DOE Technical Assistance Program

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

The Parker Ranch installation in Hawaii

Combined Heat and Power and District Energy- Endless Possibilities

November 10, 2010

Brian Olsen

Midwest Energy Efficiency Alliance

DOE Technical Assistance Program

Team 4 – Program & Project Development & Implementation

Webinar Overview

- Technical Assistance Project (TAP) Overview
- CHP Definition
- District Cooling and Heating Definition
- CHP Technologies and Market Applications
- CHP Installation Status
- US CHP Industry Outlook
- USDOE RACs
- Q&A

What is TAP?

DOE's Technical Assistance Program (TAP) supports the Energy Efficiency and Conservation Block Grant Program (EECBG), the State Energy Program (SEP) and the Better Buildings grantees by providing state, local, and tribal officials the tools and resources needed to implement successful and sustainable clean energy programs.

How Can TAP Help You?

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TAP offers:

- One-on-one assistance
- Extensive online resource library, including:
  - Webinars
  - Events calendar
  - TAP Blog
  - Best practices and project resources
- Facilitation of peer exchange

On topics including:

- State and local capacity building
- Energy efficiency and renewable energy technologies
- Program design and implementation
- Financing
- Performance contracting

Provider Network Resources

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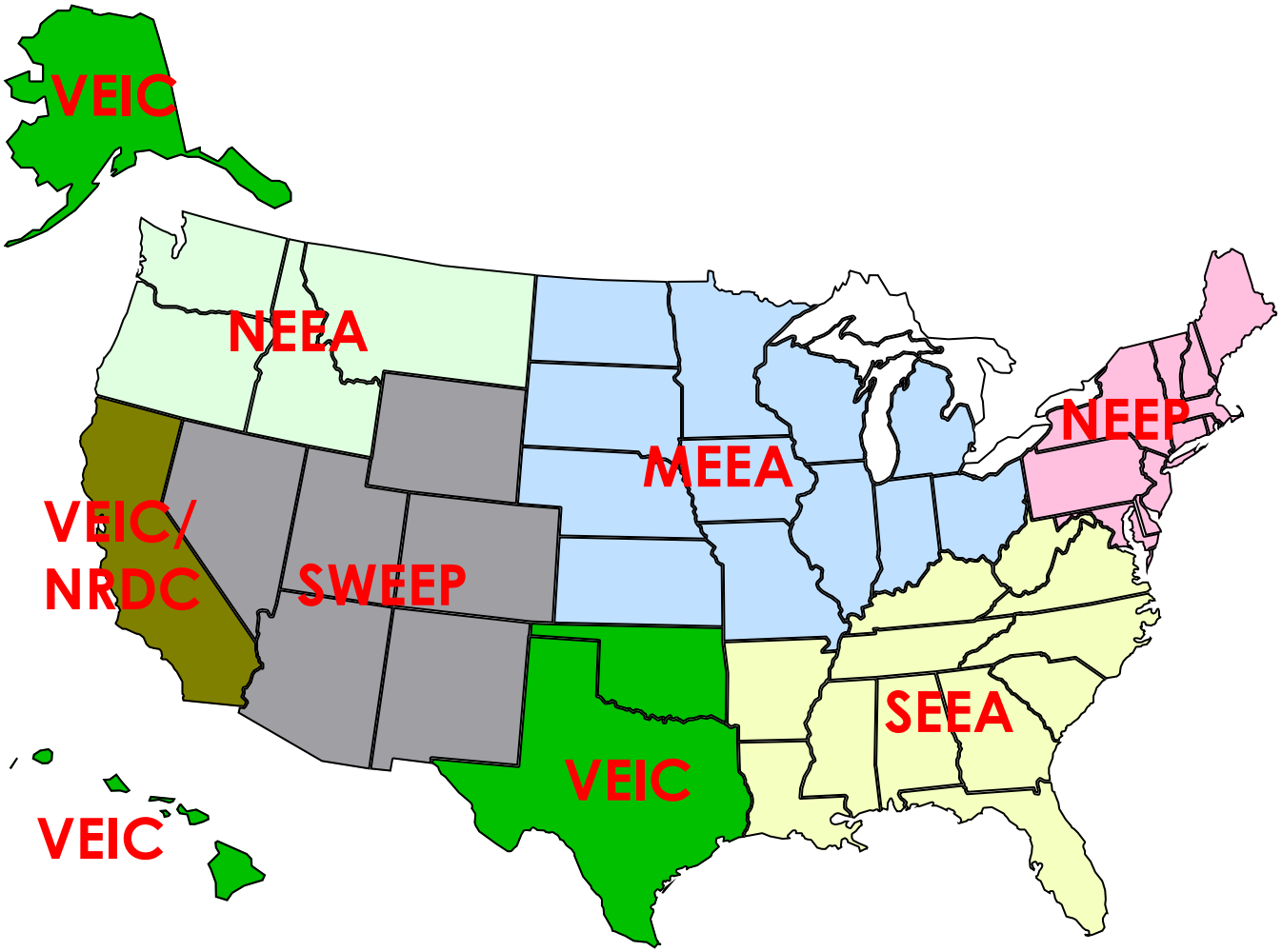
State and Local Capacity Building	• Trainings • Workshops • Peer-to-peer matching
Technical	• Renewable energy siting and development • Review of technical specs for RFPs • Strategic planning, energy management, and conservation strategies • Green building technologies • Building codes
Program Design and Implementation	• Policy and program development • Coordinating rate-payer funded dollars with ARRA projects and programs • Sustainable community and building design • State and regional EE and RE assessments and planning • EE and RE portfolio program design elements
Financial	Program design support and guidance on financing mechanisms such as: • Revolving loan funds (RLFs) • Property-assessed clean energy (PACE) • Loan loss reserves and enhanced credit mechanisms
Performance Contracting	• Designing and implementing a performance contract • Leveraging private investment • Reducing institutional barriers • Tracking and comparing programs

Who We Are: Team 4



VERMONT ENERGY INVESTMENT CORPORATION

EF GROUP FUTURES ENERGY

MEEA Midwest Energy Efficiency Alliance

neep

SWEEP

NORTHWEST ENERGY EFFICIENCY ALLIANCE

seea

NRDC THE EARTH'S BEST DEFENSE

ACEEE American Council for an Energy-Efficient Economy

ACEEE, NRDC: National Support

“Clean Energy” Technologies

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CHP

The sequential production of electric and thermal power from a single dedicated fuel source

Waste Heat Recovery

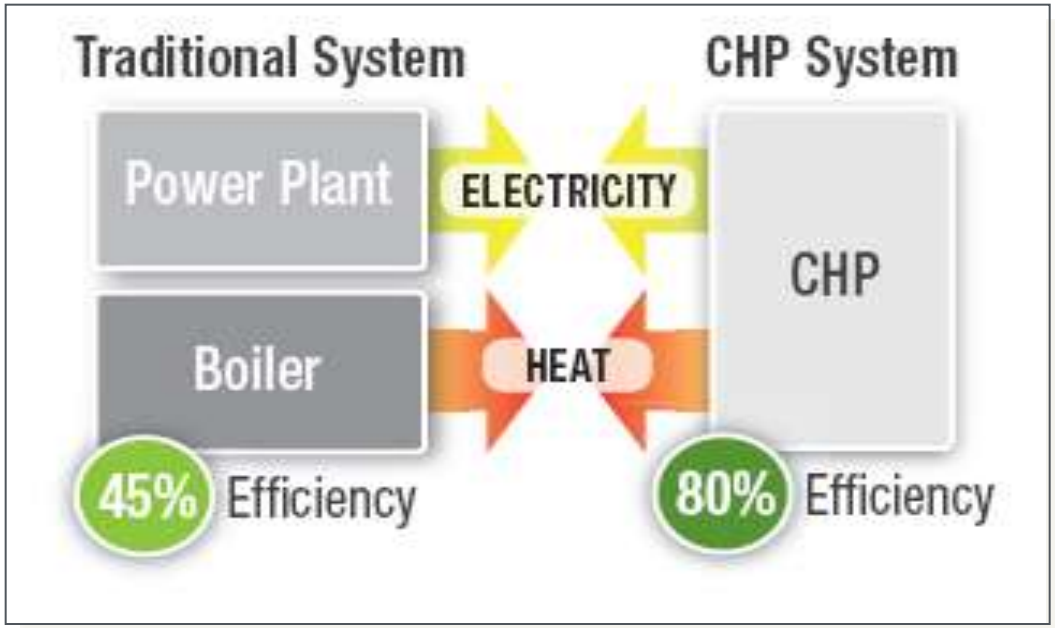
Captures heat otherwise wasted in an industrial process and utilizes it to produce electric power. These systems may or may not produce additional thermal energy

