



# CHP: The Concept

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***A Workshop for the Iowa Ethanol Industry***  
***April 1, 2004***  
***West Des Moines, IA***



**MIDWEST**  
**CHP**  
**APPLICATION**  
**CENTER**

*In Partnership  
with the US DOE*

***Presented By: Leslie Farrar***

***Midwest CHP Application Center***

***[www.CHPCenterMW.org](http://www.CHPCenterMW.org)***

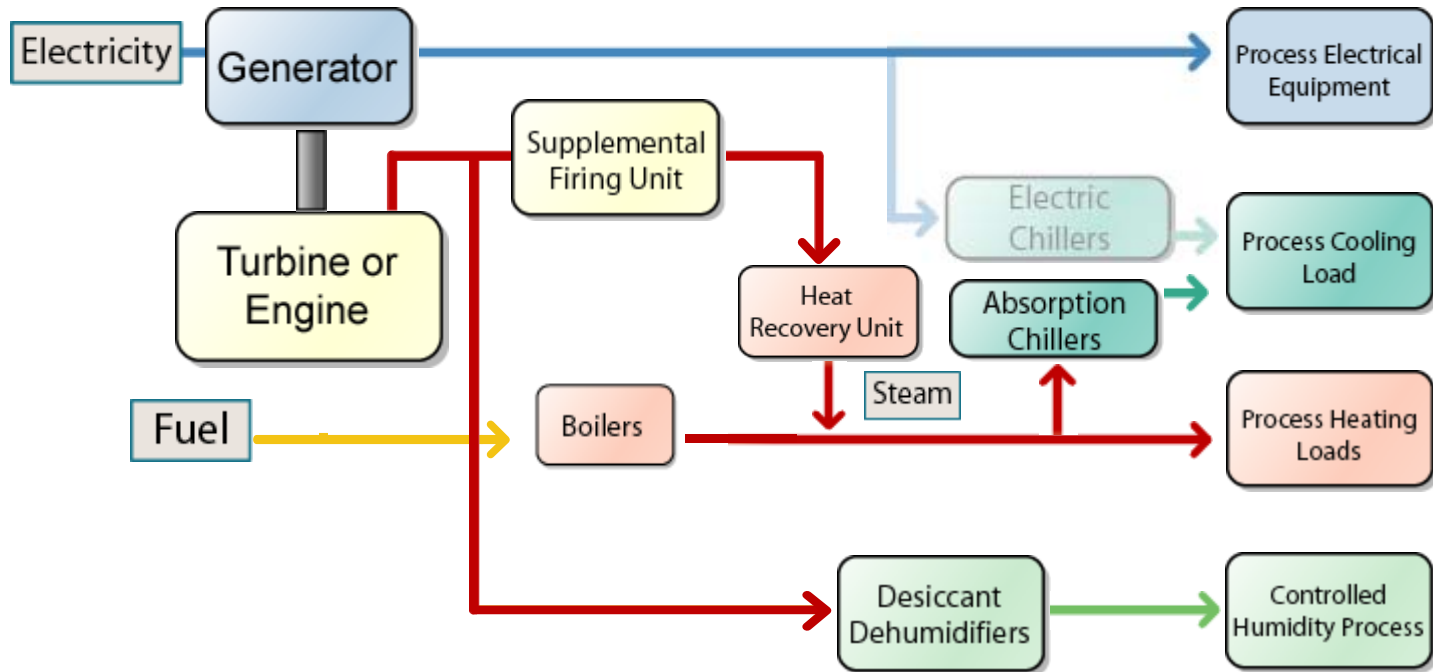
# Acronyms

- **Combined Heat & Power (CHP)**
- **Buildings Cooling, Heating & Power (BCHP)**
- **CHP for Buildings (CHPB)**
- **Integrated Energy Systems (IES)**
- **Total Energy Systems (TES)**
- **Trigeneration (Trigen)**
- **CHP for Industry**
- **Cogeneration**

