Distributed Power, Cogeneration and Executive Order 13423

Jeff Anderson

Defense & Federal Products

Caterpillar, Inc.

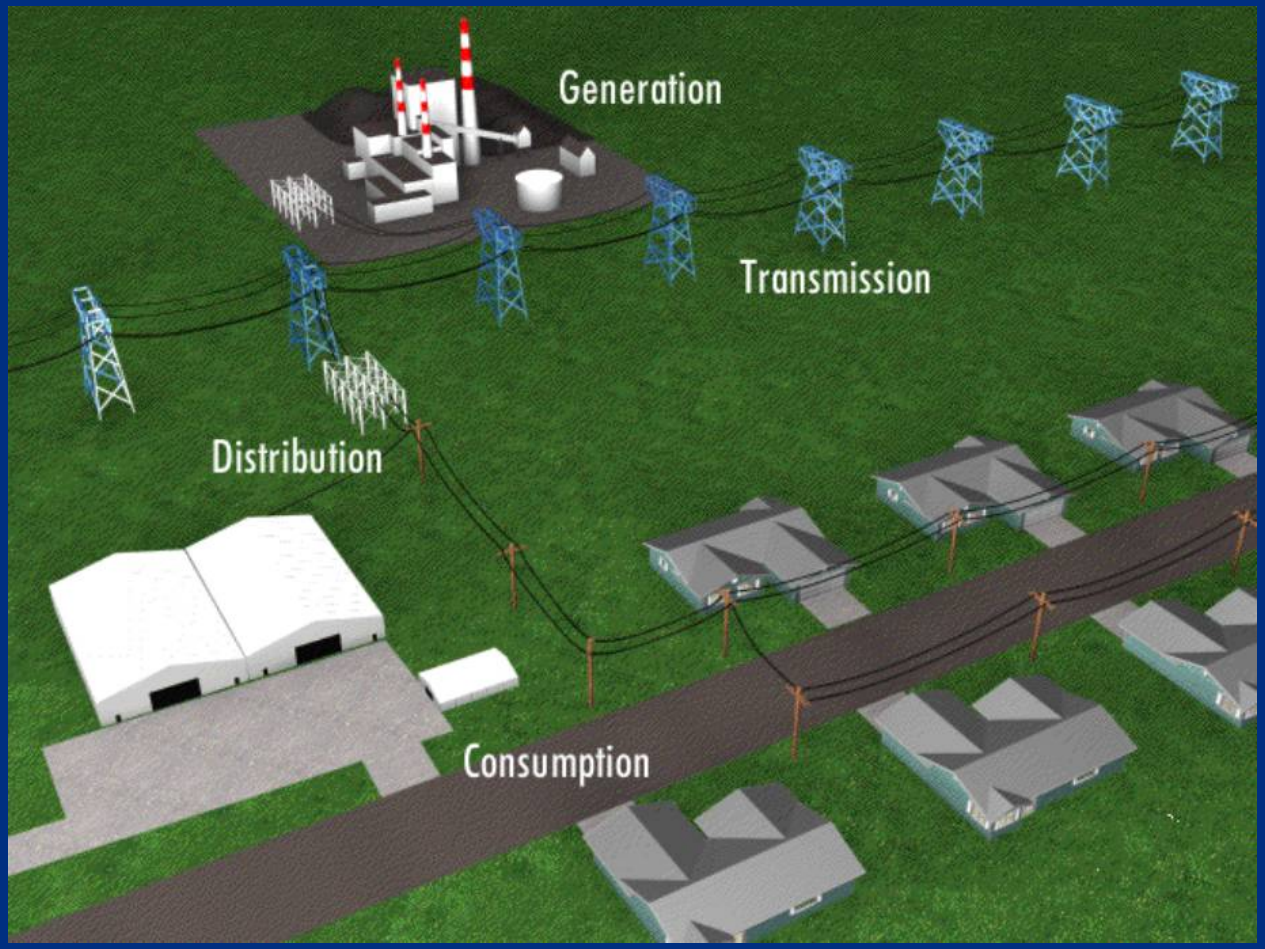
GovEnergy

www.govenergy.gov

Implementing E.O.13423

(2) Distributed Generation. Where life-cycle cost effective, each agency shall implement distributed generation systems in new construction or retrofit projects, including renewable systems such as solar electric, solar lighting, geo (or ground coupled) thermal, small wind turbines, as well as other generation systems such as fuel cell, cogeneration, or highly efficient alternatives. In addition, agencies are encouraged to use distributed generation systems when a substantial contribution is made toward enhancing energy reliability or security.