District Energy

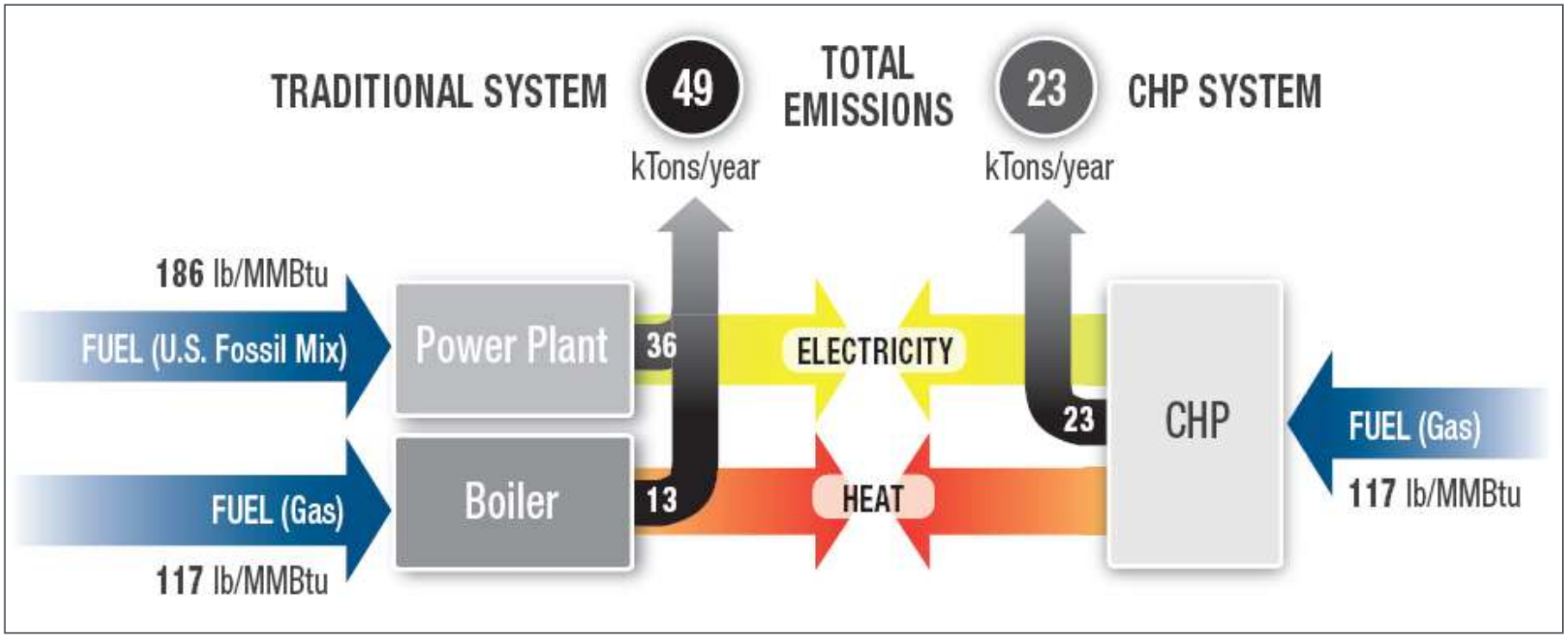
Central heating & cooling plants that incorporate electricity generation along with thermal distribution piping networks for multiple buildings (campus / downtown area)

Combined Heat & Power (CHP)

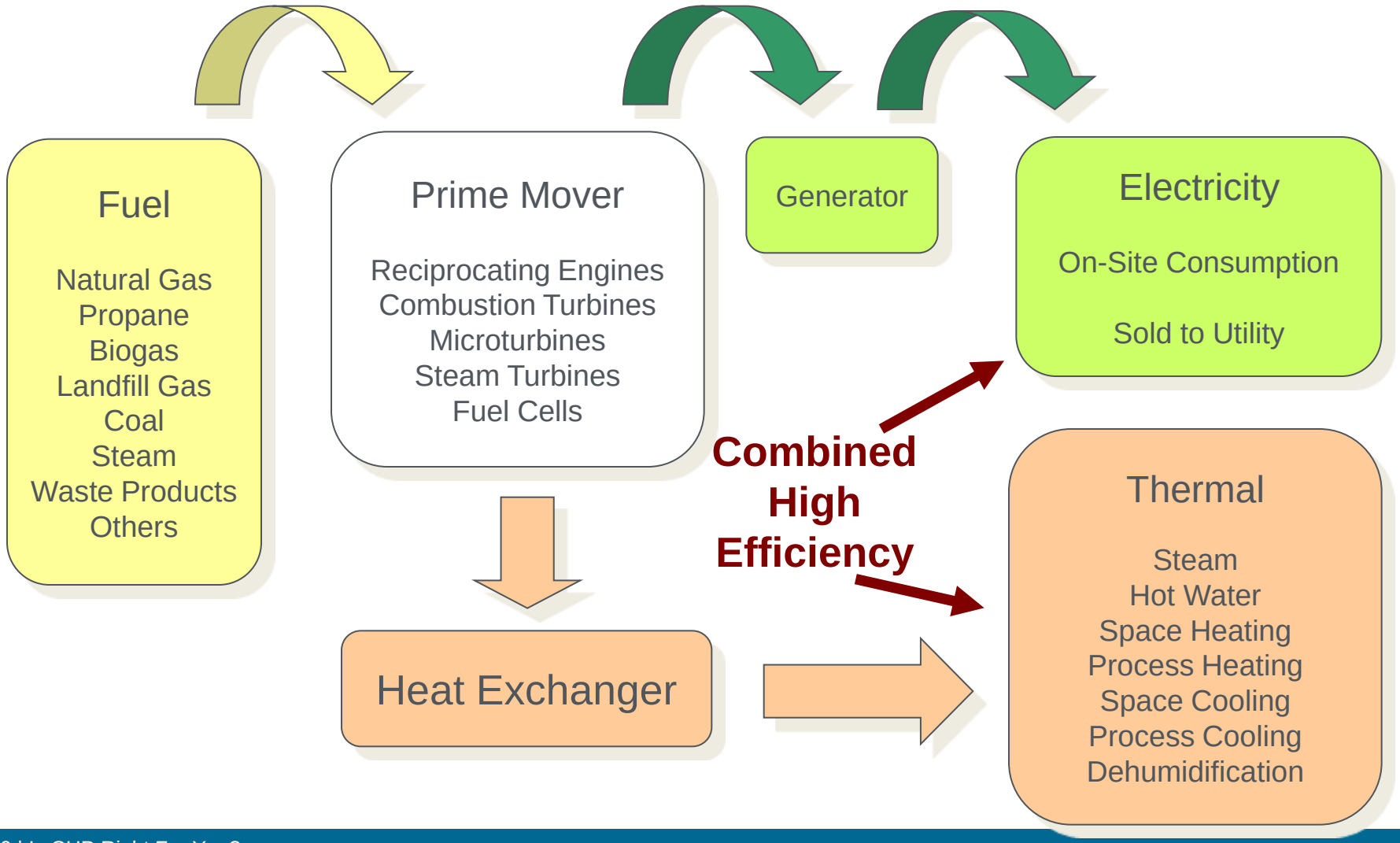
- Form of Distributed Generation (DG)
- An Integrated System
- Located At or Near a Building/Facility
- Provides at Least a Portion of the Electrical Load and
- Recycles the Thermal Energy for
  - Space Heating / Cooling
  - Process Heating / Cooling
  - Dehumidification