# What is CHP?

- **Integrated System**
- **Located At or Near a Building or Facility**
- **Provides a Portion of the Electrical Load**
- **Utilizes the Thermal Energy**
  - **Process Heat**
  - **Heating**
  - **Cooling**
  - **Drying**

# Typical Industrial CHP System

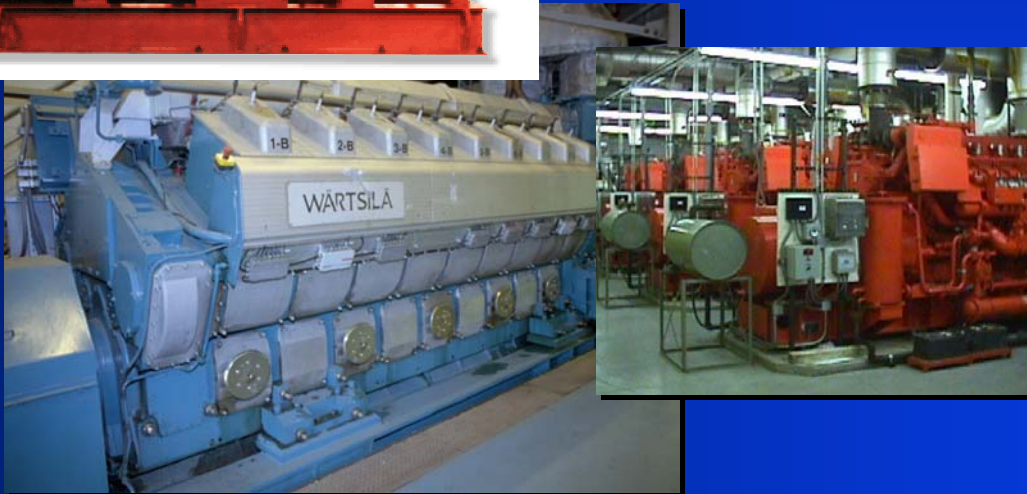
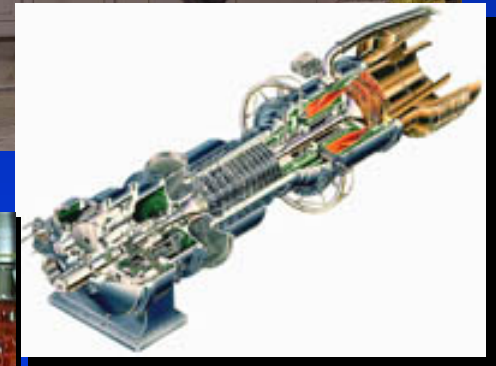
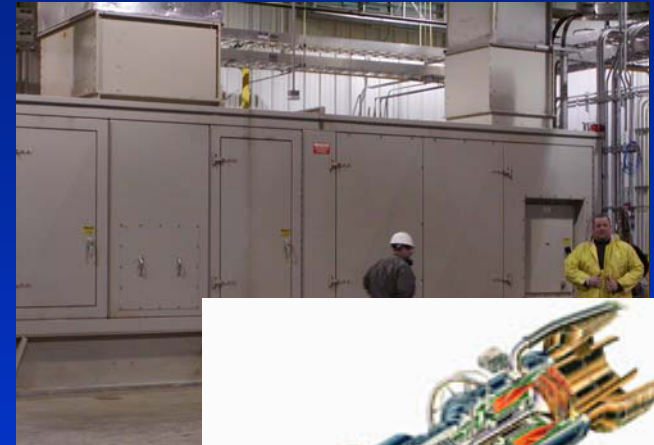
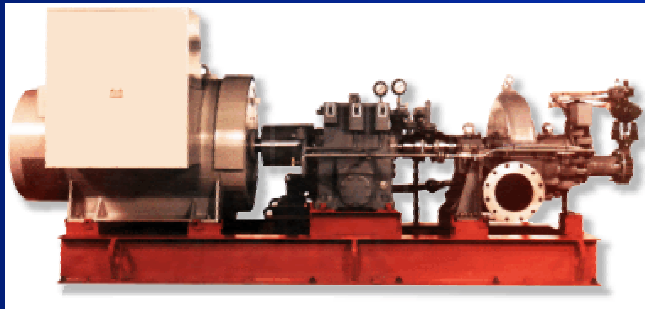