Electric Power Transmission and Distribution



Jeff Anderson

GovEnergy
www.govenergy.gov

August 3-6, 2008

Prime Power Generation

Prime Power Installation in Quarry

Jeff Anderson

GovEnergy
www.govenergy.gov

August 3-6, 2008

Stationary Diesel Particulate Filters

- ULSD Required (<15 ppm Sulfur)
- Applications: generators, pumps, industrial engines
- Passive regeneration
- Maximum reduction of PM, CO, HC

GovEnergy
www.govenergy.gov

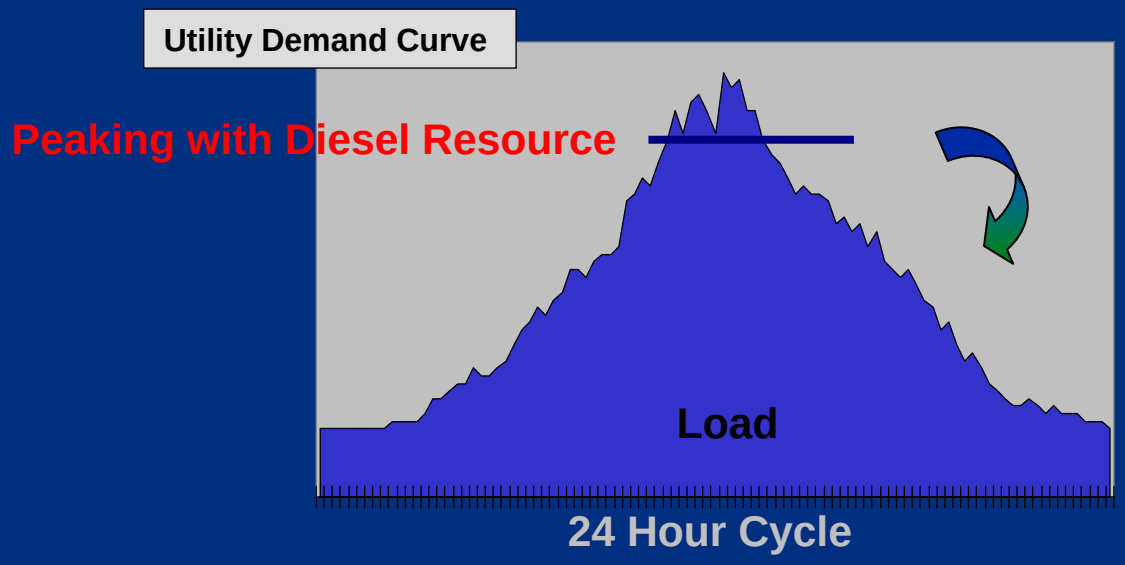
Electric Power Quality and Availability

Jeff Anderson

GovEnergy
www.govenergy.gov

August 3-6, 2008

Electric Utility Demand For Electric Power



Distributed Generation With Diesel Resources
Reduces Peak Operating Cost/kw-hr
Operates 100 – 500 hours/yr

