



WEAVER



Walker



CHP Workshops
by
Steve Killian

CATERPILLAR

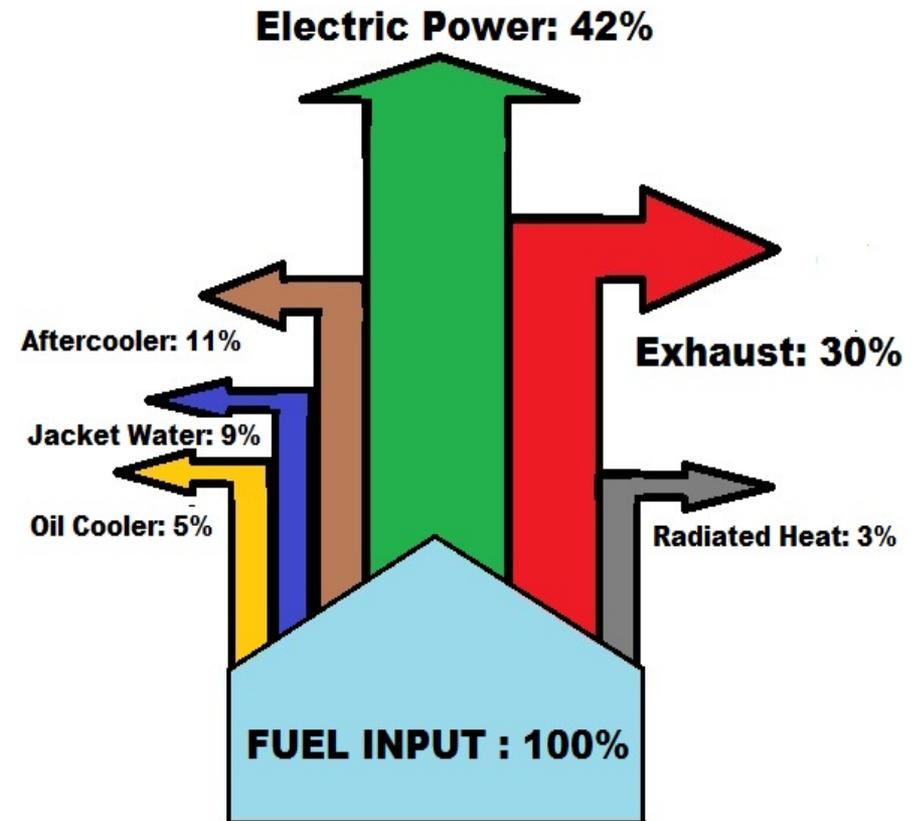
EPA Internal Combustion Engine Categories

- “CI” Compression Ignition Liquid Fueled Primarily Diesel Fuel, Biodiesel
- “SI” Spark Ignition Gaseous Fuel, Natural Gas, Biogas, Sewage Gas, Landfill Gas, Digester Gas, Coal Methane Gas, Wellhead Gas, and Propane
 - Rich Burn
 - Lean Burn

Combined Heat & Power

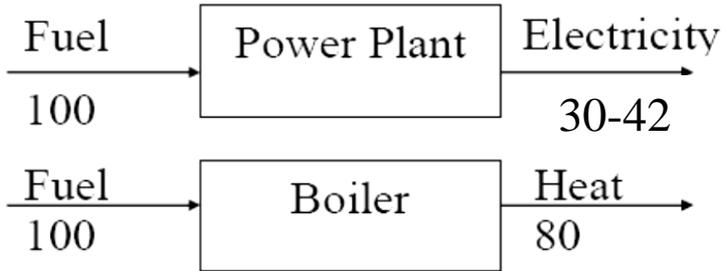
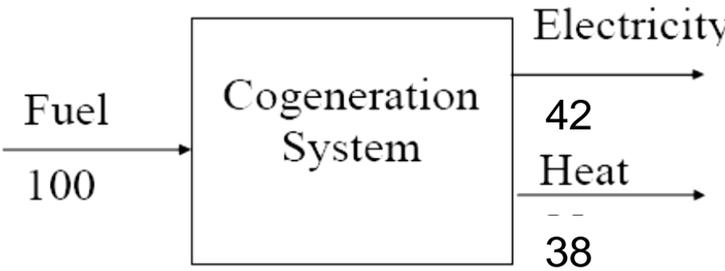
One powerful future.