# CHP System Sizes *(Terminology)*

System Designation	Size Range	Comments
Mega	50 to 100+ MWe	<ul style="list-style-type: none"> <li>• Very Large Industrial</li> <li>• Usually Multiple Smaller Units</li> <li>• Custom Engineered Systems</li> </ul>
Large	10's of MWe	<ul style="list-style-type: none"> <li>• Industrial &amp; Large Commercial</li> <li>• Usually Multiple Smaller Units</li> <li>• Custom Engineered Systems</li> </ul>
Mid	10's of kWe to Several MWe	<ul style="list-style-type: none"> <li>• Commercial &amp; Light Industrial</li> <li>• Single to Multiple Units</li> <li>• Potential Packaged Units</li> </ul>
Micro	<60 kWe	<ul style="list-style-type: none"> <li>• Small Commercial &amp; Residential</li> <li>• Appliance Like</li> </ul>

# Reliable CHP Technologies

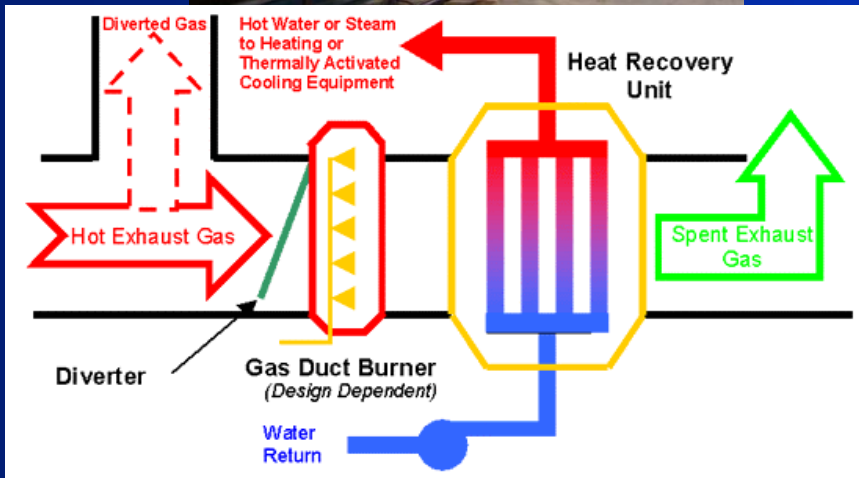
- Electric Generation Equipment
  - Gas Turbines
  - Reciprocating Engines
  - Steam Turbines



# Reliable CHP Technologies



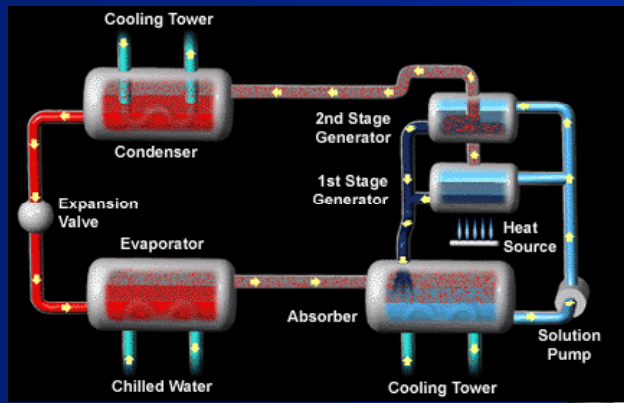
- Heat Recovery Systems
  - Steam and Hot Water
  - Exhaust Gases



