



CHP and the Industrial Sector (Recycling Energy)

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Energy / Environmental Issues

- High Natural Gas Prices
- Natural Gas Price Volatility
- Rising Electric Prices
- Competitive Electric Market (Potential Price Volatility)
- Uncertain Environmental Constraints
 - Air & Water Permits
 - Global Warming (CO₂)
- Reliability – Natural / Man Made Disasters

Energy Efficiency

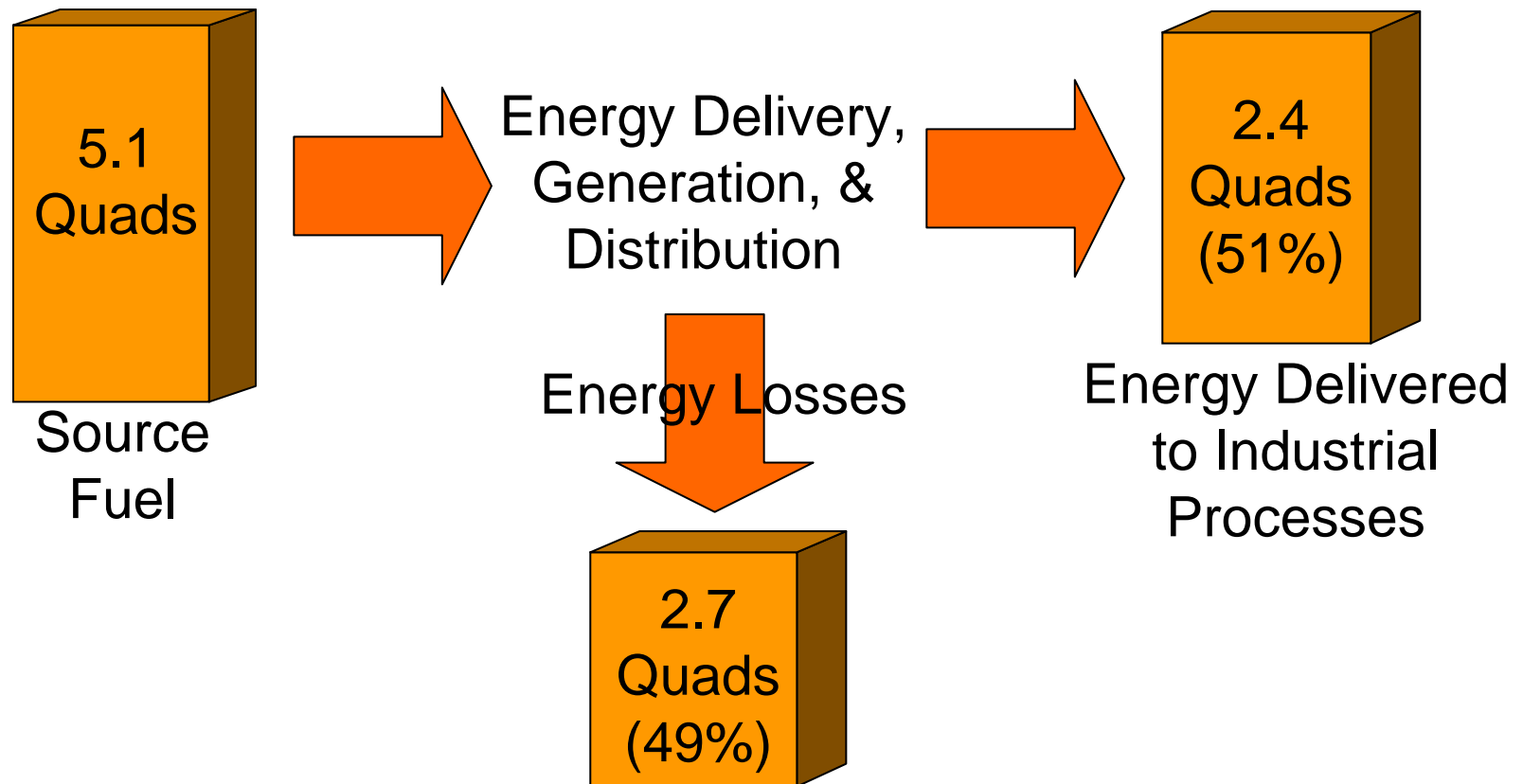
- “One” of Several Potential Solutions
- Reducing Energy Consumption Wisely In the Industrial Process Will:
 - Lowers Energy Bills
 - Lowers Emissions
 - Should Lower Energy Prices

Industrial Energy Efficiency Measures

- Eliminate Steam Leaks
- Energy Efficient Motors
- High Efficiency Boilers
- High Efficiency Chillers
- Energy Efficient Lighting
- Compressed Air Systems

What About CHP?