Jeff Anderson

Temporary Power Generation

Jeff Anderson

GovEnergy
www.govenergy.gov

August 3-6, 2008

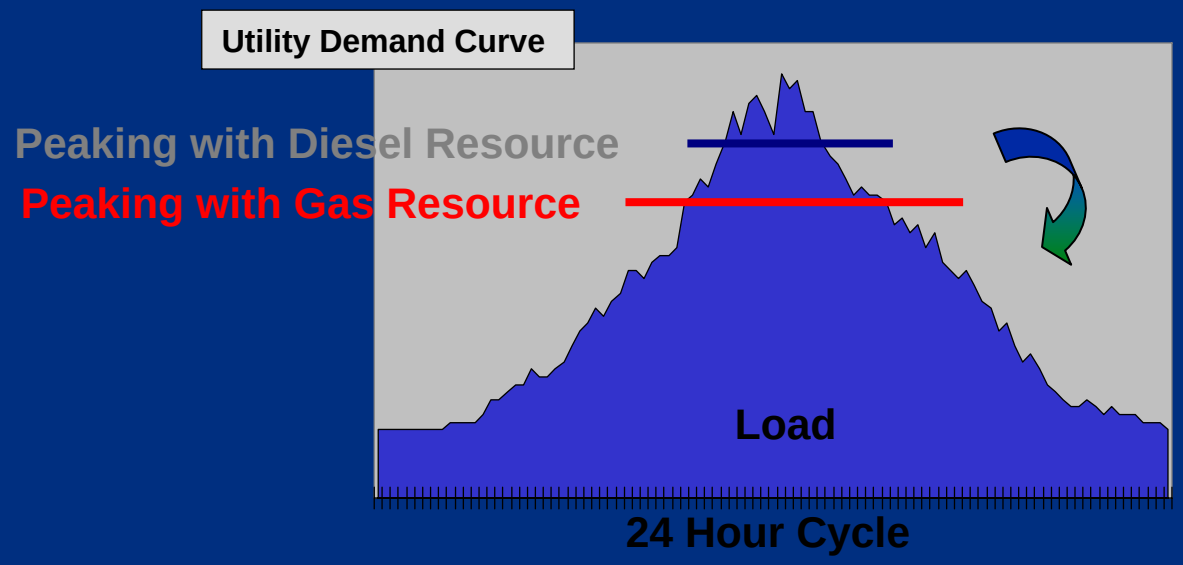
Temporary Power Generation

Jeff Anderson

GovEnergy
www.govenergy.gov

August 3-6, 2008

Improved Gas Product Utilization



Distributed Generation With Gas Resource
Improves Operating Cost/kw-hr
Allow Increased Time Online
100 – 500 hrs/yr → 100 – 3000 hrs/yr