# Reliable CHP Technologies

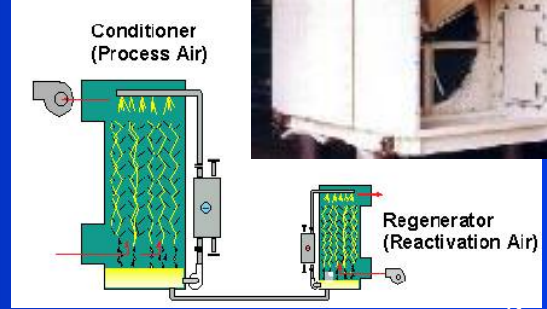
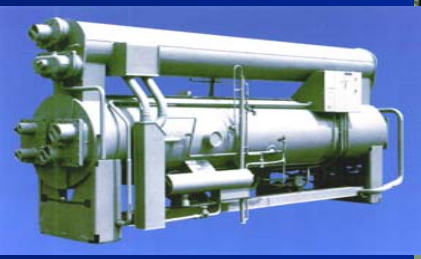
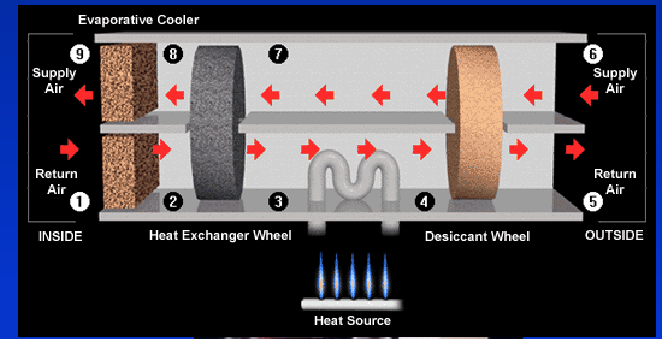
- **Thermally Activated Technologies**

  - **Absorption Chillers**





  - **Desiccant Dehumidification**



*In Partnership with the US DOE*



# Benefits of CHP

*High Efficiency, On-Site Generation Means ...*

- Improved Reliability
- Lower Energy Costs
- Better Power Quality
- Lower Emissions (including CO<sub>2</sub>)
- Conserve Natural Resources
- Support Grid Infrastructure
  - Fewer T&D Constraints
  - Defer Costly Grid Upgrades
  - Price Stability
- Facilitates Deployment of New Clean Energy Technologies
- Enhances Competition