Example Industry Energy Situation

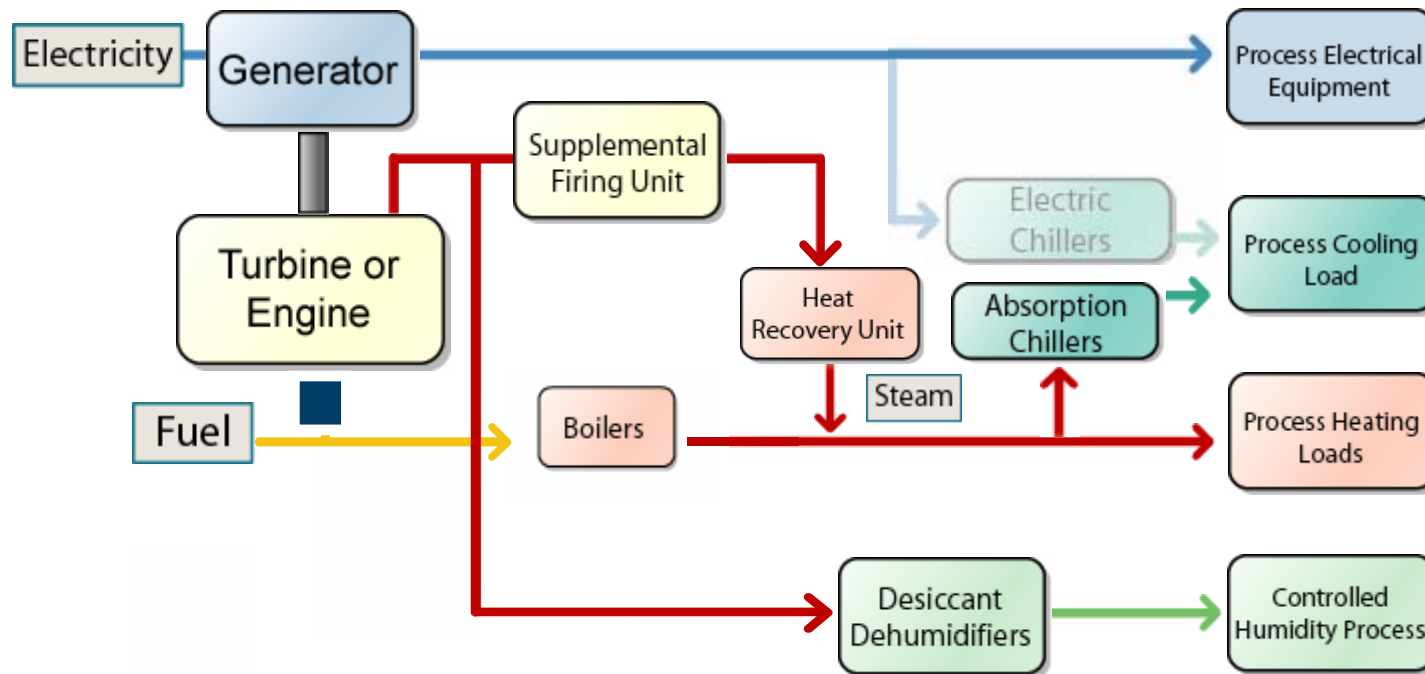


Source: MECS 1998

Why 50% of the Source Energy is Lost

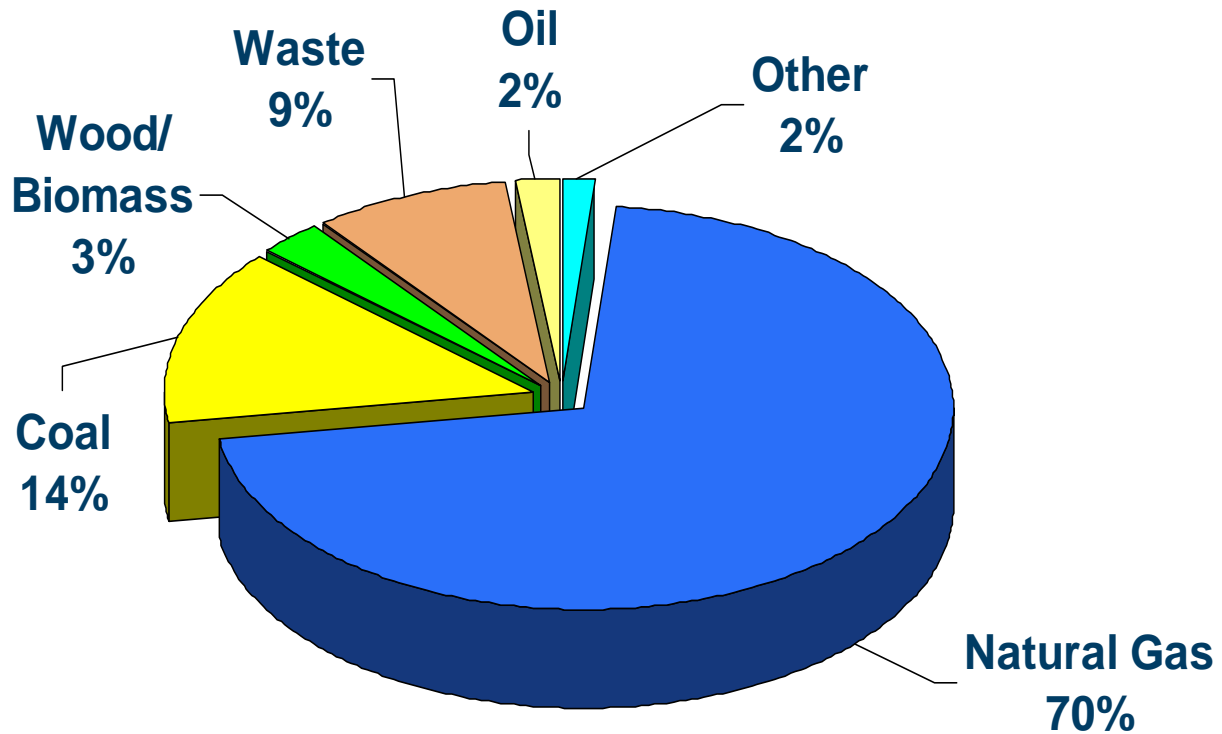
- Customer purchases power from grid
 - ✓ Power plant economy of scale
 - ✓ 10 units of fuel produces 3 units of power
 - ✓ No recovery of low/medium grade heat
- On-site generation of steam/hot water
 - ✓ 10 units of fuel produces 6-8 units of heat
- Combined grid power + on-site heat
 - ✓ Efficiency depends on heat/power ratio
 - ✓ 40 to 55% energy efficiency is common

Typical Industrial CHP System



Fuel Sources for CHP

- *Existing CHP Capacity (2005): 82,411 MW*



Source: EEA

Distributed Generation and CHP

DG is ...

- An Electric Generator
- Located At a Substation or Near a Building / Facility
- Generates at least a portion of the Electric Load

CHP is ...

- An Integrated System
- Located At or Near a Building / Facility
- Generates at Least a Portion of the Electric Load
- **Recycles** the Heat From the Generation Equipment for
 - Space Heating / Cooling
 - Dehumidification
 - Process Heat / Chilled Water

CHP System Sizes (Terminology)

<u>System Designation</u>	<u>Size Range</u>	<u>Comments</u>
Mega	50 to 100+ MWe	Very Large Industrial Usually Multiple Smaller Units Custom Engineered Systems
Large	10's of MWe	Industrial & Large Commercial Usually Multiple Smaller Units Custom Engineered Systems
Mid	10's of kWe to Several MWe	Commercial & Light Industrial Single to Multiple Units Potential Packaged Units
Micro	<60 kWe	Small Commercial & Residential Appliance Like

Why is There an Opportunity?

- DOE/EIA Project Over 360 GWe of New Capacity
 - To Meet Growing Demand
 - To Compensate for Plant Retirements
- Today's Central Station Plants Lose 23 Quads of Thermal Energy
- Aging Electric Transmission/Distribution System
 - Difficult to Site New Lines
 - Capacity Constrained
 - Costly to Maintain

Why is There an Opportunity?

- Rising Concerns Over
 - Blackouts/Brownouts
 - Power Supply Constraints
 - Electricity Prices
- Selected Power Outage Costs

<u>Industry</u>	<u>Avg. Cost of Downtime</u>
Cellular Communications	\$41,000 per hour
Telephone Ticket Sales	\$72,000 per hour
Airline Reservations	\$90,000 per hour
Credit Card Operations	\$2,580,000 per hour
Brokerage Operations	\$6,480,000 per hour

What are the Customer Benefits of CHP?



CHP does not make sense in all applications, but where it does make technical and economic sense, it will provide

- Lower Energy Costs
- Reduced Energy Consumption
- Increased Reliability
- Standby Power
- Lower Emissions than Central Station Plants

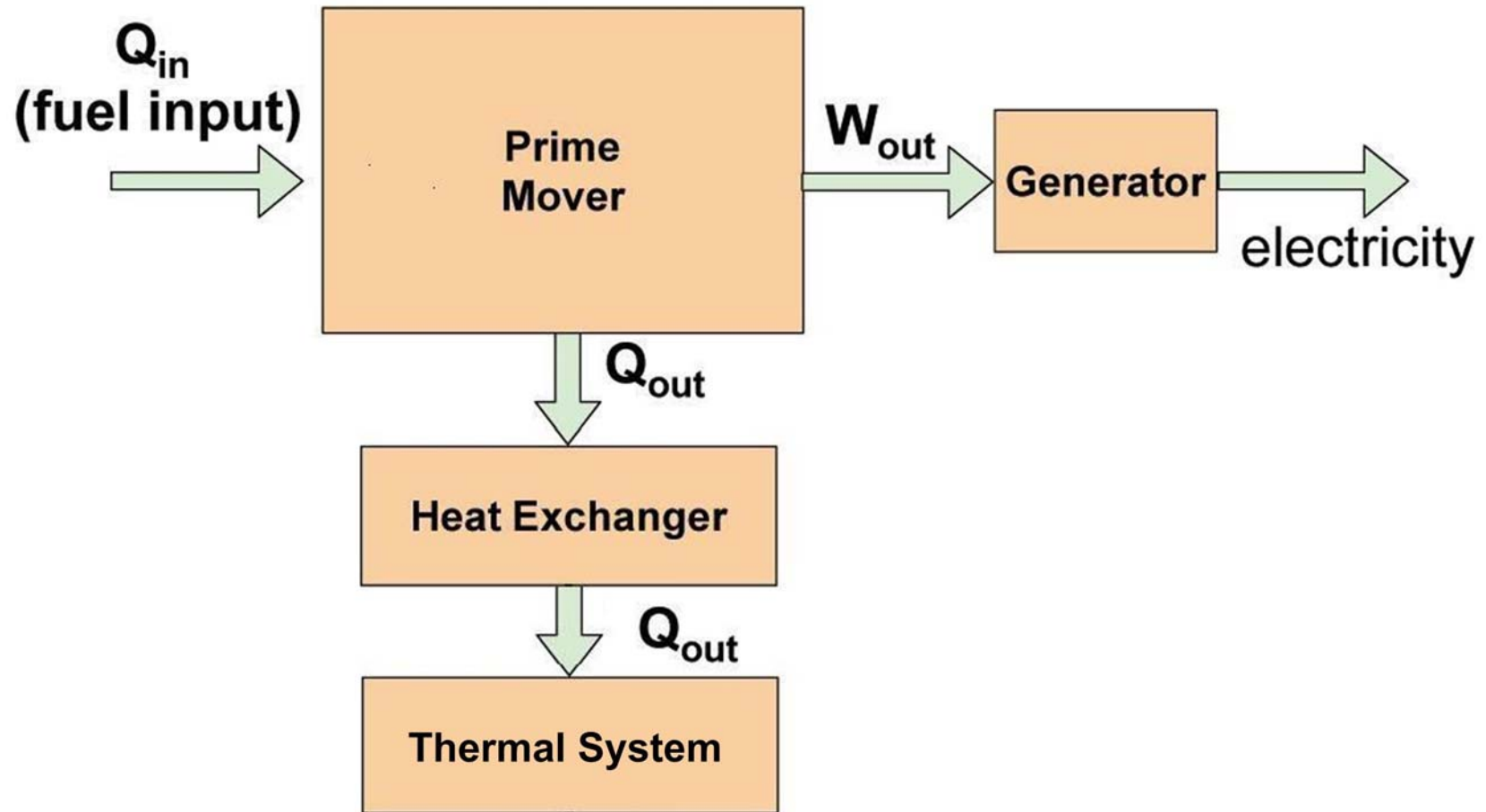
Market Challenges

- Lack of a Critical Need (high energy prices??)
- Unstable / Uncertain Energy Prices (Deregulation?)
- Electric Utility Resistance
- Lack of Awareness of the Technology Concept, Status, Benefits, and Issues
- Need for Internal Champions: Technical & Financial
- Competing for Capital Development \$
- Quantifying Non Utility Cost Benefits