Jeff Anderson

2 MW Utility Distributed Generation Installation

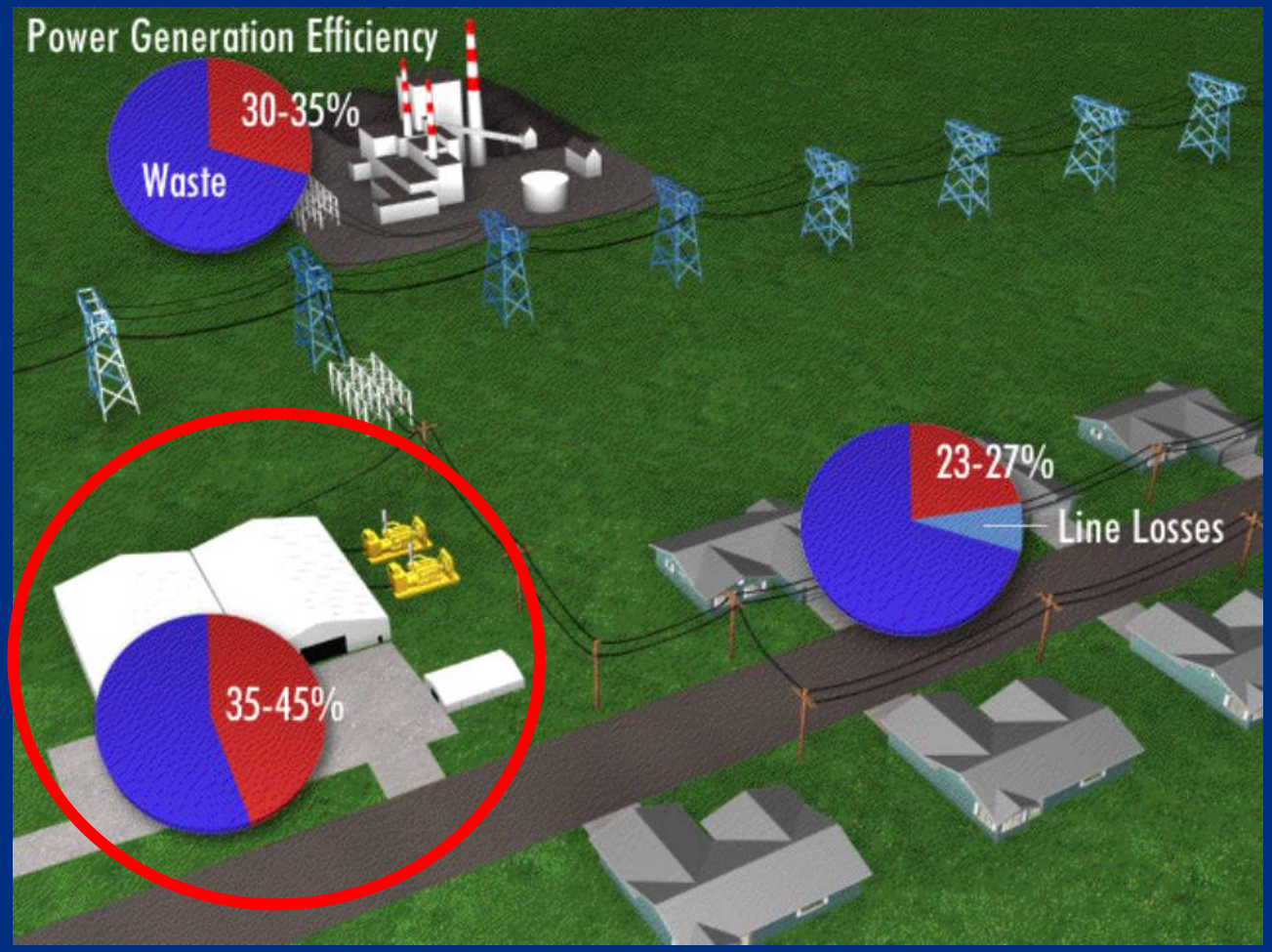
G3520C Utility DG Application

Jeff Anderson

GovEnergy
www.govenergy.gov

August 3-6, 2008

Electric Power Efficiency

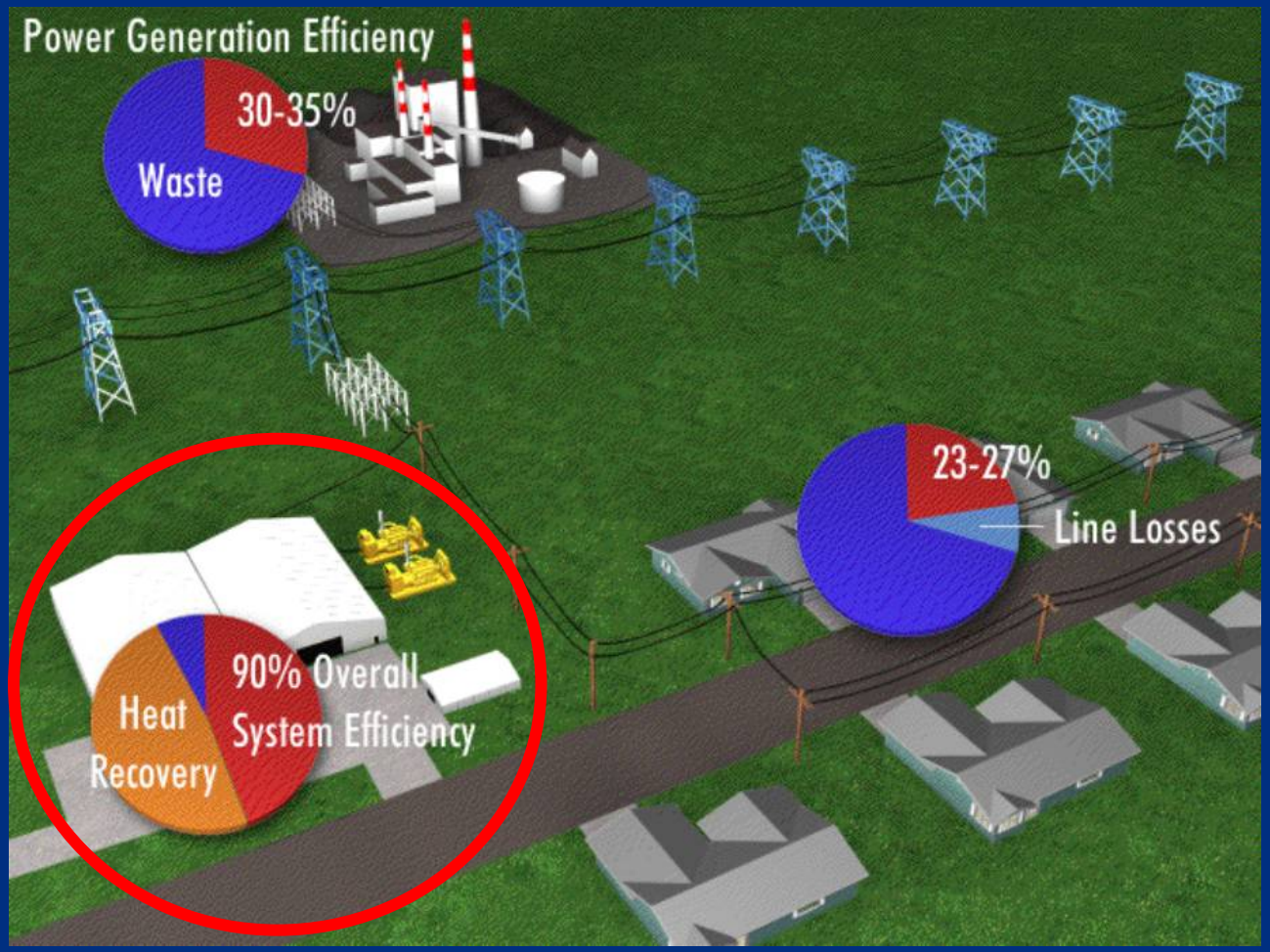


Jeff Anderson

GovEnergy
www.govenergy.gov

August 3-6, 2008

Electric Power Efficiency