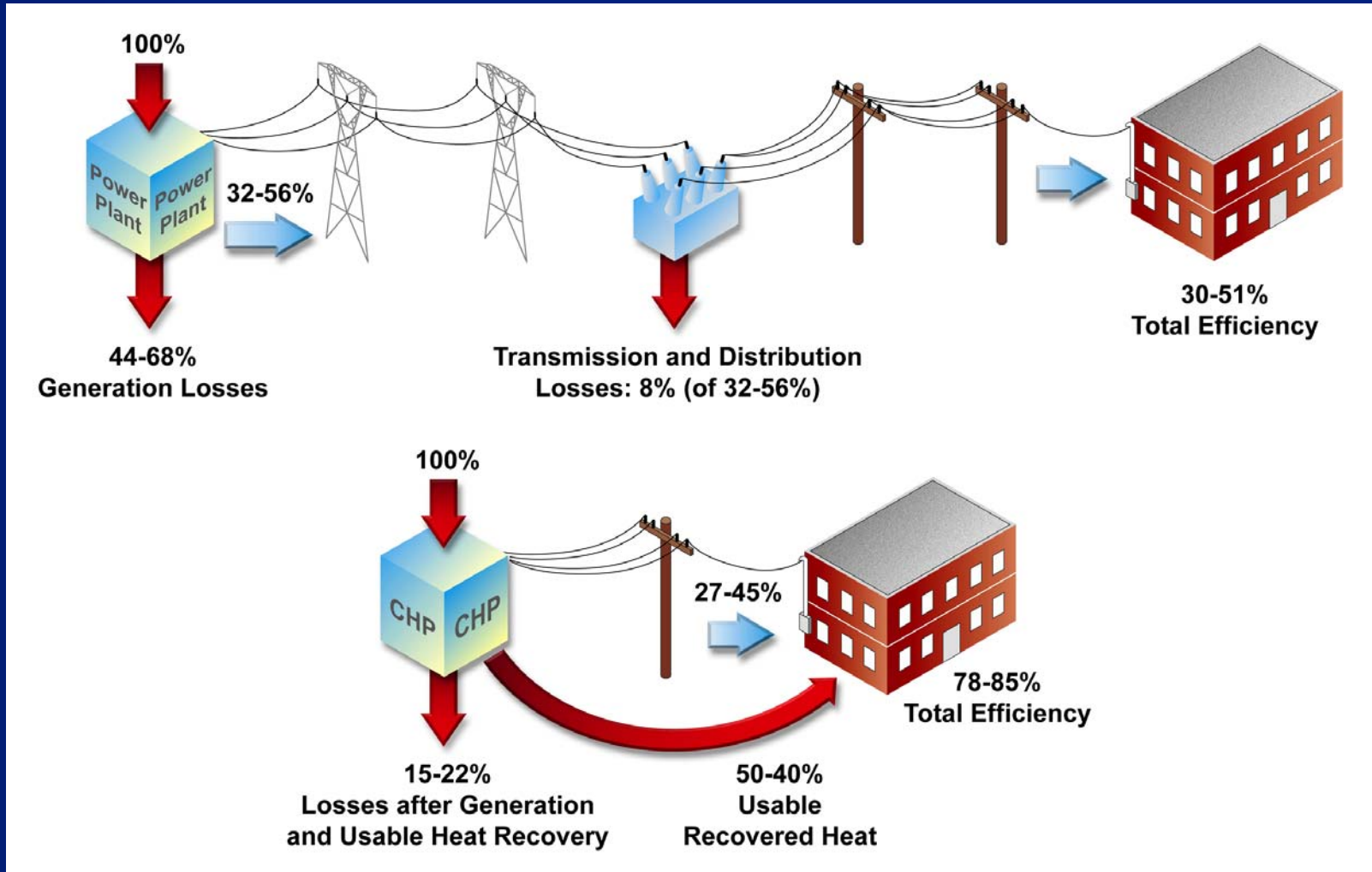
# Key Factors for CHP Attractiveness

- High Energy Use
- Coincident Needs for Electrical and Thermal Energy
- Cost of Buying Electric Power from the Grid Relative to the Cost of Fuel  
*a.k.a. “Spark Spread” > \$12 MMBTU*
- Installed Cost Differential Between a Conventional System and a CHP System

# Why is There an Opportunity?

- **DOE/EIA Projects Over 360 GWe of New Capacity**
  - Meet Growing Demand
  - Compensate for Plant Retirements
- **Today's Central Station Plants Lose 23 Quads of Thermal Energy**
- **Growth in the Ethanol Industry**

# How CHP Saves Energy



# Why is There an Opportunity?

- **Aging Electric Transmission and Distribution Systems**
  - **Difficult to Site New Lines**
  - **Capacity Constrained**
  - **Costly to Maintain**
- **Rising Concerns Over**
  - **Blackouts/Brownouts**
  - **Power Supply Constraints**
  - **Electricity Prices**

# CHP is a Triple Win

- **Saves Money** --- **Ethanol Facilities**
- **Energy Efficiency and Cleaner Environment** --- **Government**
- **Provides Business Opportunity** --- **Industry**