Types of DG and CHP Systems – Technology Building Blocks

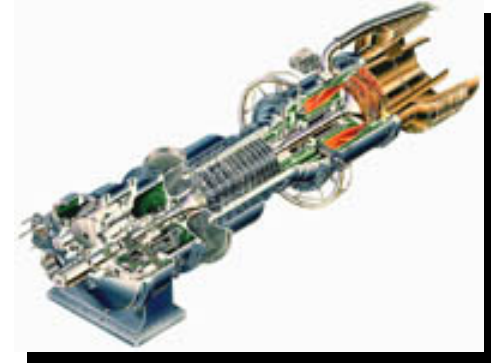
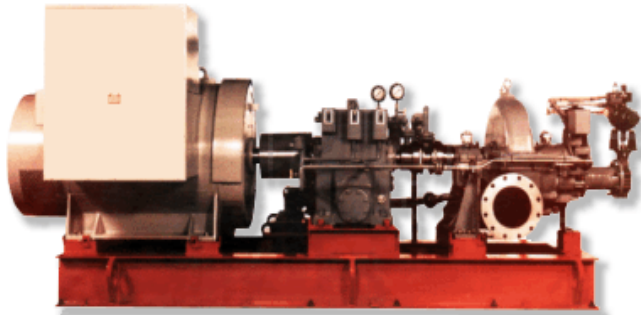


Basic Components



CHP Prime Movers

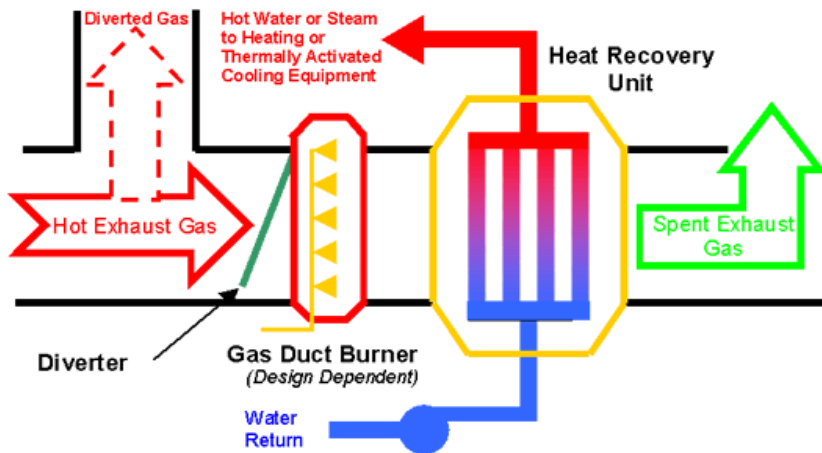
- Reciprocating Engines
- Industrial Gas Turbines
- Micro-turbines
- Steam Turbines
- Fuel Cells



Heat Recovery (Recycled Energy)

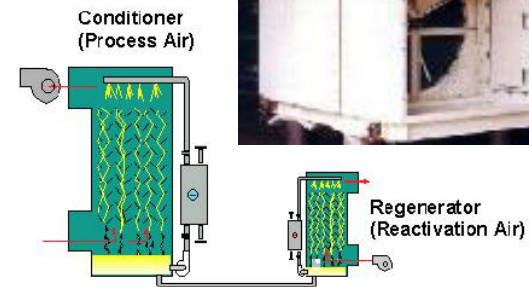
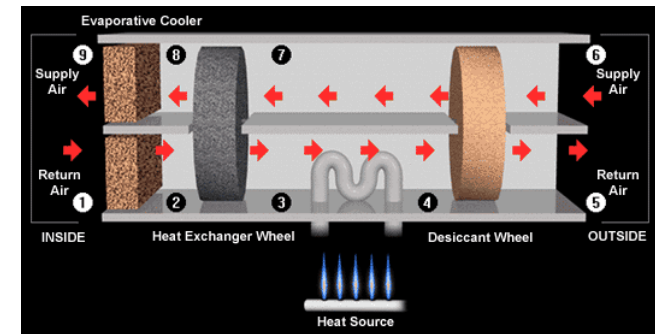
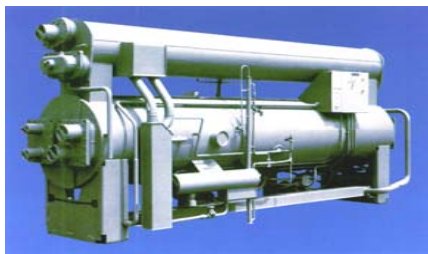
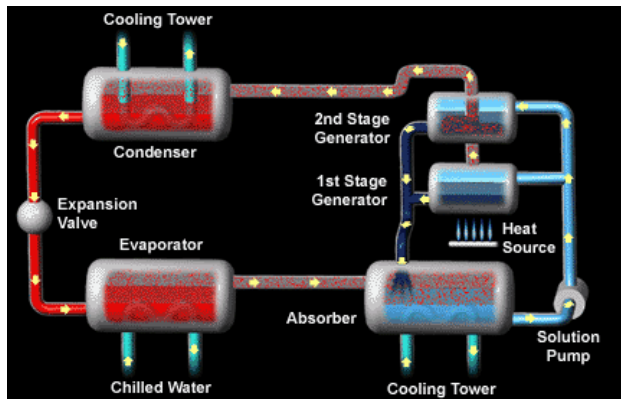


- Steam and Hot Water
- Exhaust Gases



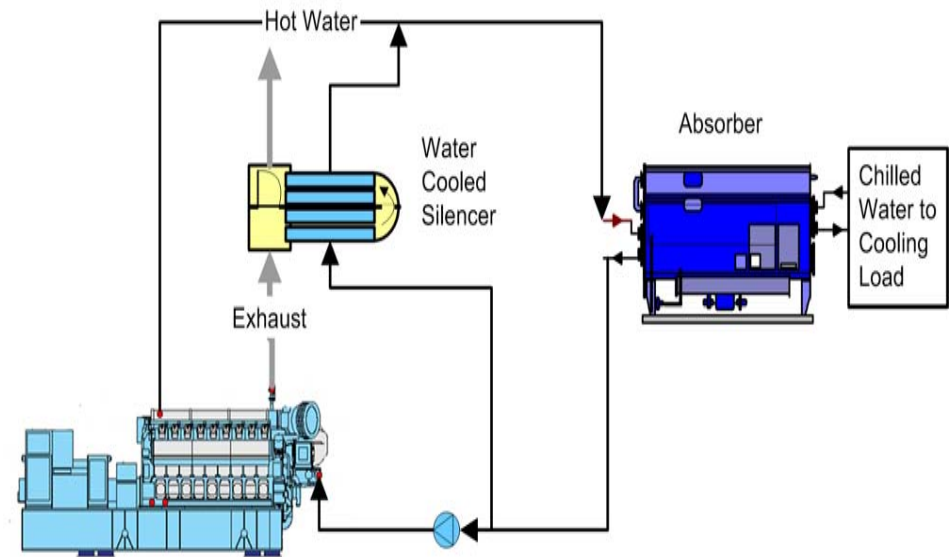
Thermally Activated Technologies

- Absorption Chillers
- Desiccant Dehumidification
- Steam or Hot Water Heating Loops



Absorption Chillers

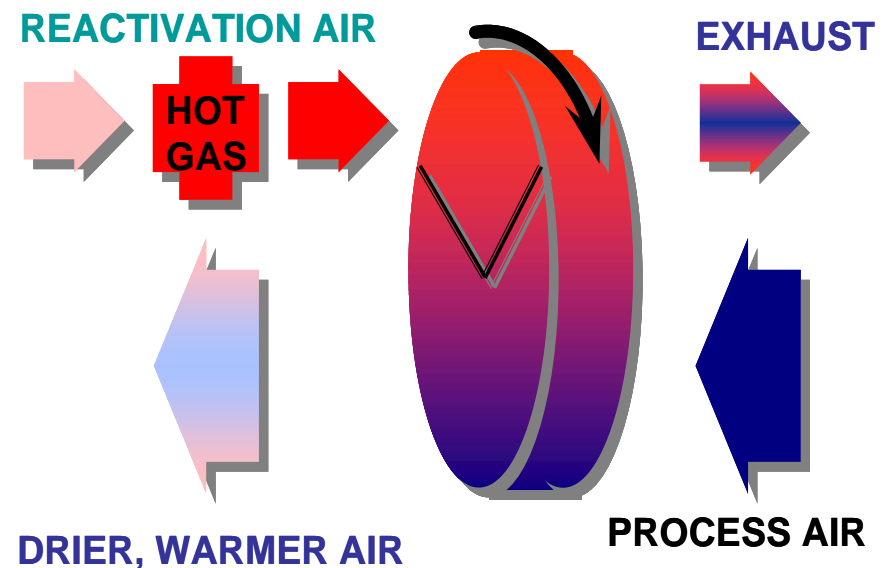
- Use Waste Heat to Generate Chilled Water for Air Conditioning
- Significant Advances in Absorption Technology
- Provides Waste Heat Load During the Cooling Season