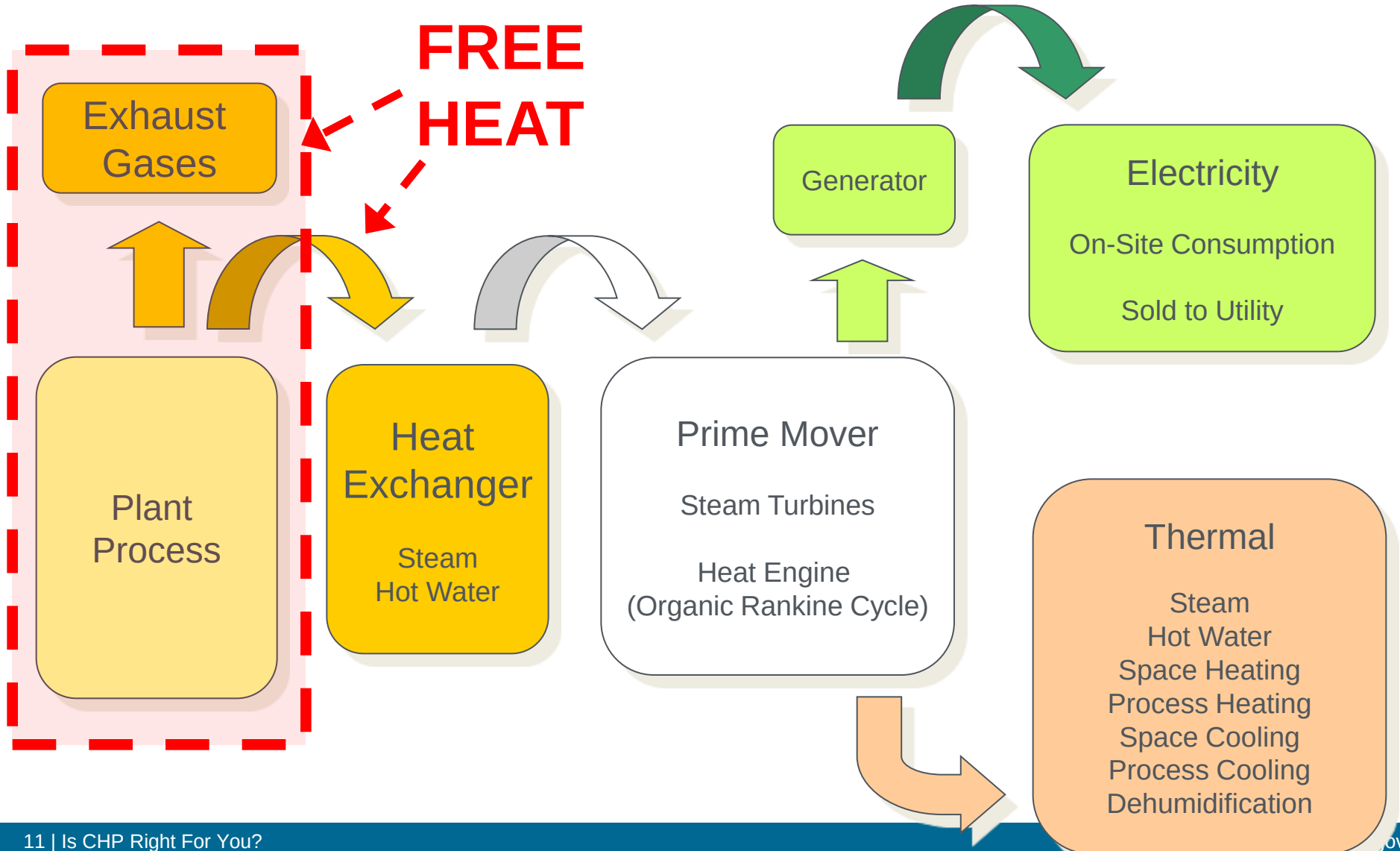
CHP Emissions Benefits

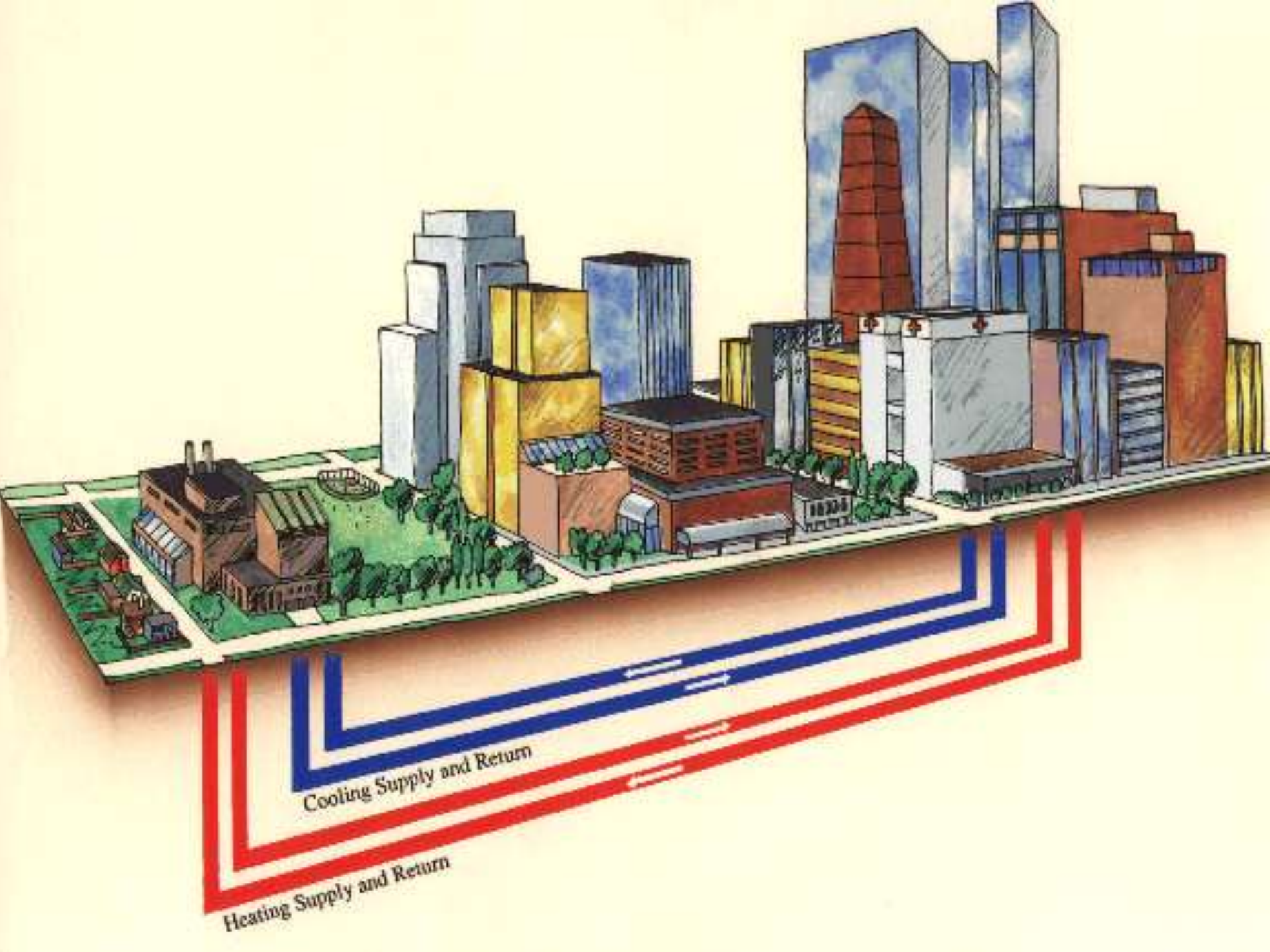


What are the components of a CHP system?



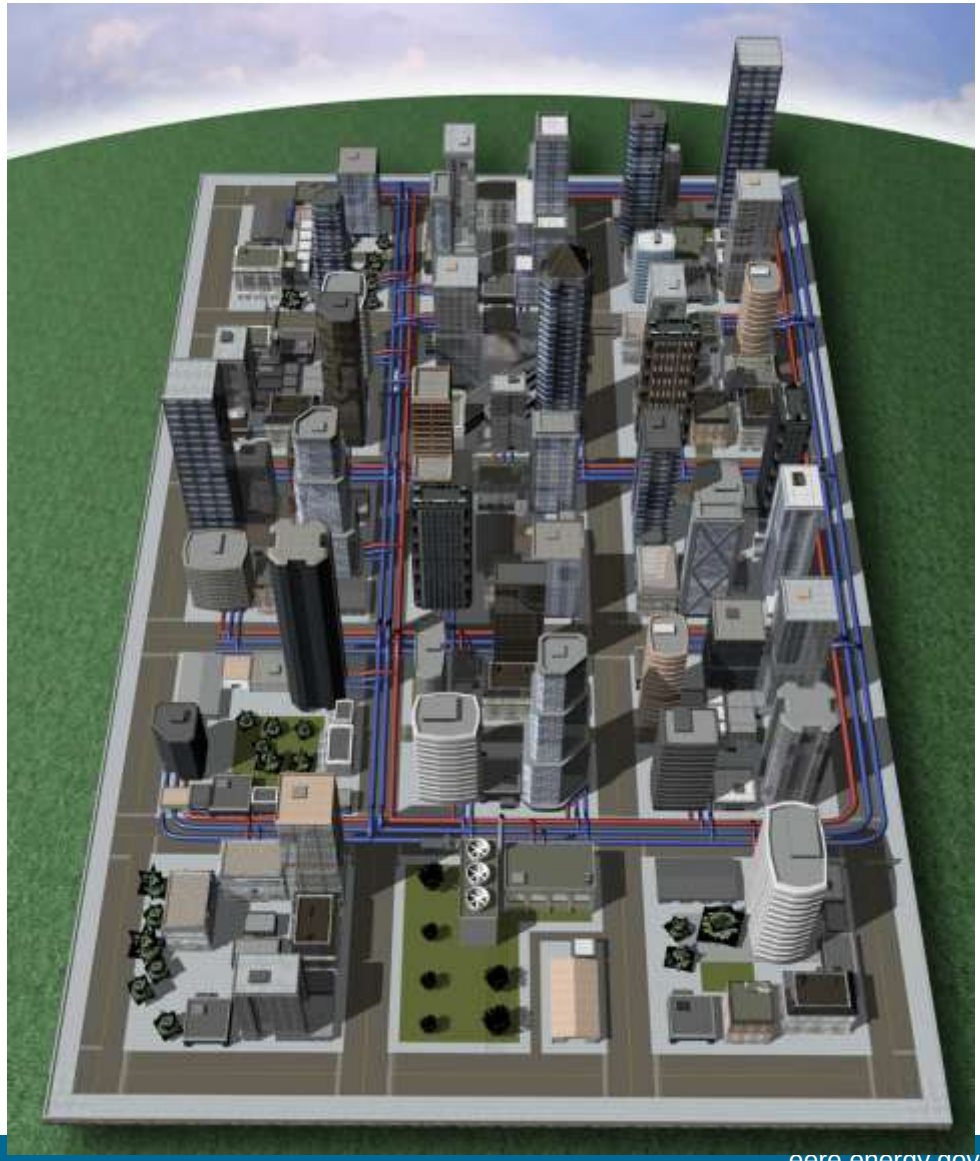
Waste Heat Recovery CHP – Bottoming Cycle