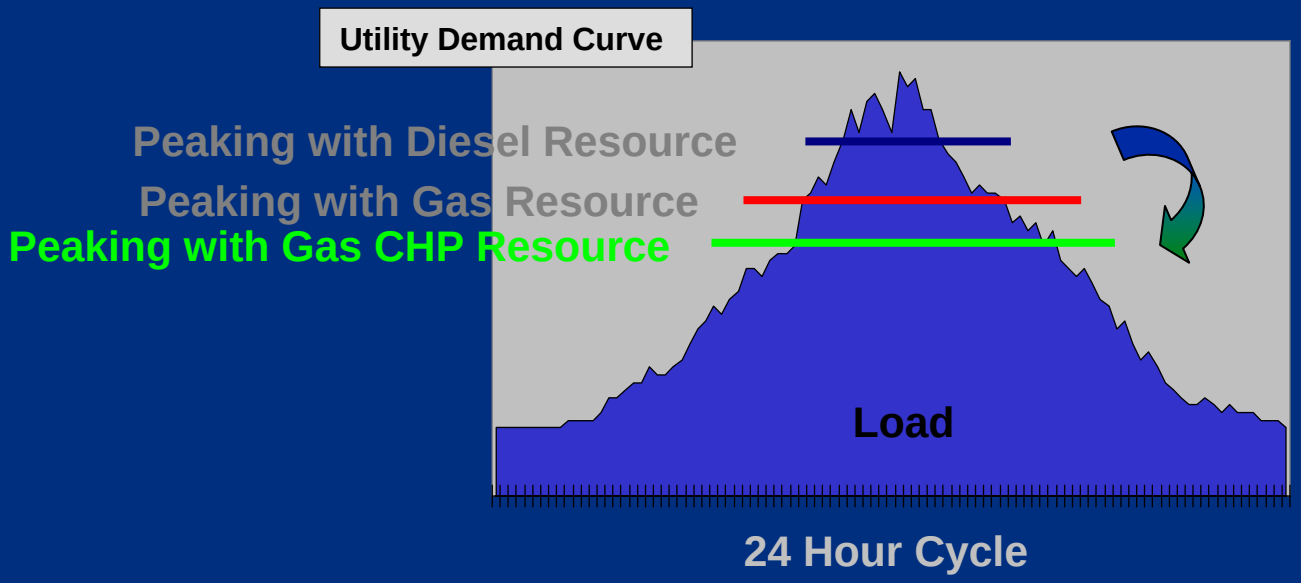


Jeff Anderson

GovEnergy
www.govenergy.gov

August 3-6, 2008

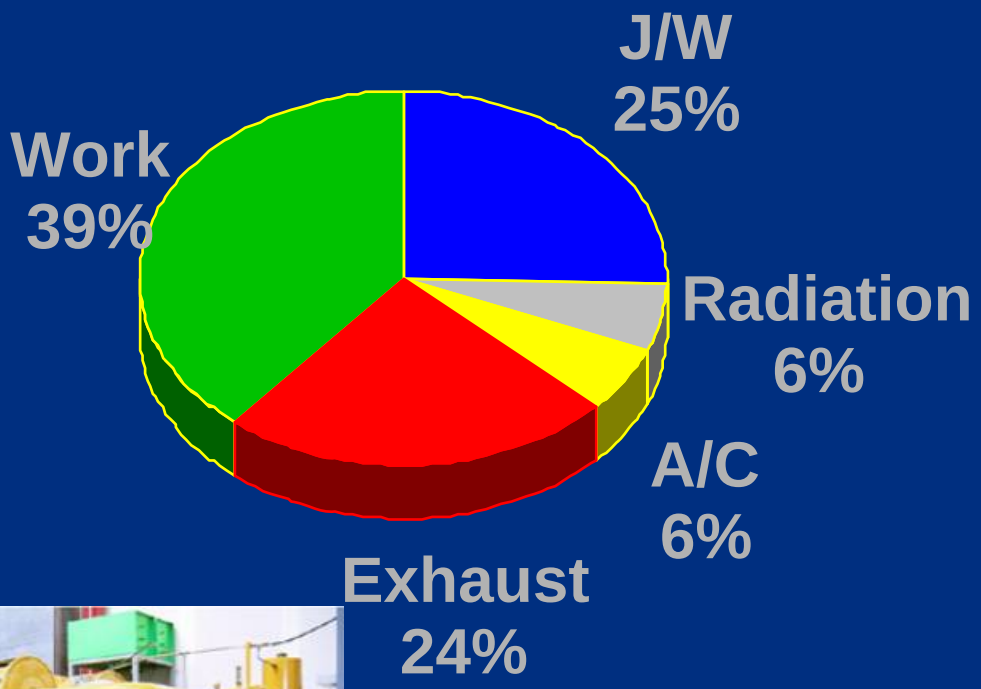
Improved Gas Product Effect



Distributed Generation With Gas Resource
Improves Operating Cost/kw-hr
Allow Increased Time Online
100 – 500 hrs/yr → 100 – 4000 hrs/yr

Combined Heat and Power

Also Known As:
-CHP
-Cogeneration
-Heat Recovery
-Total Energy
-Tri-generation



Heat Uses:

- Hot Water
- Hot Air
- Steam

GovEnergy
www.govenergy.gov

Jeff Anderson

August 3-6, 2008

CHP Definition

Combined Heat and Power (CHP) also known as Cogeneration, is broadly defined as…

"The simultaneous and sequential use of power and heat from the same fuel source."