Picture Courtesy of Trane

Desiccant Dehumidification

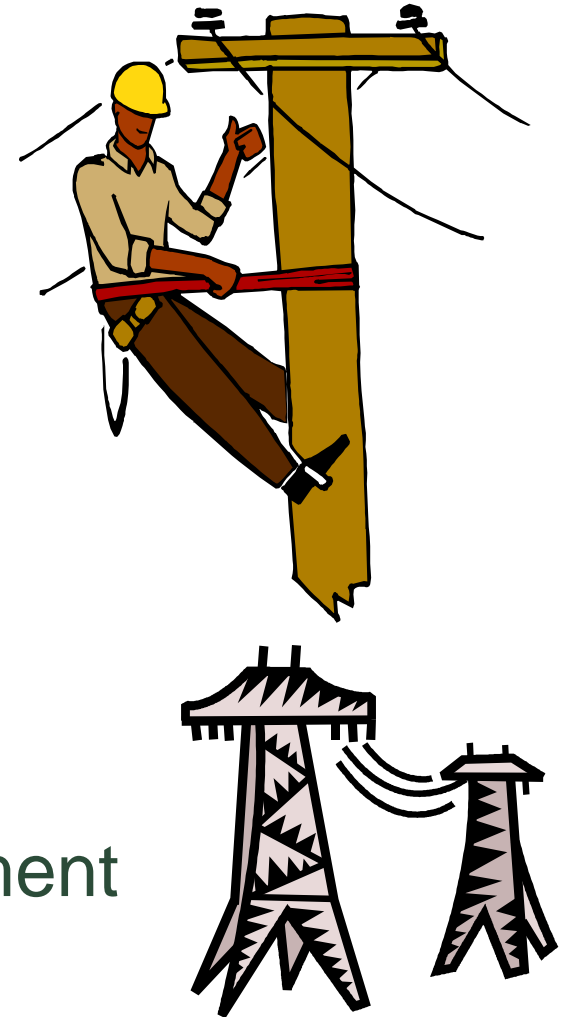
- Removes Moisture From Air (Latent Load)
 - Reduces the Demand on the Cooling System to Reduce Humidity
 - Improves Indoor Air Quality
 - Reducing Mold Growth
 - Reducing “Over Cooling”
 - Allowing Higher Make-Up Air Rates for the Same Energy Usage



Other Components to CHP Installation

- Grid Interconnect:
 - Isolation Switch
 - Switchgear
 - Protection Relays
 - Synchronizing Equipment

- Installation:
 - Equipment Footprint
 - Floor Loading
 - Proximity To HVAC Equipment
 - Number of Electrical Feeds



CHP Is A Low Technical Risk

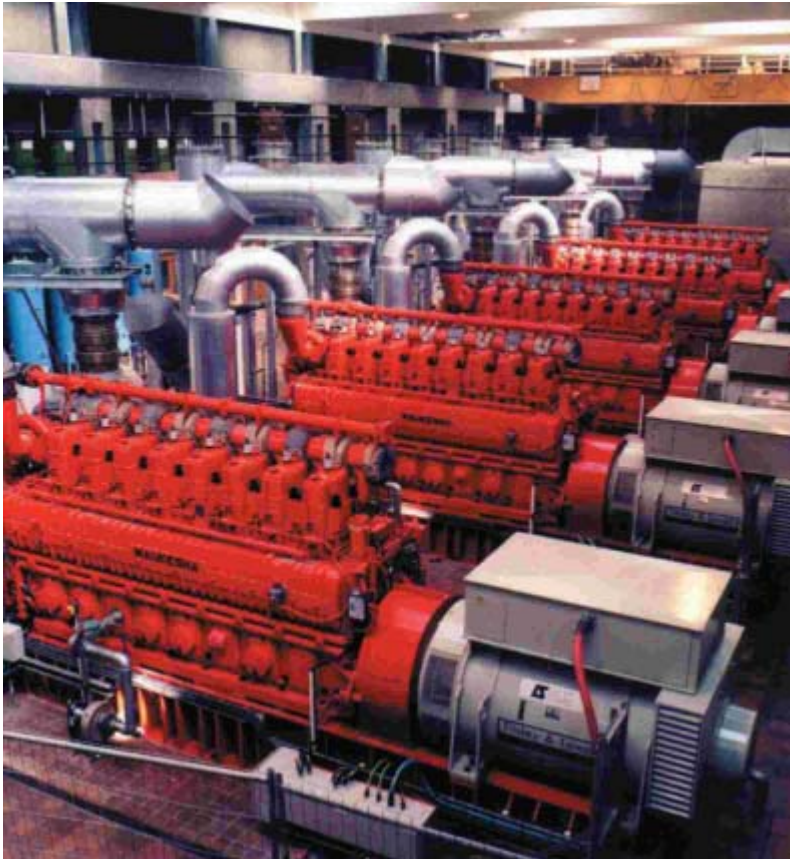
- Utilize Proven Technologies
- Employ Standard Design Practices
- Incorporate Good Maintenance Practices

CHP Is More a Financial and Regulatory Risk

CHP Regulatory Requirements

- Grid Interconnection --- Lack of Standards
- Utility Standby / Backup Rates
- Environmental Permitting
 - Air Permitting
 - Water Permitting
- Other Permitting Requirements
 - Local Codes
 - OSHA

When Does CHP Make \$ense?

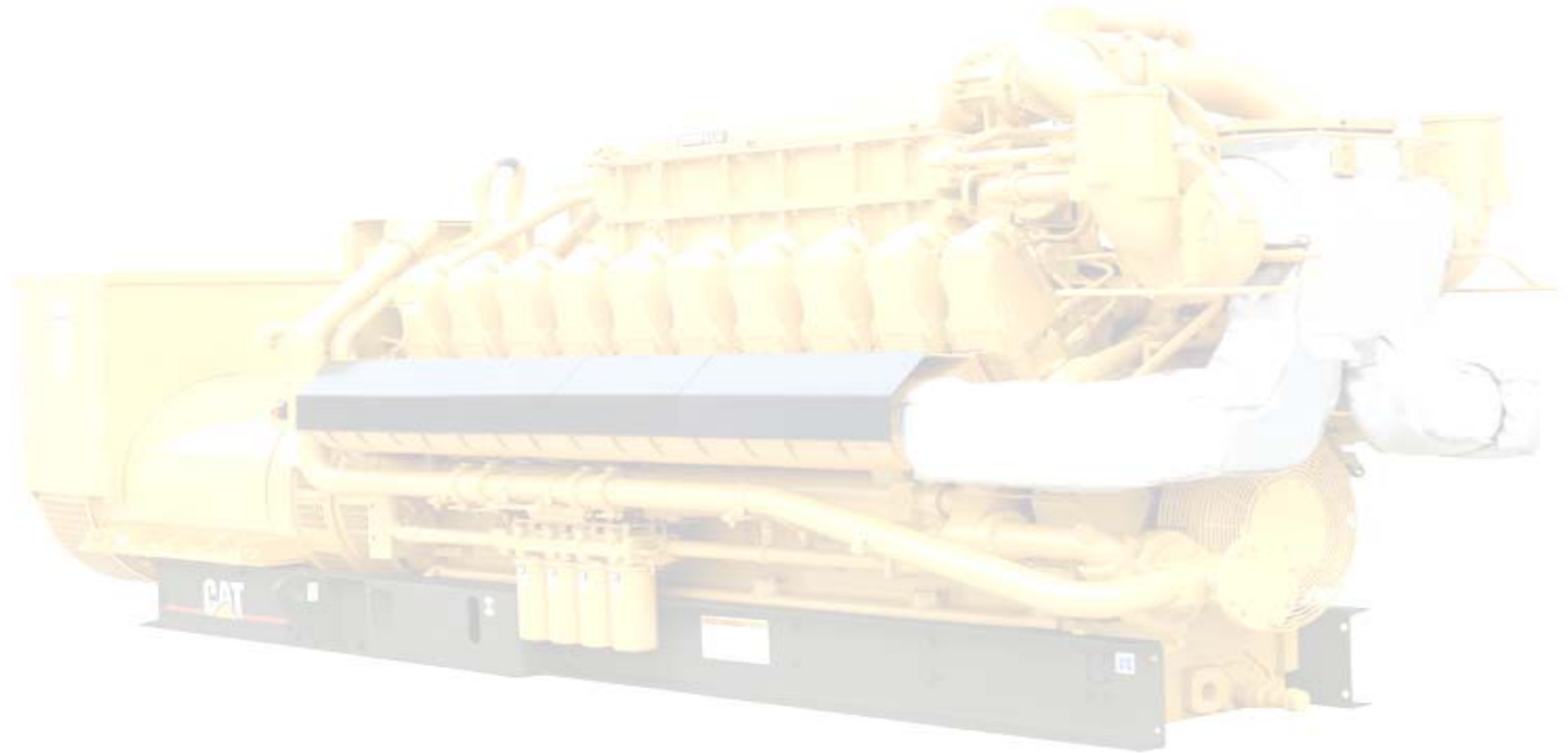


- High Thermal and Electric Loads that Occur Coincidentally
- Sufficient “Spark Spread”
- Long Operating Hours
- Central Heating and Cooling System
- Added Needs (Reliability, Power Quality etc.)

