing** (grinding, mixing, crushing)	all manufacturing	*145 (47)	0	*145 (47) ($660 MM)
16	**Energy recovery from byproduct gases**	petroleum, iron and steel	0	132	132 ($750 MM)
17	**Energy export and co-location** (fuels from pulp mills, forest biorefineries, co-location of energy sources/sinks)	forest products	0	105	105 ($580 MM)
18	**Waste heat recovery from calcining** (not flue gases)	cement, forest products	11	63	74 ($159 MM)
19	**Heat recovery from metal quenching/cooling processes**	iron and steel	0	57	57 ($275 MM)
20	**Advanced process cooling and refrigeration**	Food processing, chemicals, petroleum and forest products	*57 (15)	0	*47 (15) ($212 MM)
TOTALS			2889	2280	5162 ($18,357 MM)

cludes losses incurred during offsite generation and transmission of electricity, based on conversion factor of 10500 Btu/kWh. Number in parenthesis does not include losses.

For More Information...

Office of Electricity Delivery and Energy Reliability

www.oe.energy.gov

Office of Energy Efficiency and Renewable Energy

www.eere.energy.gov