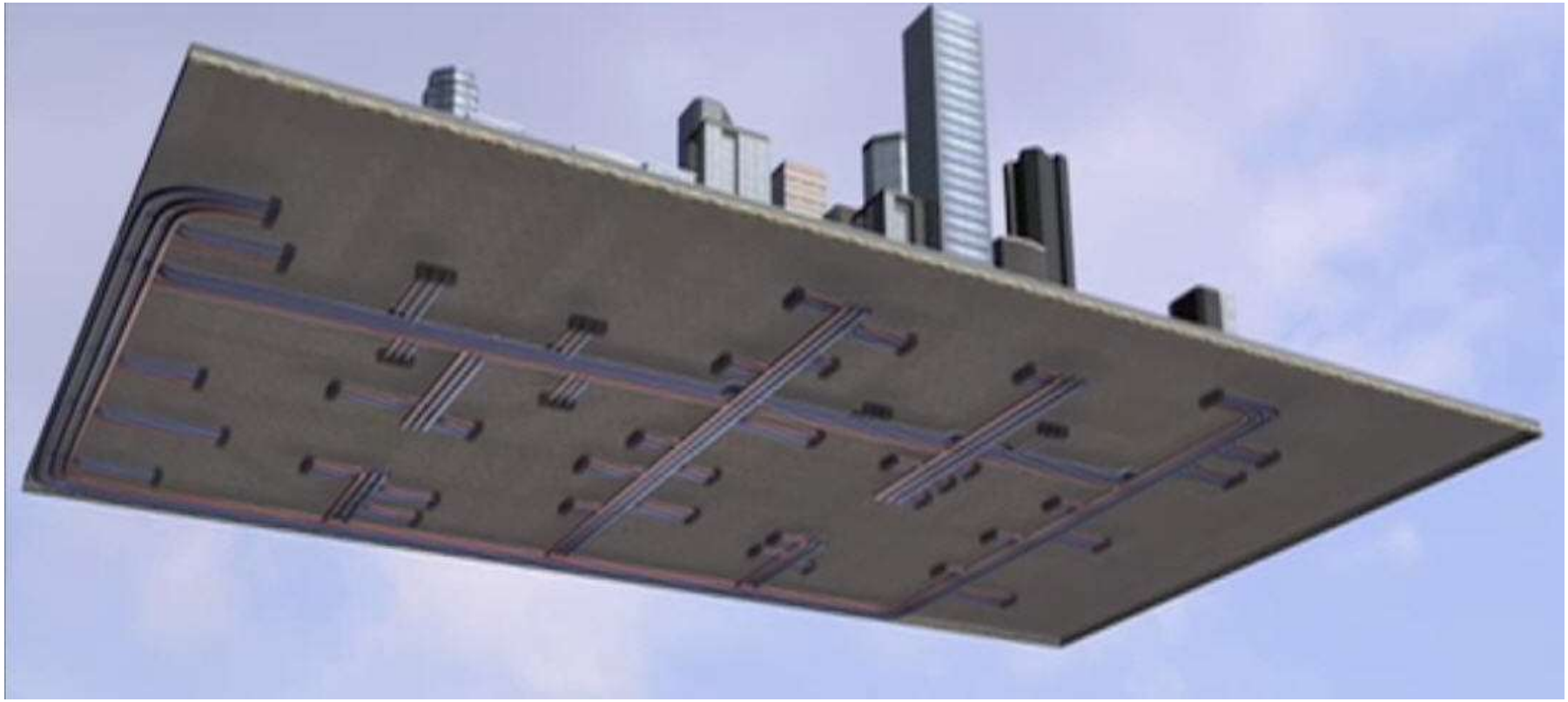

Cooling Supply and Return
Heating Supply and Return

District Energy – Community Scale Heating and Cooling

- Underground network of pipes "combines" heating and cooling requirements of multiple buildings
- Creates a "market" for valuable thermal energy
- Aggregated thermal loads creates scale to apply fuels, technologies not feasible on single-building basis
- Fuel flexibility improves energy security, local economy



Infrastructure for Local Clean Energy Economy



- Connects thermal energy sources with users
- Urban infrastructure – hidden community asset
- Energy dollars re-circulate in local economy
- High quality jobs in construction & operation

Impact on End User/Customer

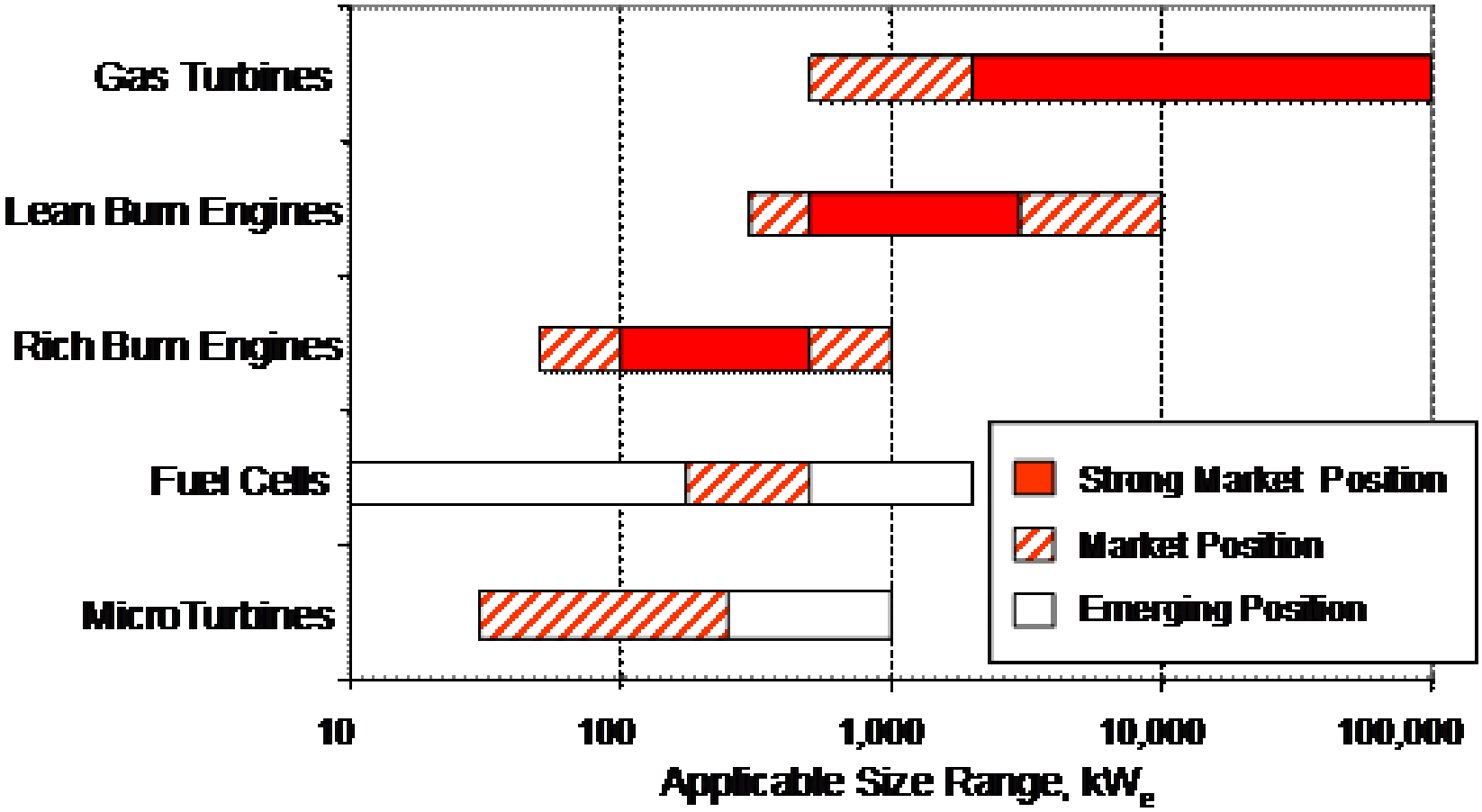
- Customer capital costs reduced or amortized over long term service agreement
- Reduces size mechanical room; electrical vaults; condenser shafts and roof loads
- Colder CHW supply improves HVAC performance
- Lower owning, operating and maintenance costs
- More leasable space

CHP Integrated System

- Prime Movers:
  - Reciprocating Engines
  - Industrial Gas Turbines
  - Micro-turbines
  - Steam Turbines
  - Fuel Cells
- Heat Recovery (Exchangers)
  - Hot Water
  - Steam
  - Direct Exhaust Gases

- Thermal Systems:
  - Absorption Chillers
  - Steam or Hot Water Heating Loops
  - Steam Turbines (Bottoming Cycle)
  - Desiccants
- Generators
  - Synchronous
  - Induction
  - Inverter

CHP Prime Movers (Power Generation Technologies)



Source:

Gas Combustion Turbines

- Similar to a jet engine as a stream of inlet air is compressed, heat is added and then the high pressure outlet stream turns a reaction turbine at high speed which in turn drives a generator
- Generally used for larger applications (>4MW)
- Good when high pressure steam is required