Candidate Applications for CHP

- Hospitals
- Colleges / Universities
- High Schools
- Residential Confinement
- High Rise Hotels
- Fitness Centers
- Food Processing
- Paper / Lumber Mills
- Chemical Plants
- Metal Fabrication
- Petroleum (Refining)
- Plastic Forming
- Ethanol Plants
- Landfill / Waste Water Treatment Plants

CHP – Example Application

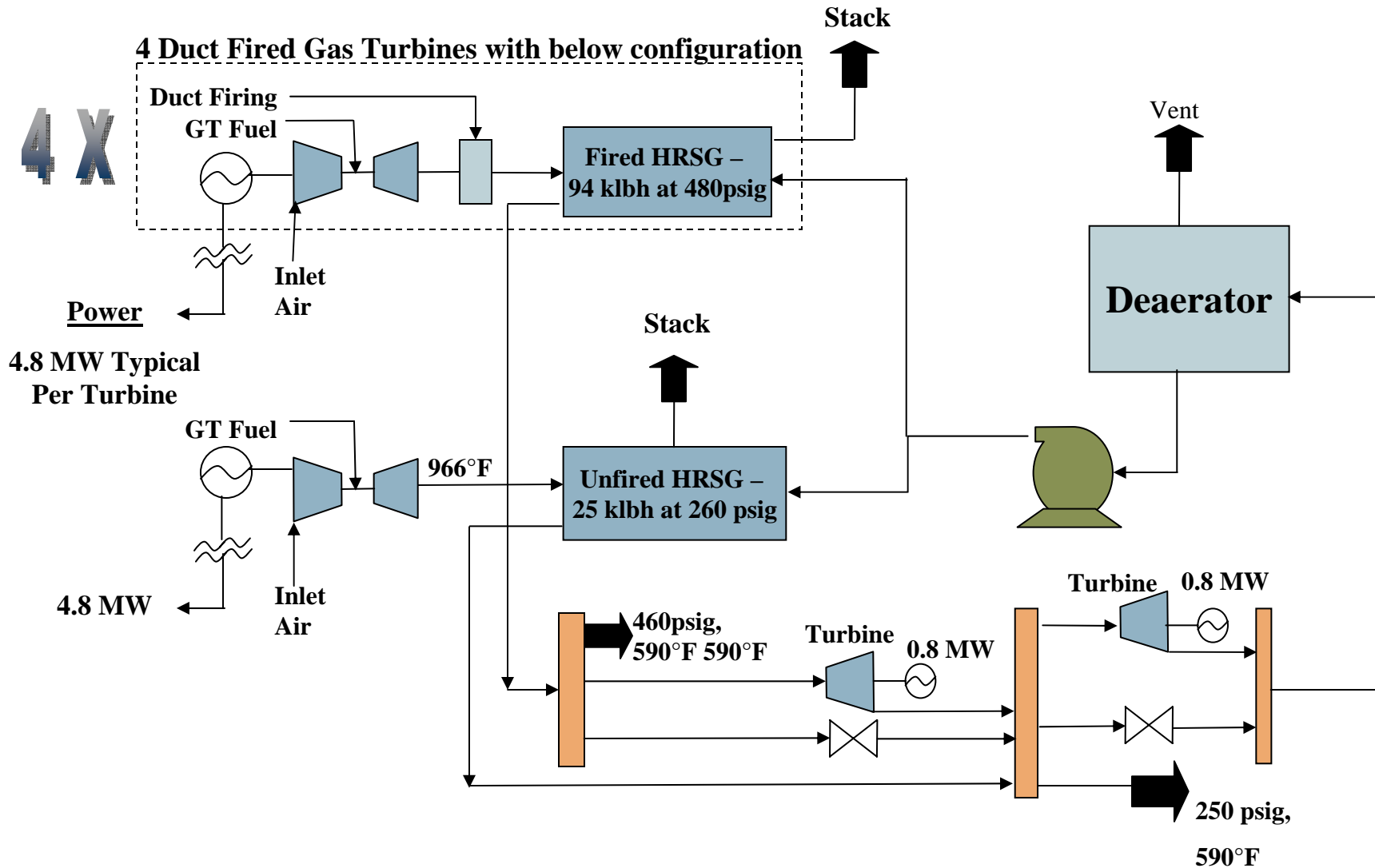


Ashtabula - Combined Heat & Power – Customer Profile

- Customer – Lyondell, formerly Millennium Inorganic Chemicals
- Produces Titanium-Dioxide (TiO₂)
- Electric load averages about 18 MW
- Steam load
 - ✓ 100 to 125 klbs/hour at 480 psig and 590 F
 - ✓ 100 to 125 klbs/hour at 260 psig and 590 F
- System owned and operated by Cinergy Solutions

Ashtabula - Equipment Summary

- 5 – 4.8 MW Rolls Royce gas turbine generators (24 MW)
- 2 – Turbo-Steam back pressure steam turbine generators
 - ✓ 1 - 0.8 MW @ 480 to 250 psig steam
 - ✓ 1 - 0.8 MW @ 250 to 50 psig steam
- 1 – 0.6 MW Kohler black start diesel
- 5 – ERI Heat Recovery Steam Generators
 - ✓ 4 – 94 klb/hr @ 480 psig/635 F with duct burners
 - ✓ 1 – 25 klb/hr @ 260 psig/635 F without duct burners