- The simultaneous and sequential use of power and heat from the same fuel source.
- Utilize the heat that otherwise would have been wasted.
 - Heat
 - Hot Water
 - Steam



CHP Improved Efficiency

One powerful future.

Separate Production of Electricity and Heat	
 <p>Fuel 100 → Power Plant → Electricity 30-42</p> <p>Fuel 100 → Boiler → Heat 80</p>	Total efficiency: $\eta = \frac{42 + 80}{200} = 0.61$
Cogeneration	
 <p>Fuel 100 → Cogeneration System → Electricity 42</p> <p>Heat 38</p>	Total efficiency: $\eta = \frac{42 + 38}{100} = 0.80$
<p>“The simultaneous and sequential use of power and heat from the same fuel source”</p>	

How to Use the Heat?

One powerful future.

Applications

Manufacturing

Building

Greenhouses

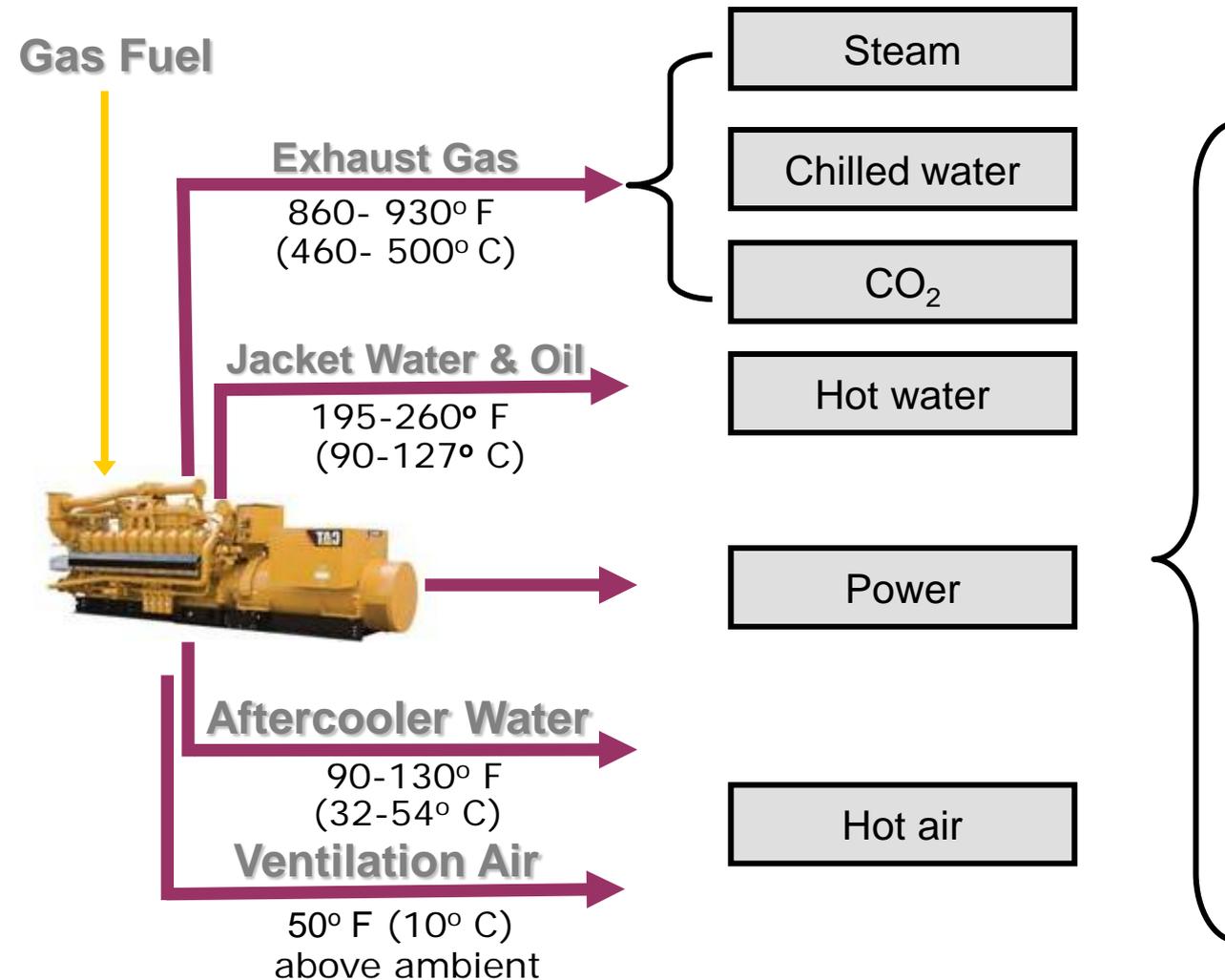
District Heating

Drying

Desalinization

Refineries / Oil

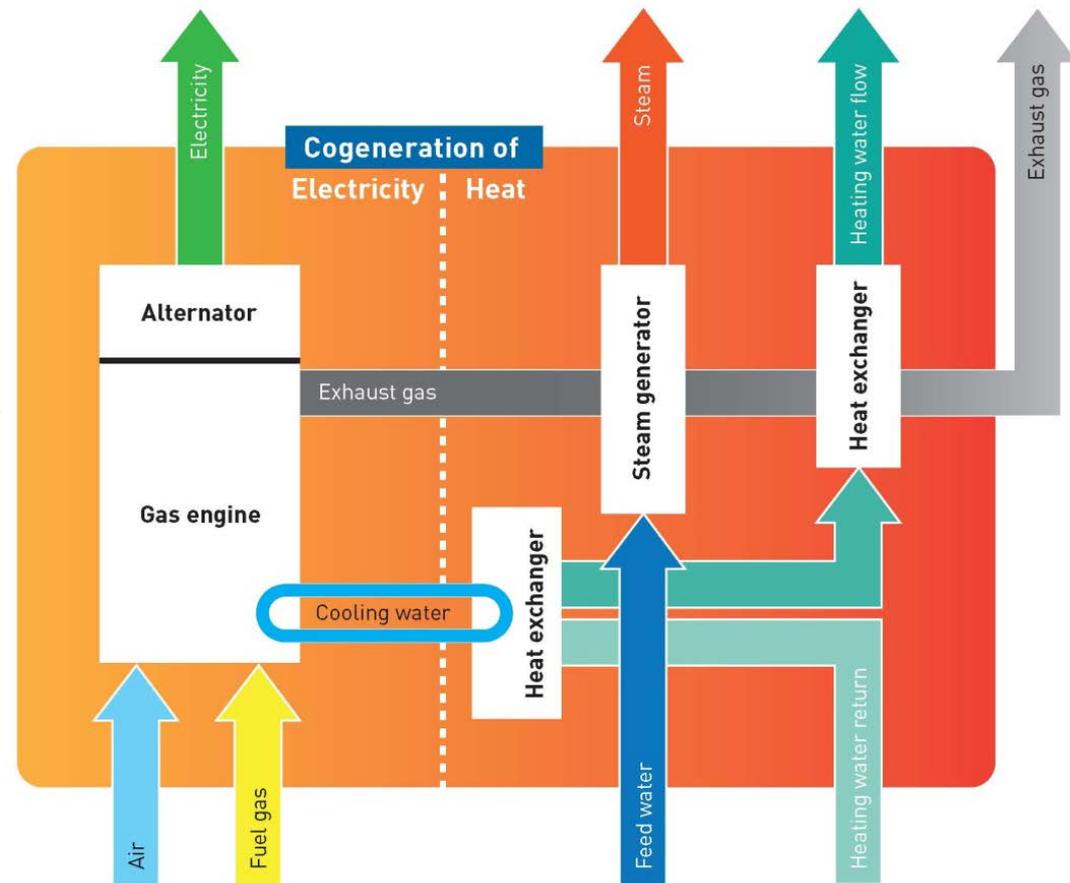
Institutions



CHP - Independency with Higher Efficiency

Combined Heat and Power (CHP) or Cogeneration

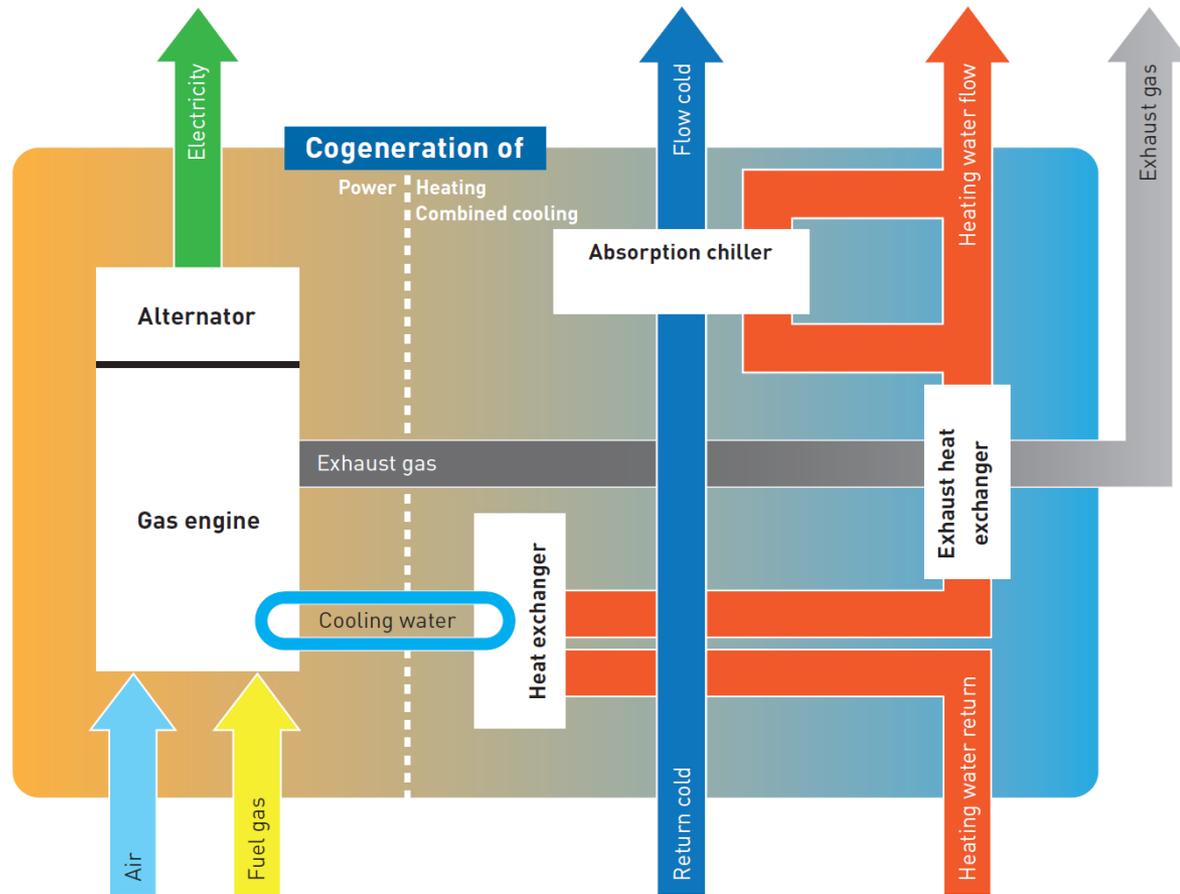
- Decentralized energy production – energy for onsite use
- The energy is produced where it is needed and according to the consumers needs (power led or heat led)
- Total resource efficiency of up to 95 %.
- Independent from outages or grid problems
- Use of waste heat for heating, cooling, steam or heat recovery



CCHP – Combined Production of Cool, Heat and Electrical Power

Trigeneration

- Improvement of the CHP process
- Chillers use the waste heat of the power plant
- Cooling is done by using the absorption process
- Longer system operation time as cooling is provided in summer



When Does CHP Makes Sense?

- High electric and/or thermal demands.
- Possible effect of carbon and electricity.
- Extended operating hours.
- Need for emergency/backup systems.
- Ability to export power to the grid.
- Need Reliable and quality power.
- Operate with reduced emissions.
- Standards for energy efficiency