Source: Industrial Turbine by Siemens Westinghouse
www.siemenswestinghouse.com

Reciprocating Engines

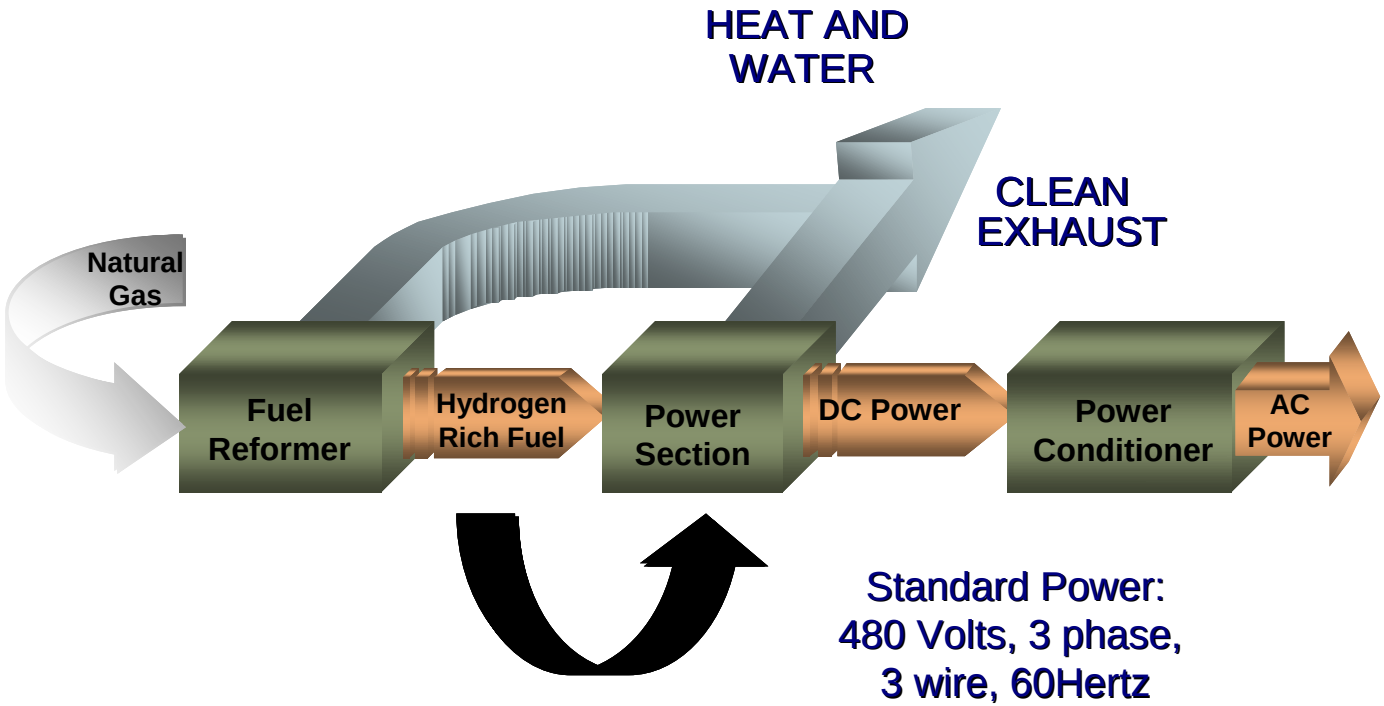
- Similar to gasoline fuelled cars (spark-ignited Otto cycle) or diesel counterparts (compression ignited)
- Most common for CHP <5 MW
- Good for hot water/low

  pressure steam applications

Picture Courtesy of Caterpillar

Fuel Cell System

- Electrochemical Reaction (like a battery)
- Up to 250kW modules (can be stacked)
- Base load only, very quiet, environmentally clean
- Expensive Option



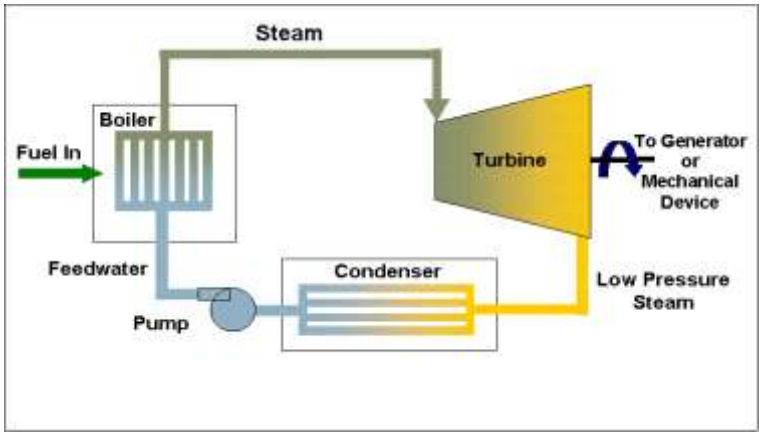
Microturbines

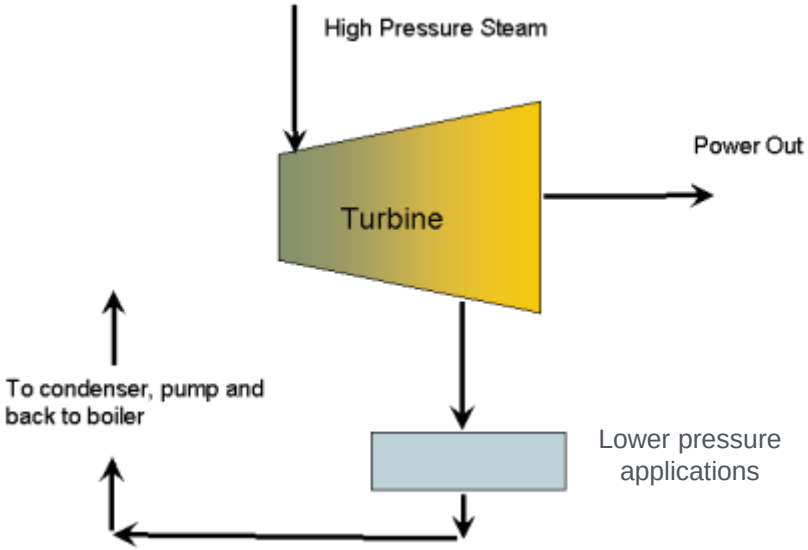
- Use heat to move turbine blades that produce electricity
- Compact in size, brought on line quickly, fuel flexibility, low emissions
- Usually below 200kW unless multiple units utilized
- Good for hot water

Source: 30-kilowatt Capstone microturbine
www.capstone.com

Steam Turbine

- One of the oldest prime mover technologies still in use
- Steam turbines extract heat from steam and transform it into mechanical work by expanding the steam from high pressure to low pressure
- Size range: <1 MW to >500 MW
- Two types of steam turbines: condensing and backpressure





CHP Prime Movers (Power Generation Technologies)

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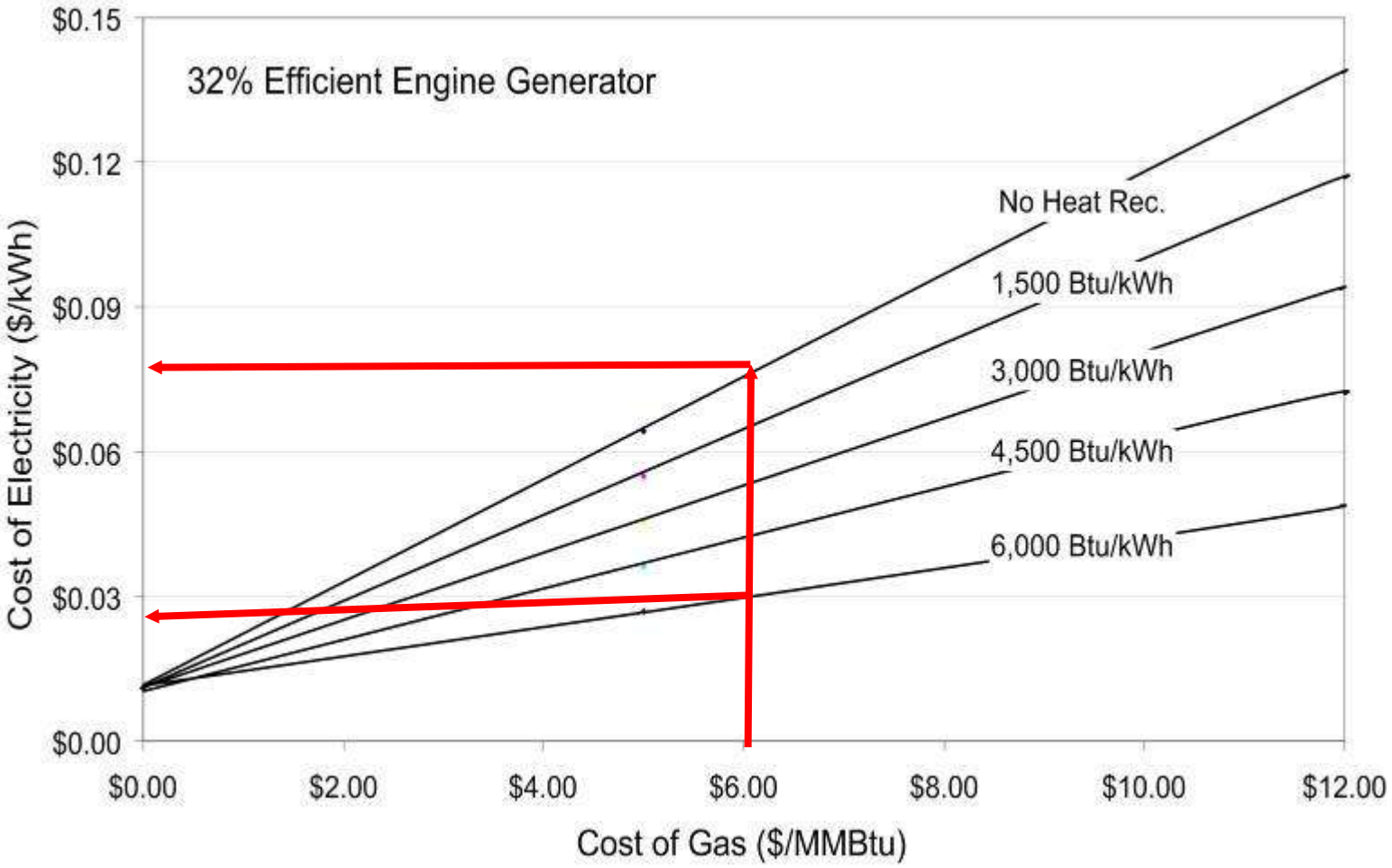
Prime Mover	Pic	Description	Size Range	Heat Recovery
Reciprocating Internal Combustion (IC) Engines		Operate on a wide range of liquid and gaseous fuels but no solid fuels. The reciprocating shaft power can produce either electricity through a generator or drive loads directly.	< 5 MW	Hot water, Low Pressure Steam, Exhaust
Gas (combustion) Turbines		Use heat to move turbine blades that produce electricity (larger applications).	> 2 MW	Large steam loads and high pressure steam
Microturbines		Use heat to move turbine blades that produce electricity (smaller scale).	30 – 250 KW	Hot water and exhaust gases
Fuel Cells		Produces an electric current and heat from a chemical reaction between hydrogen and oxygen rather than combustion. They require a clean gas fuel or methanol with various restrictions on contaminants.	< 2 MW	Hot water and low pressure steam
Steam Turbines		Convert steam energy from a boiler or waste heat into shaft power.	> 50 kW	High pressure to low pressure steam drops