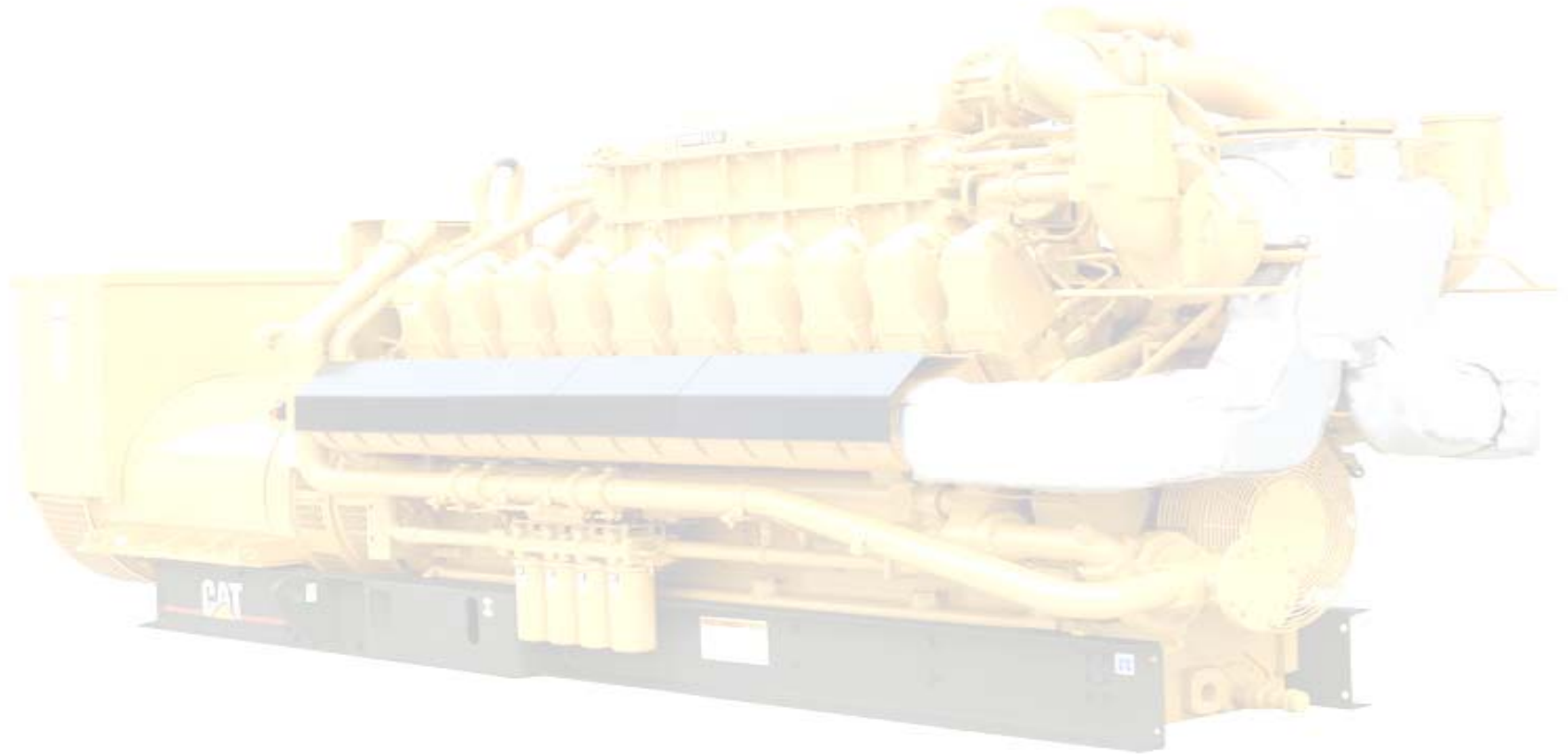


Ashtabula – CHP System Configuration

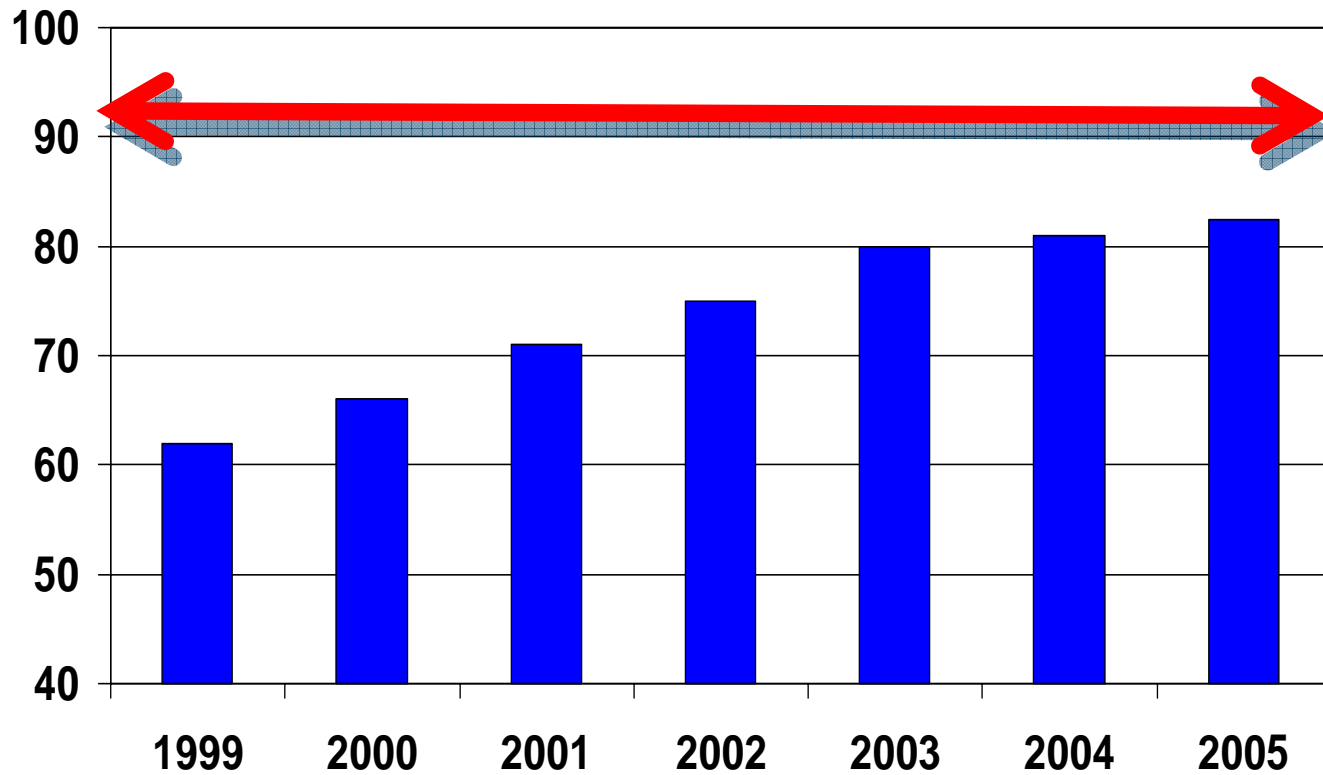
Ashtabula – August 2003 Blackout

- Provided electricity and steam to host throughout the electric outage
- Customer had to shut down production due to lack of nitrogen
- CHP System provided electricity to host after manufacturing was shutdown to keep processes warm and equipment ready for operation
- The only power plant in NE Ohio that stayed on throughout the blackout

Market Status of CHP



Annual Installed Capacity (GW)

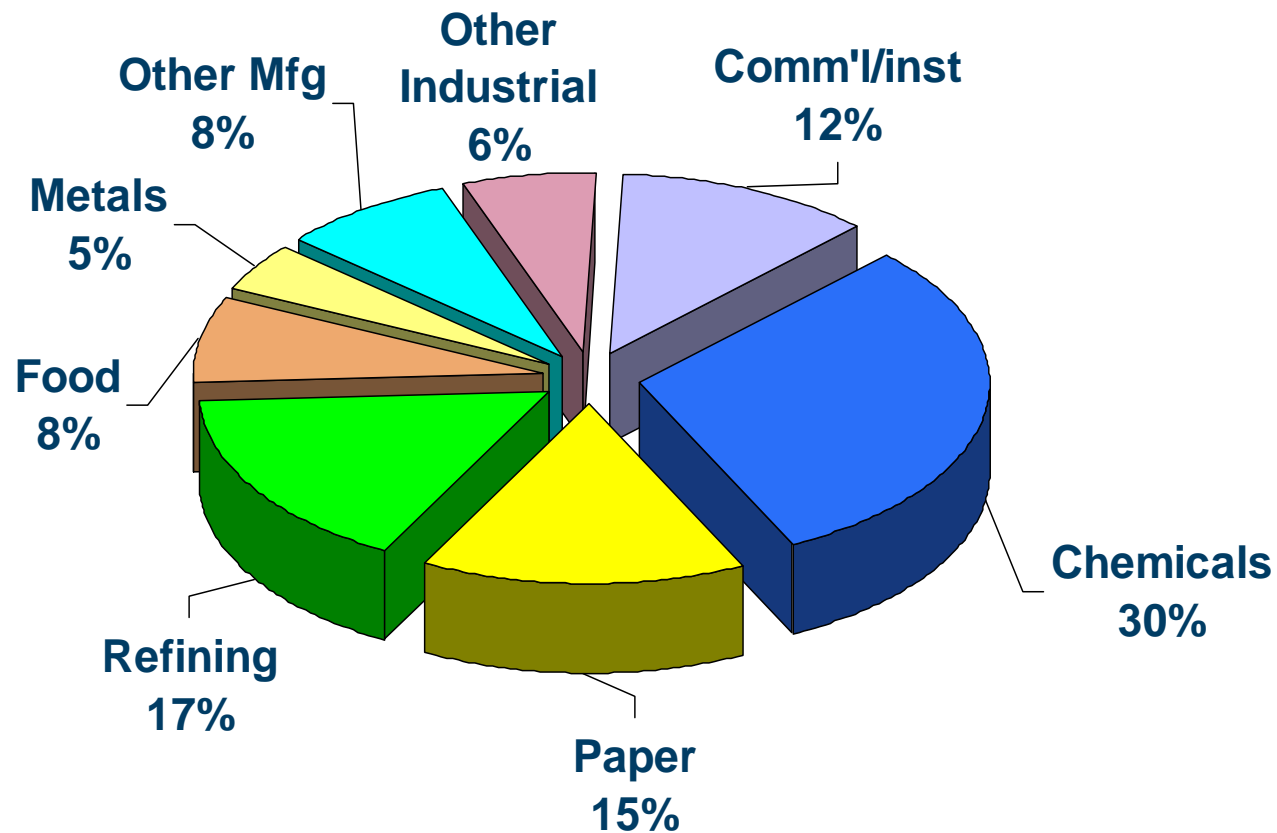


Installed CHP in 2005

- 82,400 MW at 2,960 sites
- Average capacity is 28 MW
- Median capacity is 2.2 MW
- Represents about 9% of total U.S. generating capacity
- Saves over 3 quads of fuel each year
- Eliminates over 400 million tons of CO₂ emissions each year