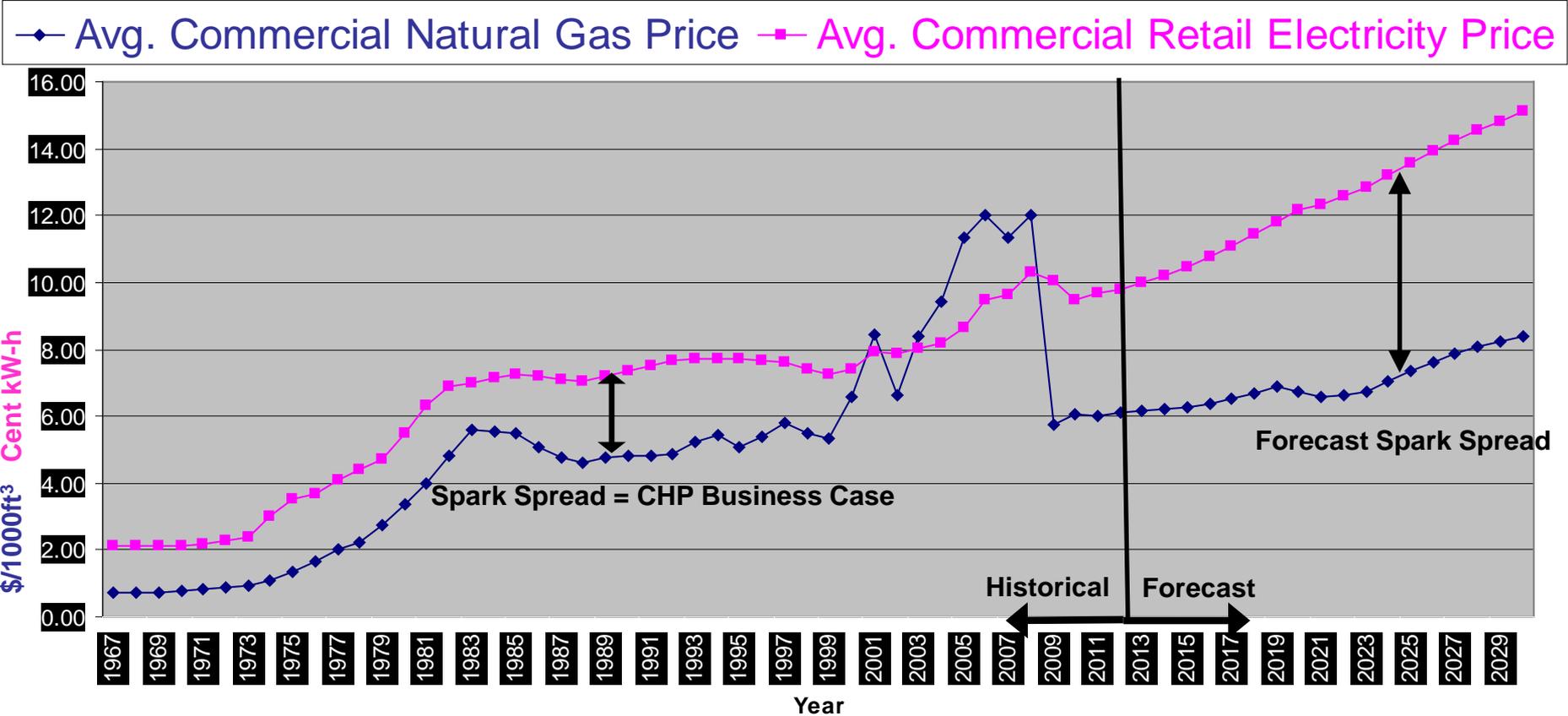
**ECONOMIC
DECISION**

If >50% of available thermal energy can be used on an annual basis, CHP makes good economic sense



Key Market Driver: Spark Spread

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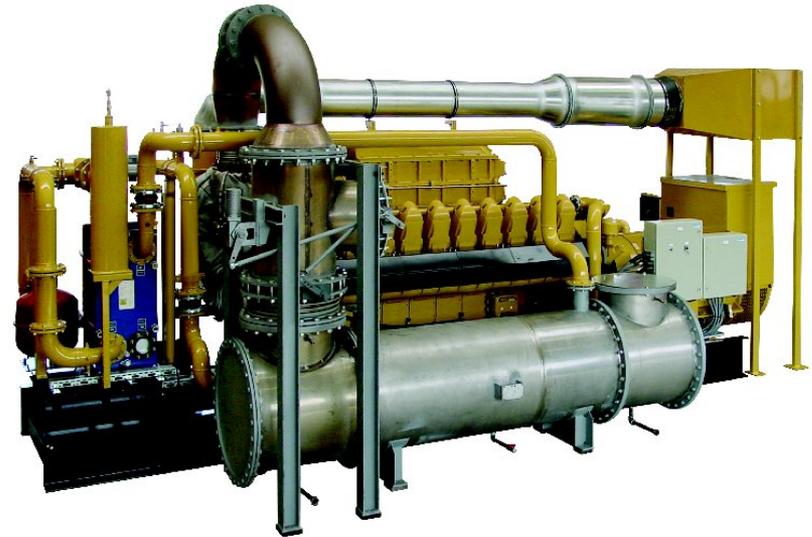
US Spark Spread 1967-2009

Source = US DOE Energy Information Administration

CHP Key Benefits

One powerful future.