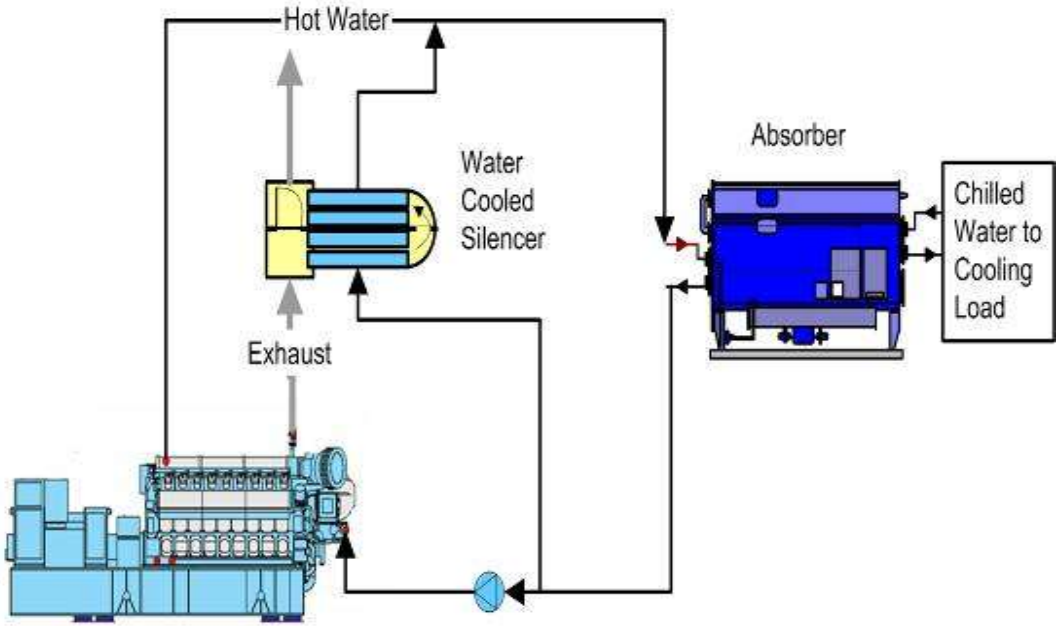
Source:

Impact of Heat Recovery is Critical



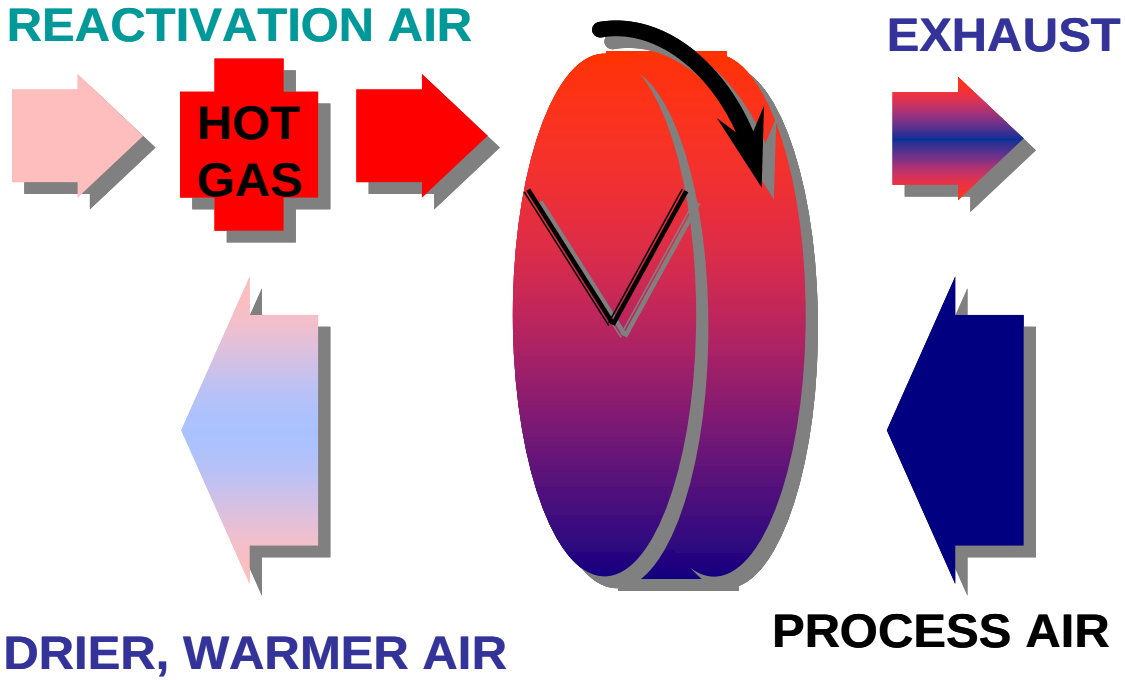
CHP Thermally Activated Technologies

- Absorption Chillers
  - Uses Waste Heat to Generate Chilled Water for Air Conditioning
  - Provides Waste Heat Load During the Cooling Season



CHP Thermally Activated Technologies

- Desiccant Dehumidifiers
  - Removes Moisture From Air (Latent Load)



Normal CHP Electrical Configuration

- CHP Systems are Normally Installed in Parallel with the Electric Grid (CHP does not replace the grid)
- Both the CHP and Grid Supply Electricity to the Customer

Generators

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Induction

- Requires External Power Source to Operate (Grid)
- When Grid Goes Down, CHP System Goes Down
- Less Complicated & Less Costly to Interconnect
- Preferred by Utilities

Synchronous

- Self Excited (Does Not Need Grid to Operate)
- CHP System can Continue to Operate thru Grid Outages
- More Complicated & Costly to Interconnect (Safety)
- Preferred by CHP Customers

U.S. CHP Installation Status (2009)

- 84,570 MW installed at 3,500 sites (nationally)
- Average capacity is 24.2 MW
- Median capacity is 1.2 MW
- Represents almost 8% of total U.S. generating capacity
- *Saves over 3 quads of fuel each year!*
- *Eliminates over 400 million tons of CO_2 emissions each year!*