Industrials Represent 88% of Existing CHP

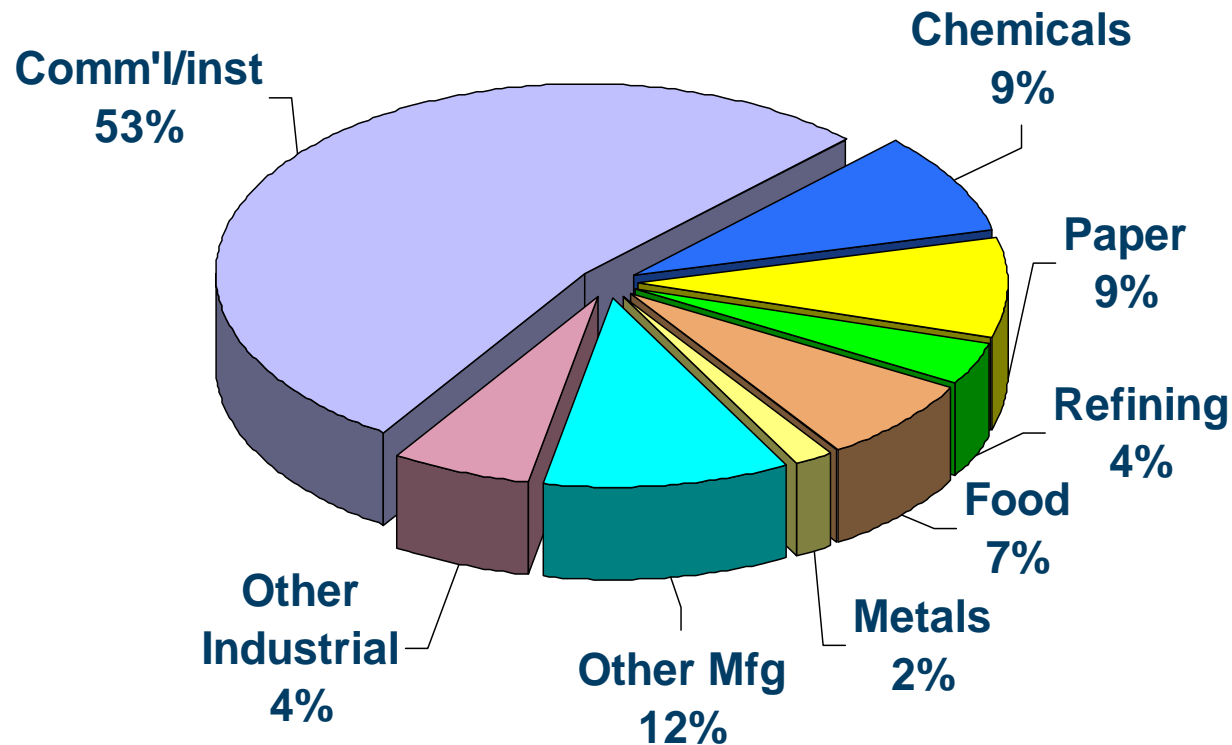
- Existing CHP Capacity (2005): 82,411 MW



Source: EEA

But Over 50% of the Installations are Commercial / Institutional

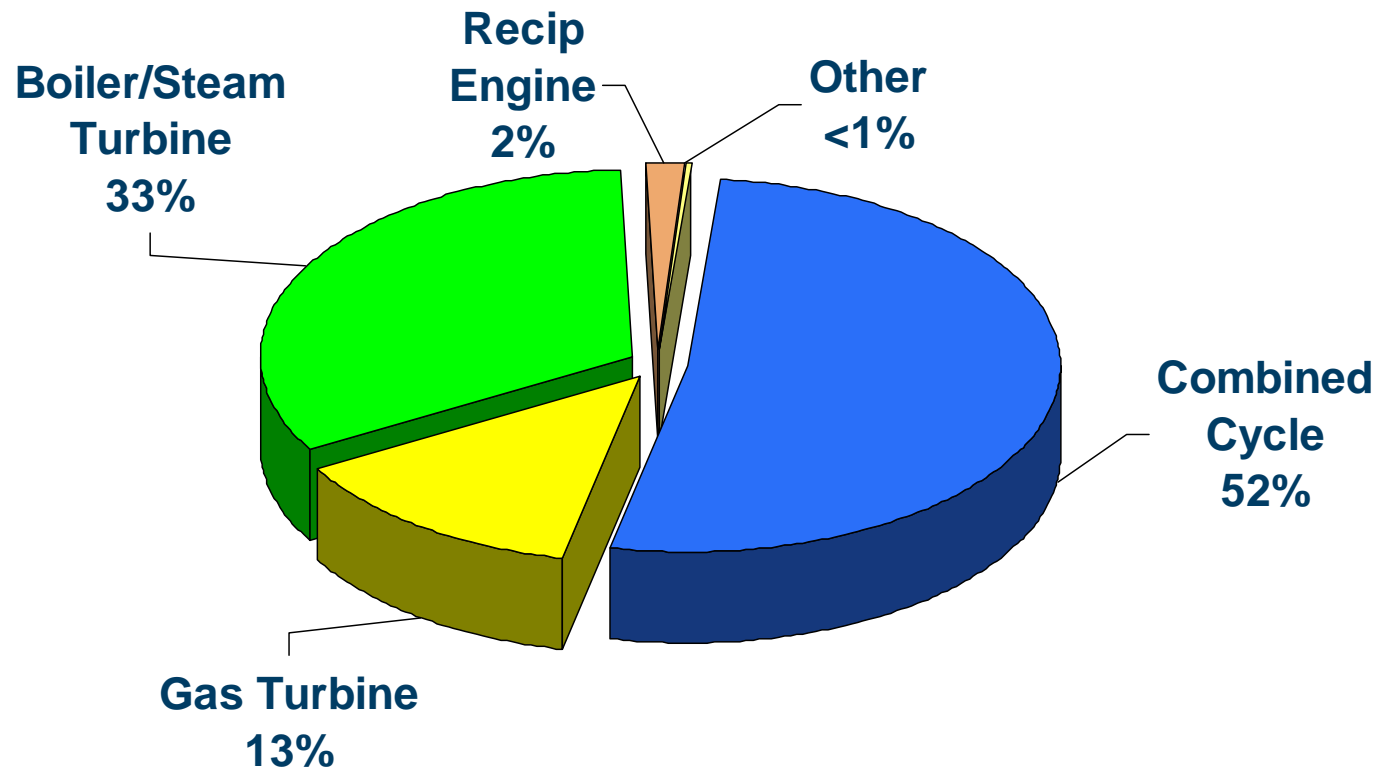
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Source: EEA