- Reduces Energy Costs
- Less GHG emissions.
- Increase efficiency.
- Power quality.
- Backup to your installation.



2.0 MWe
85% 95+% Total Efficiency
~\$600 - \$800 / kWe Installed

WHAYNE

CAT

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CAT

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Electric Power Division

Can you Depend on the Grid?

One powerful future.



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WHAINE



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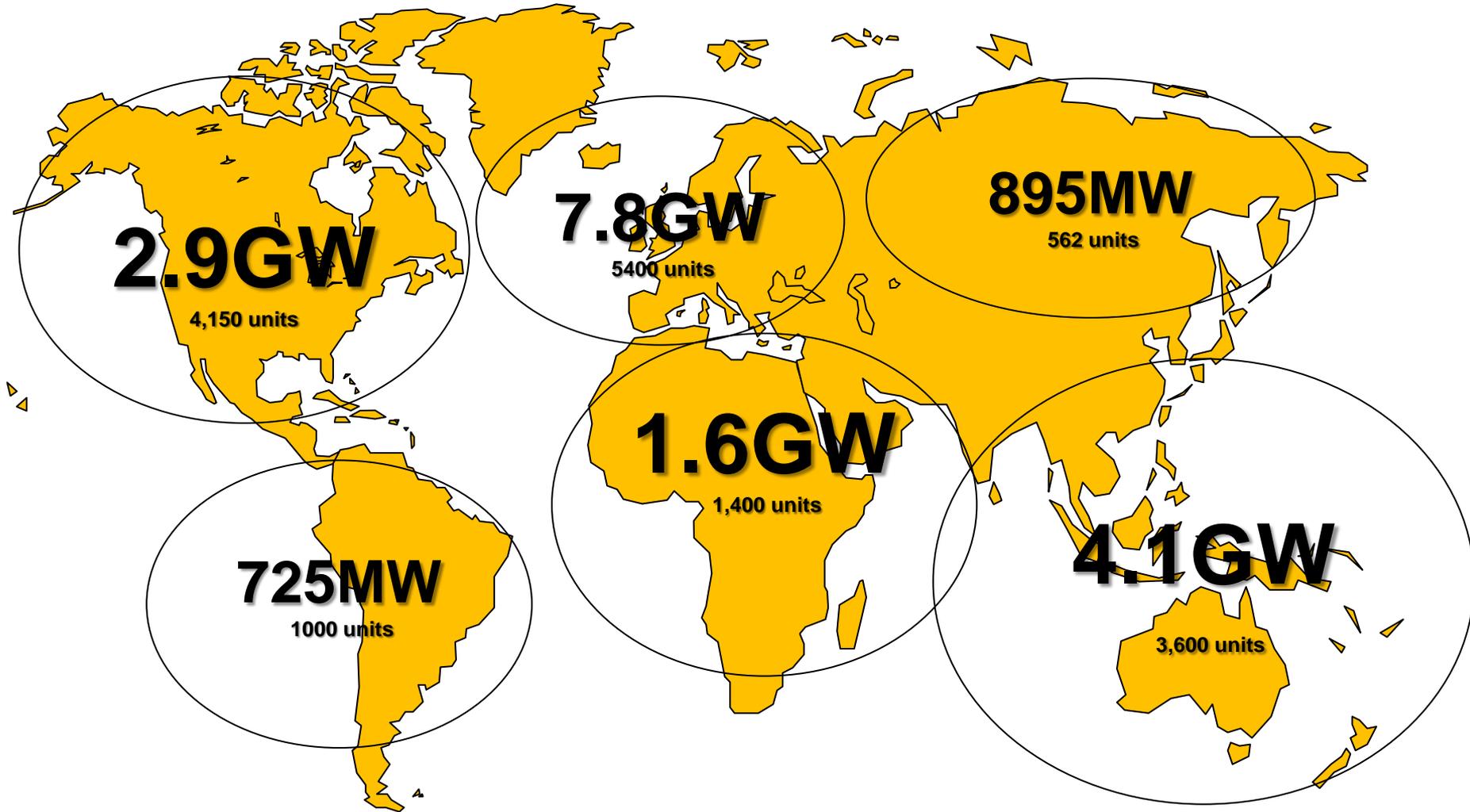
DG/CHP Improves Power Supply Security