Source: ICF International

CHP Market by Type of Prime Mover

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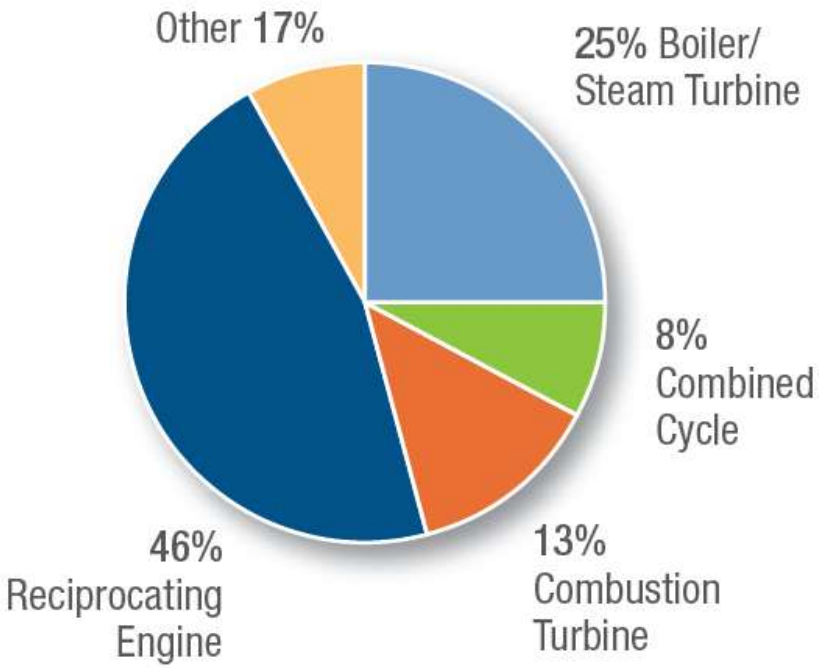
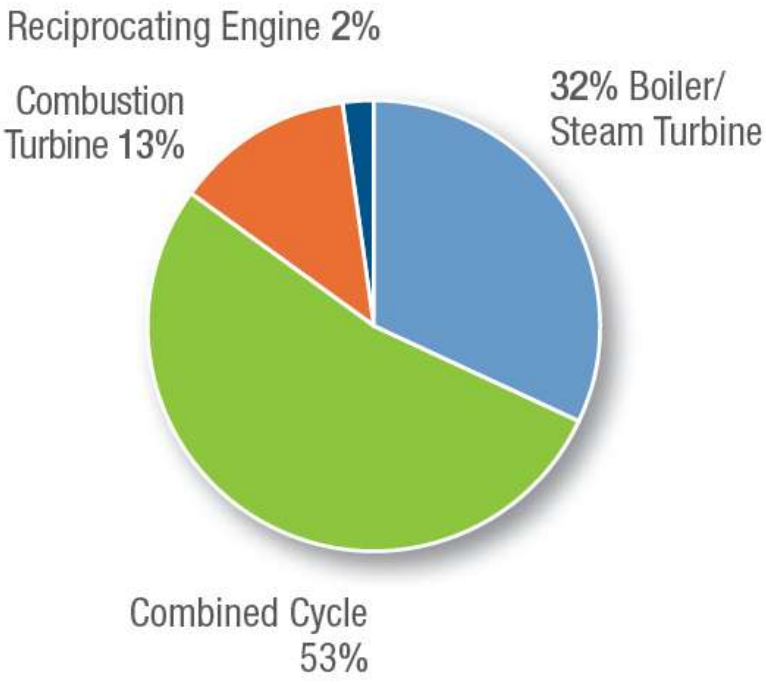
Sites by System Type



3,509 CHP Installations

Capacity by System Type



84.4 GW Generating Capacity

Almost 50% of all CHP installations incorporate reciprocating engines

CHP Market by Fuel Type

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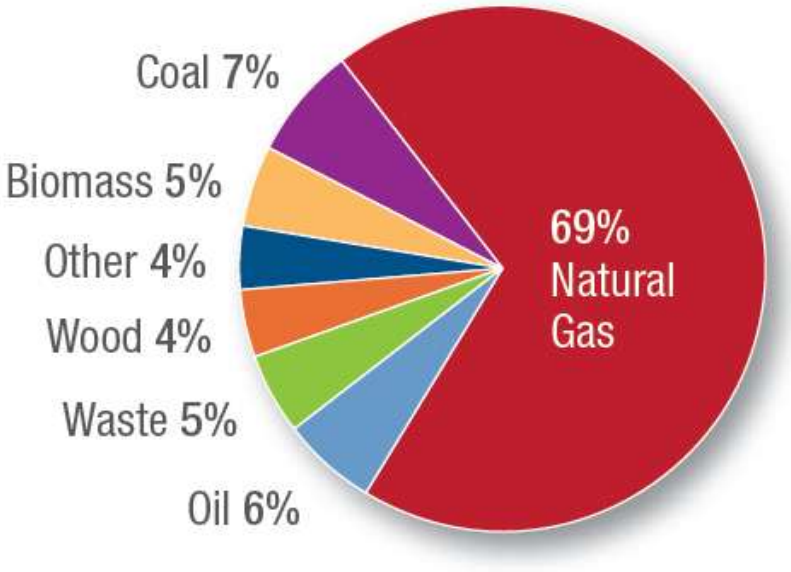
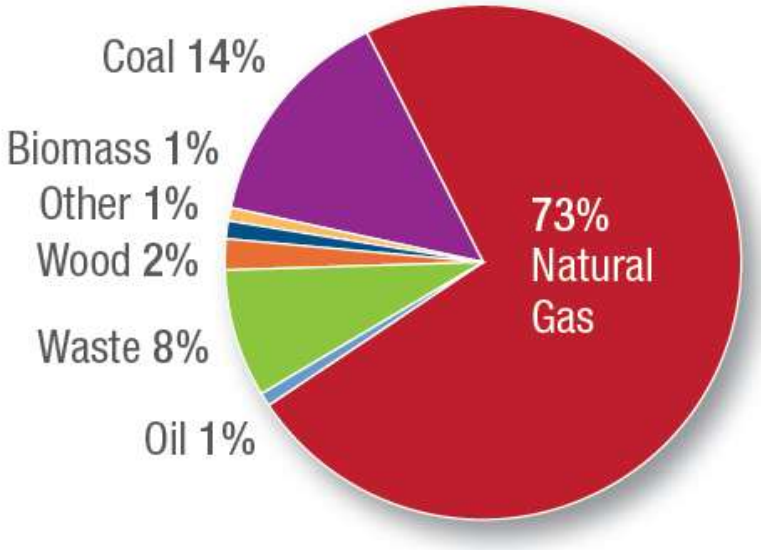
Sites by Fuel Type



3,509 CHP Installations

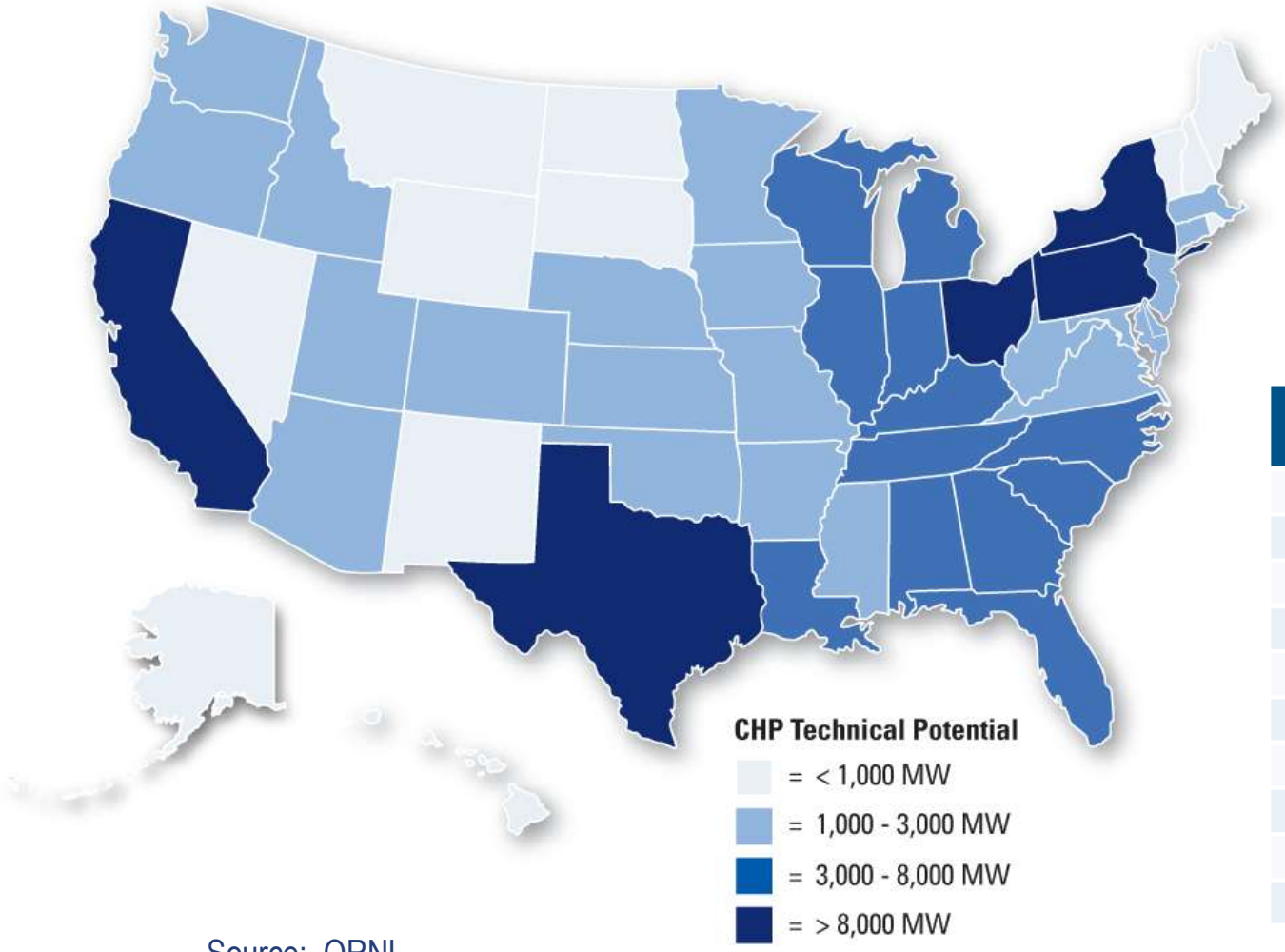
Capacity by Fuel Type



84.4 GW Generating Capacity

Natural gas dominates CHP installations

The Potential for Additional CHP Is Nationwide



Source: ORNL

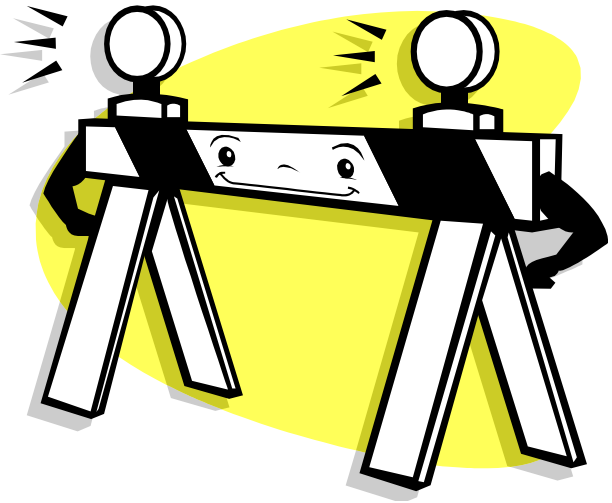
Rank	State	Total Capacity 2006 (MW)
1	TX	17,240
2	CA	9,220
3	LA	6,959
4	NY	5,789
5	FL	3,545
6	NJ	3,493
7	AL	3,362
8	PA	3,242
9	MI	3,104
10	OR	2,523

Where does CHP make sense?