Gas Turbines Represent Almost Two Thirds of the Capacity

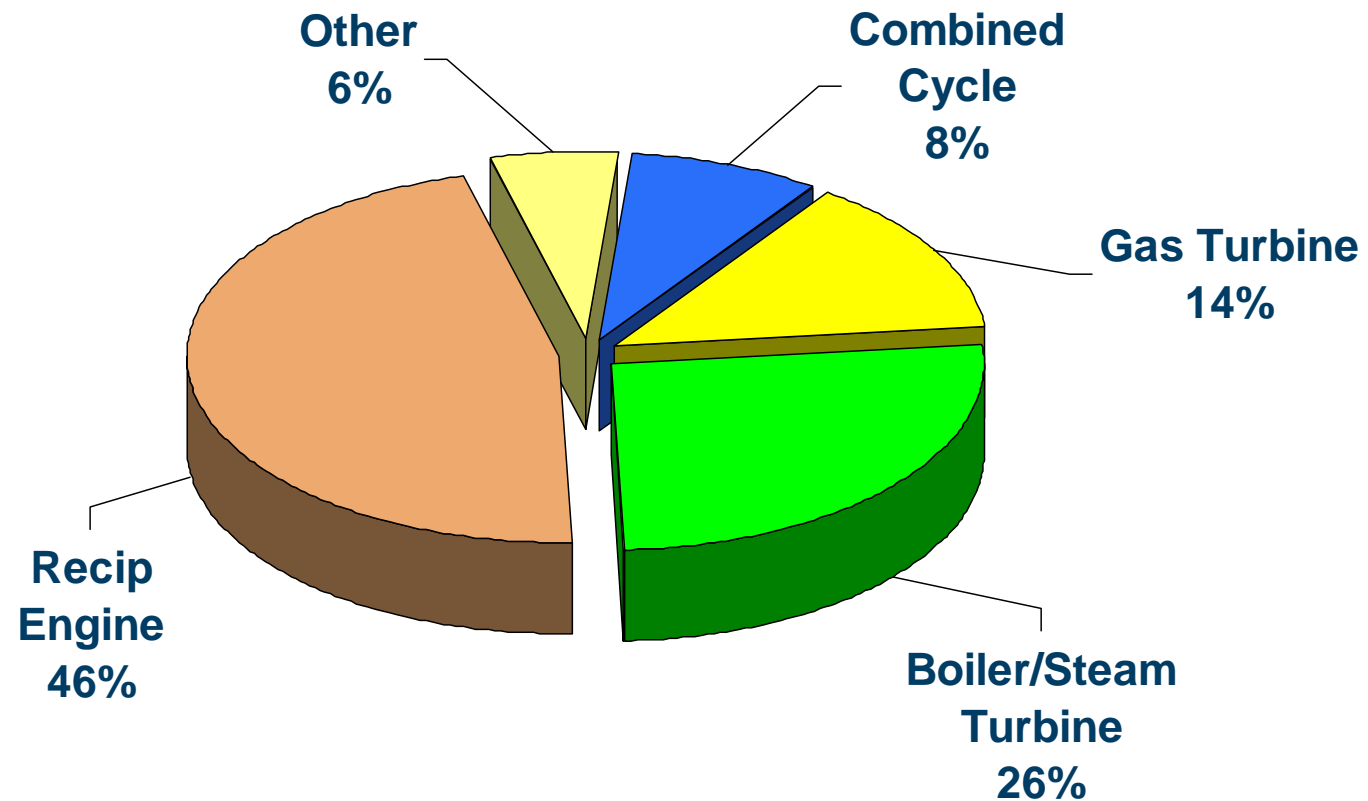
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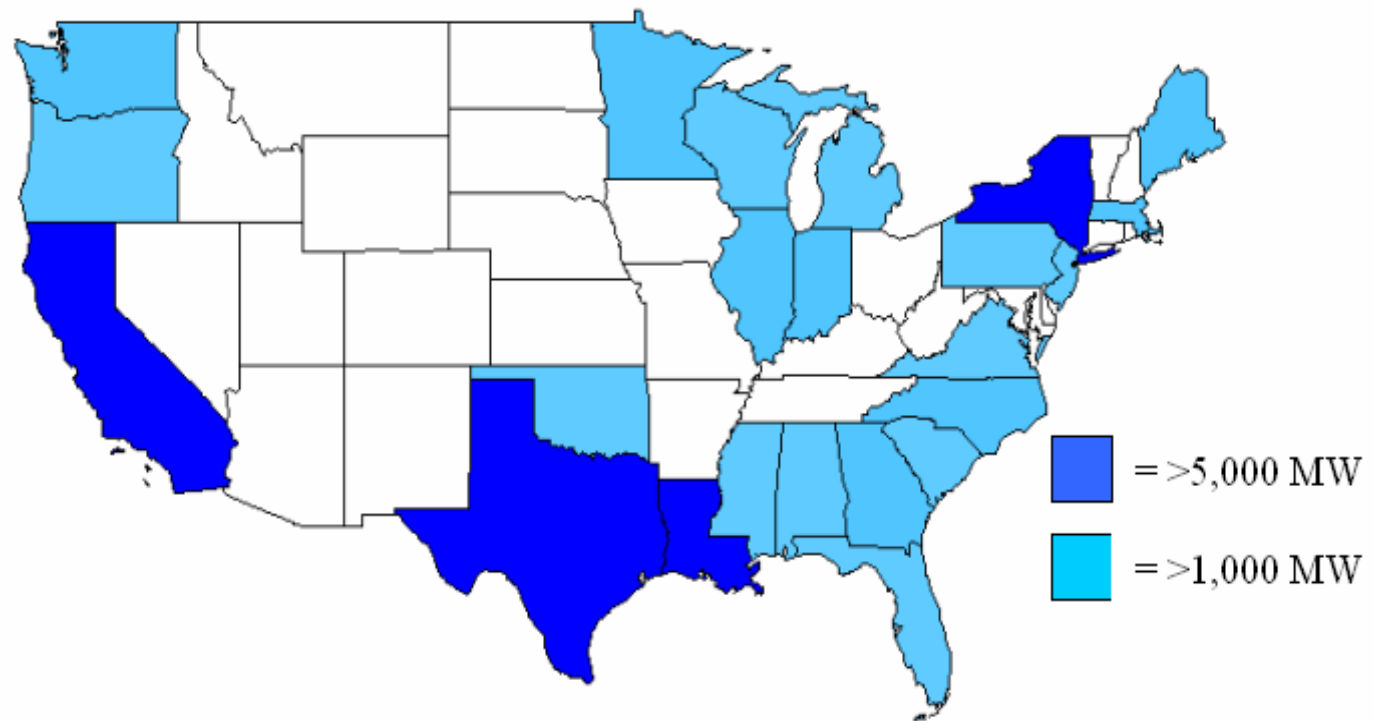
Recip. Engines Represent 46% of the Sites Nationwide

- *Existing CHP Capacity (2005): 2,960 sites*



Source: EEA

Regional CHP Intensities



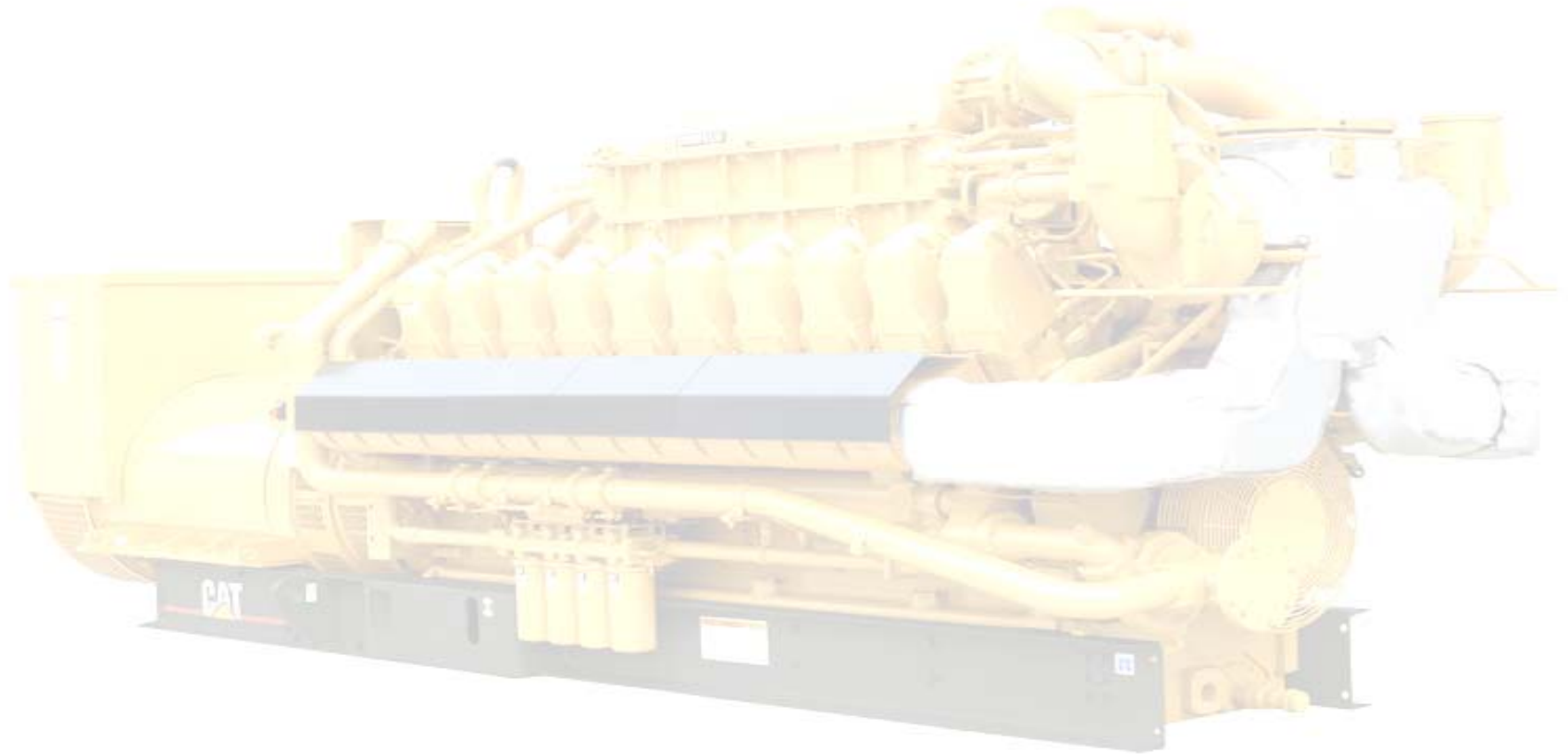
Summary Messages

- CHP Is Not Right For Every Application In Every Location
- Where CHP Makes Sense, It Can & Will:
 - Lower Energy Costs
 - Increase Reliability
 - Improve Power Quality
 - Provide Standby Power
 - Lower Emissions

Summary Messages

- CHP Is A Low Technology Risk
 - Utilize Proven Technologies
 - Employ Standard Design Practices
 - Incorporate Good Maintenance Practices
- Each Application Must Be Evaluated
 - Initial Screening: Rules Of Thumb / Averages
 - Capital Investment Analysis: Detail Analysis Provides Accurate Estimates of Savings / Cash Flows

Where To Obtain More Information?



Midwest CHP Application Center

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312 / 996-4382

Questions?