- Existing critical infrastructure power supply strategies reflect historical risks and recovery experience

*After Mills and Huber,
"Critical Power" white paper,
www.digitalpowergroup.com,
August 2003*



1.8GW CAT Gas Genset Capacity in 15 years!



Gas Engine Combined Heat and Power



Jacket Water
Heat Recovery Module

Gas Engine Combined Heat and Power



Exhaust
Heat Recovery Module
And Silencer

Operation & Maintenance Considerations

- A CHP system will require maintenance.
- A maintenance plan/contract is recommended.
- Seek expertise, a single point of contact that can provide all the required services.
- Accessibility to your CHP installation will facilitate maintenance.

Proper maintenance will help you
maximize availability and savings!

Whayne Walker CAT Power Systems Locations



CHP is an Economic Decision based upon:

Electrical power or heat recovery

- Some electric power requirements are sized to meet heat load needs.
- Some system run times are determined by electric load needs.

Bottom Line:

What is the \$ value of the heat recovered

Vs. the cost associated with retrieving and distributing the heat.

Key Evaluation Points

Understand the details of the utility costs

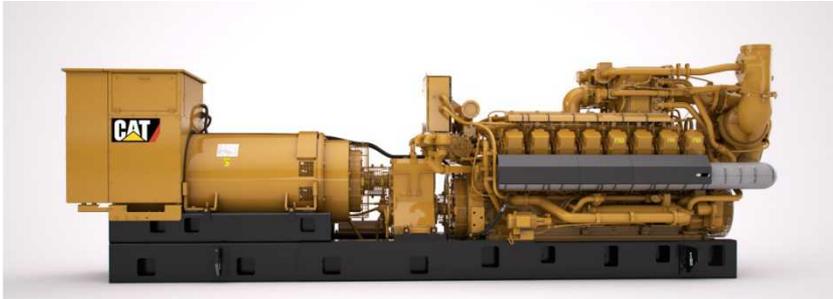
- Tariff
- Demand Charge \$/kW-Month Peak and off Peak
 - Month To Month
 - Ratcheted
- Energy Charge cents/kWh Peak and Off Peak
- Standby Charges & Non availability penalties
- Customer Capacity Load Curves
- Existing or Pending CHP Incentives

Sizes and Efficiencies

- 100KW to 10MW
- Combined Efficiencies above 87%



Focus – Lowest Total Lifecycle Cost in its Class



Lowest Owning Electrical Efficiency

- Top Tier Electrical Efficiency
- Lowest Maintenance & Overhaul Costs
 - Low Oil Consumption
 - Extended Service Intervals
 - Reduced Downtime
- Two Configurations:
 - High Efficiency (HE) – Optimized for Fuel Efficiency
 - High Response (HR) – Altitude and Ambient Capability Flexibility

G3516H 60Hz	
Power (1.0pf, w/o pump)	2,005 kW _{el}
Electrical Efficiency*	44.2% (HR) - 44.4% (HE)
Thermal Efficiency	42.1% (HR) – 41.7% (HE)
Service Interval	2,000 hrs
Major Overhaul	80,000 hrs
Available Frequencies	60Hz & 50Hz
Fuel	Natural Gas

G3516H - Maintenance

Maintenance and Overhaul

Number of PM Service Intervals to 80,000 Hrs		40
Total Oil Consumed (Oil Changes + Oil Consumption at Full Load) to 80,000 Hours	Gallons	13,500
Operational Hours to Top End Overhaul	Hours	20,000
Operational Hours to Top In-Frame Overhaul	Hours	40,000
Operational Hours to Major Overhaul	Hours	80,000
Time Between Oil Changes	Hours	2,000
Time Between GB Oil Change	Hours	4,000
Midlife Oil Consumption	g/kwh	.122 g/kwh

One powerful future.

Thank You!



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Electric Power Division



Kentucky CHP Program Workshop –November, 2014