- **Industrial** – metallurgical, chemicals, cement, gypsum, ethanol, pulp and paper, food processing, etc.
- **Commercial** – hotels, office buildings, fitness centers, data centers, restaurants, supermarkets, etc.
- **Institutional** – hospitals, colleges/universities, high schools, etc.
- **District Energy** – campuses, business parks, communities, etc.
- **Municipal** - landfills, wastewater treatment facilities, etc.
- **Agriculture** – livestock waste (dairy, hog, poultry), energy crops, etc.

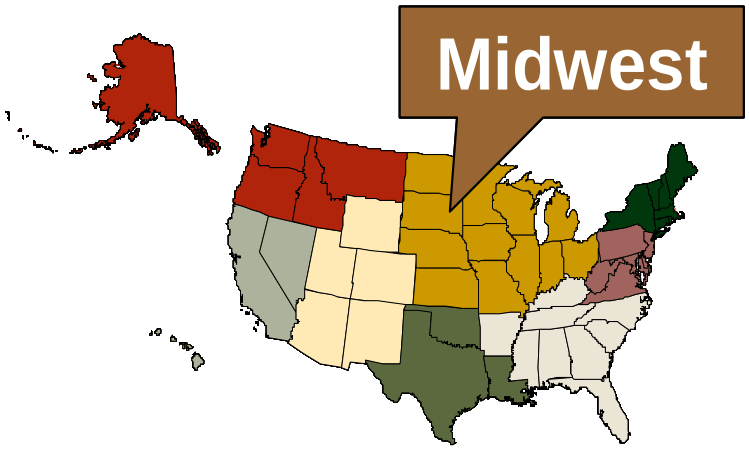
What Are The Barriers?

- **Technology is not the issue**
- **Financing and Policy are the issues**
  - Electric Utility Resistance
  - Unfavorable / Confusing Utility Rate Structures
  - Unstable Energy Prices
  - Energy Policies that do not adequately recognize CHP / waste heat recovery
  - Lack of adequate end user demand (education and frustration)

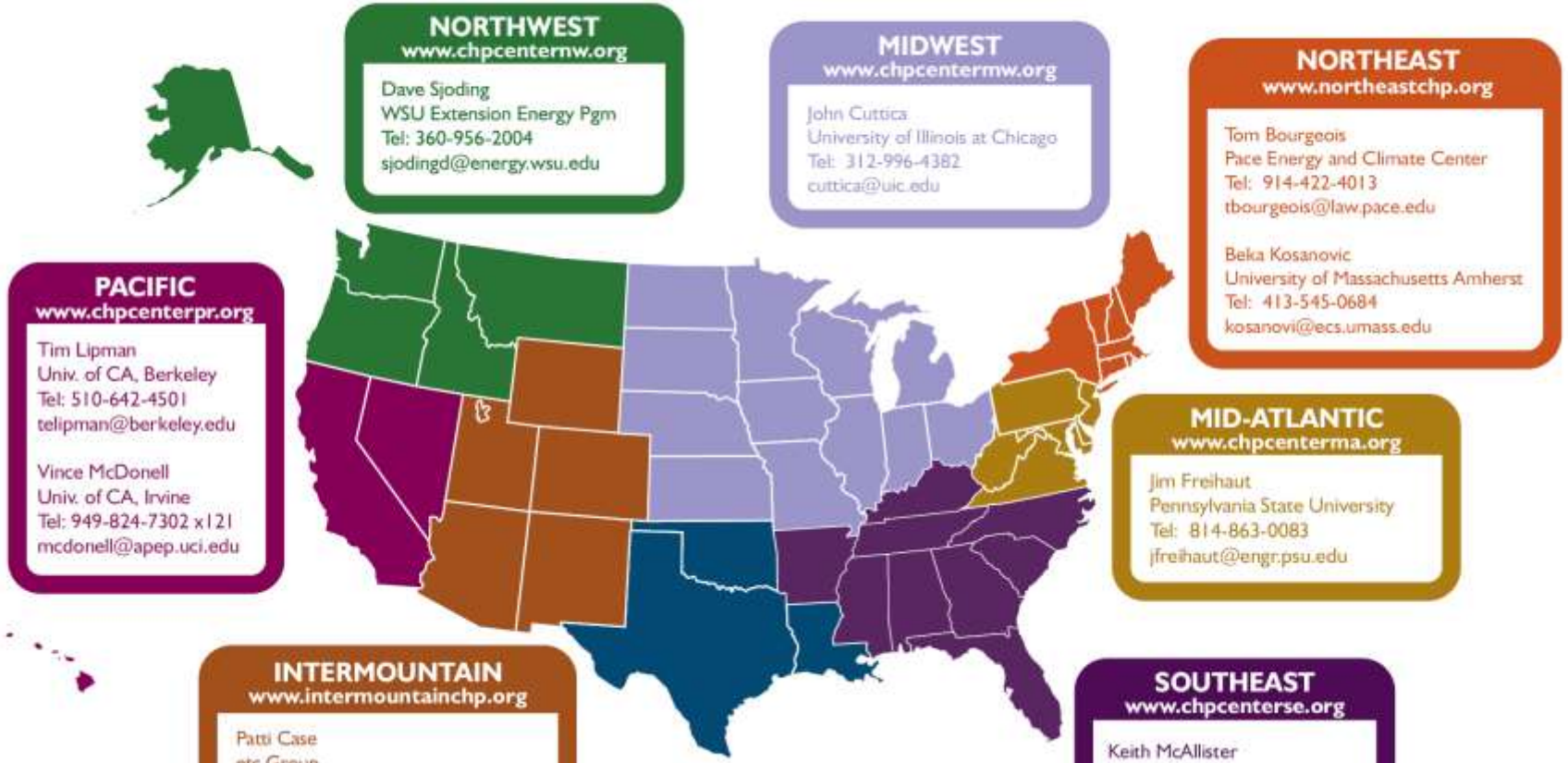


Acknowledgment

- **U.S. DOE Midwest Clean Energy Application Center**
- Originally established in 2001 by US DOE to support DOE CHP Challenge
- Today the center promotes the use of CHP, District Energy, and Waste Heat Recovery Technologies
- Strategy: Provide a technology outreach program to end users, policy, utility, and industry stakeholders focused on:
  - Targeted Education
  - Unbiased Information
  - Technical Assistance
- www.chpcentermw.org



DOE Clean Energy Application Center Locations, Contacts, and Web Sites



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Accessing TAP Resources

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

We encourage you to:

1) Explore our online resources via the Solution Center

2) Submit a request via the Technical Assistance Center

3) Ask questions via our call center at 1-877-337-3827 or email us at solutioncenter@ee.doe.gov

Upcoming Webinars

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Please join us again:

Title**: Local Power Empowers: CHP and District Energy**
Host: Jay Wrobel, MEEA
Date: November 8, 2010
Time: 2:00-3:00 EST
Title: **Driving Demand: Working with and Learning from Contractors**
Host: Merrian Fuller, LBNL
Date: November 9, 2010
Time: 2:00-3:15 EST
Title**: EM&V101: General Approaches to Tracking Data and Estimating Savings**
Host: Julie Michals, NEEP
Date: November 10, 2010
Time: 2:00-3:00 EST
Title: **Energy Efficiency Rebate Programs 101**
Host: Catul Kiti, Senior Manager Energy Efficiency Programs, ICF International
Date: November 15, 2010
Time: 12:00 -2:00 PM EST
Title: **State Clean Energy Policy Impact**
Host: Liz Doris, NREL
Date: November 17, 2010
Time: 3:00 -4:15 PM EST
Title: **Negotiating and Entering Into an ESPC**
Host: Meg Giuliano, ICF International and Sentech
Date: November 18, 2010
Time: 1:30 -2:30 PM EST
Title: **Community Renewables Projects**
Host: Cheryl Jenkins, VEIC
Date: November 30, 2010
Time: 2:00 -3:00 PM EST

For the most up-to-date information and registration links, please visit the Solution Center webcast page at www.wip.energy.gov/solutioncenter/webcasts

Questions & Comments

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Questions?

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EFG: Richard Faesy, rfaesy@energyfuturesgroup.com, 802-482-5001