*Bottom Line*

**Recovers Energy that  
Otherwise Would be *Wasted!***



# Top 10 Impediments to CHP

## 6. High First Cost

*Discourages Investment Despite Life Cycle Benefits*

## 7. Assessing CHP Value (Beyond Energy Cost Reduction)

*Hard to Identify, Quantify, and Allocate Among Parties*

## 8. Stakeholder Apathy

*Lack of Incentive for Facility Managers and Engineering Firms to Try Something Different*

## 9. Too Few Case Studies

*Inconsistent, Hard to Find, and Often Incomplete in Financial Details*

## 10. Permitting Process

*Sometimes Long, Cumbersome, and Costly*



# Top 10 Impediments to CHP

## 1. Electric Utility Response / Interconnection

*Often Times Ambivalent at Best, Hostile at Worse - Inconsistent Standards, Complex Process, Network Issues and Unpredictable or High Costs*

## 2. Natural Gas Prices / Volatility

*Creates Uncertainty in Energy Costs*

## 3. Utility Tariffs

*Standby Charges and General Rate Design*

## 4. Lack of Familiarity

*With CHP Technologies, Concepts, and Environmental Benefits*

## 5. Electric Restructuring

*Creates Uncertainty and a "Wait and See" Attitude*





# Why CHP at an Ethanol Facility?

- **High Energy Users**

*(Typical 40 MMGY)*

- **Thermal**

- » **75–80% Energy Costs are Natural Gas**

- Steam Production
- Dryers

- » **~ \$10 Million/Year**

- **Electrical**

- » **~ \$2.5 Million/Year**

- » **3.5 to 4.5 MWe Load => 30 to 40 Million kWh/Year**

- **Process Can Use all the Thermal Produced**

- » **Expect Between 4,300 and 5,300 lbs/hour per Installed MWe**



# Why CHP at an Ethanol Facility?

- **Both Thermal and Electric Reliability Very Important**
  - Lose Batch
  - Several Hours to Restart
- **Electric Reliability**
  - Grid Backs Up CHP System
  - CHP System Backs up Grid
- **Thermal Reliability**
  - CHP System Provides Part of Thermal Load
  - Boilers Sized to Provide All of Thermal Load
- **Reliability In Design**
  - Systems Need to be Designed to Do This!



# Why CHP at an Ethanol Facility?

- **Long Hours**
  - 7/24/365
- **Availability of Fuels Other than Natural Gas**
  - Coal
  - Biofuels
  - Waste Water or Land Fill Gas
- **Saves Energy**
  - Efficiencies Upwards of 85% because of High Thermal Use and Value
- **Reduces Energy Cost\$**

# Why CHP at an Ethanol Facility?

- **VOC Control**
  - **Potential Destruction**
    - » **Turbines**
    - » **Supplemental Burners**
  - **Thermal Oxidizers**
    - » **Heat Recovery into CHP System**
- **Differential Cost in Adding CHP**
  - **Generation and Heat Recovery Equipment**
  - **Utility Charges to Upgrade / Supply Service**
  - **Standby Generators**

# Ethanol CHP Sizing Strategy

- **Sized for Electric Load**
  - **Satisfy a Portion of Thermal Load**
  - **Make up Difference with Packaged Boiler Systems**
- **Sized for Thermal Load**
  - **Excess Electrical**
    - » **Impractical to Sell Back Into Grid**
    - » **Partnered with Electrical Utility**

# “Walk-Aways”

- **Not a New Technology**
- **Ethanol Facilities are a Good Match**
  - **Saves Energy**
    - » **Electric and Thermal Needs High**
    - » **More Product Per Unit Energy Input**
  - **Lowers Overall Operating Costs**
    - » **Reduced Utility Costs**
  - **Lowers Overall Air Emissions**
    - » **Plus Potential for VOC Reduction**
- **Provides Increased Reliability**
  - **Properly Sized and Designed**
  - **Better than Just “Plain Old Stand By”**
    - » **CHP Can Provide a Positive ROI**