Complete CHP Package

•1250 ekW CHP System

System Designed To Meet Electrical Needs

- Engines only run when electricity is required
- Typically installed with:
  - Load balance radiators (possibly heat exchangers) connected to JW (primary circuit)
  - Exhaust circuit bypass

Applications:

Industrial Process
Hospitals
Commercial
Facilities

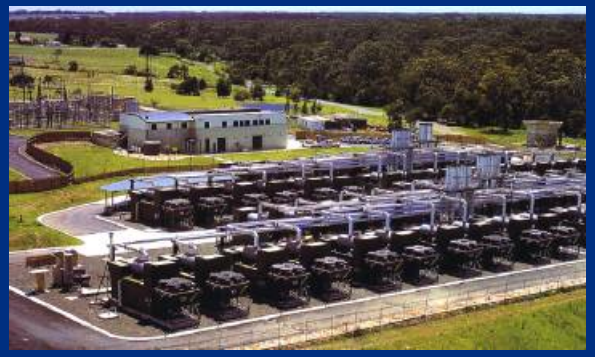
System Designed To Meet Heat Demand

- Engines only run when heat is required
- Typically installed with:
  - A thermal accumulator (hot water storage)
  - Rarely use a load balance heat exchanger (radiator)- Typically connected to user hot water/steam circuit

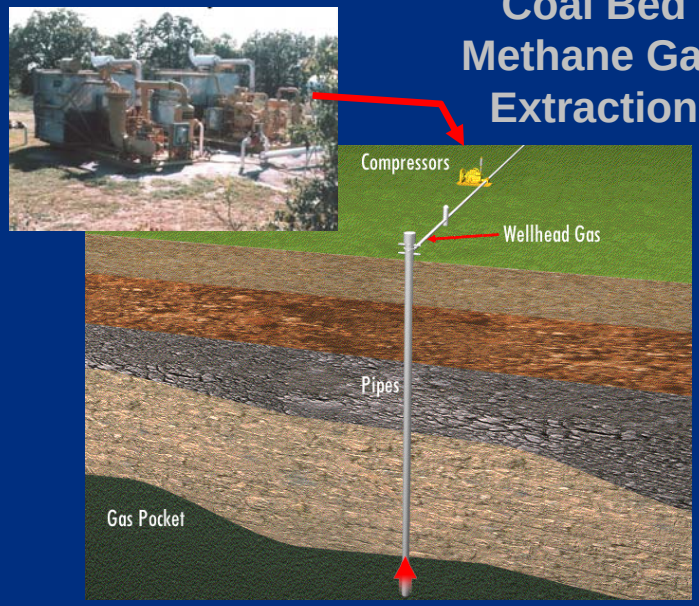
Applications:

District heating and cooling
Central plant
Greenhouses

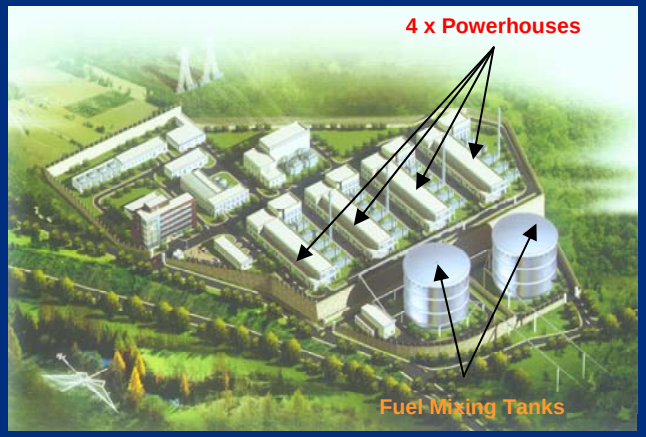
Low Energy Fuels- Coal Bed Methane



Coal Mine Methane



Coal Bed Methane Gas Extraction



Coal Mine Ventilation Air Methane

GovEnergy
www.govenergy.gov

Jeff Anderson

August 3-6, 2008

Low Energy Fuels- Biogas

Ag Biogas Collection

Landfill Gas

Commercial Digester Gas

Municipal Digester Gas

GovEnergy
www.govenergy.gov

Jeff Anderson

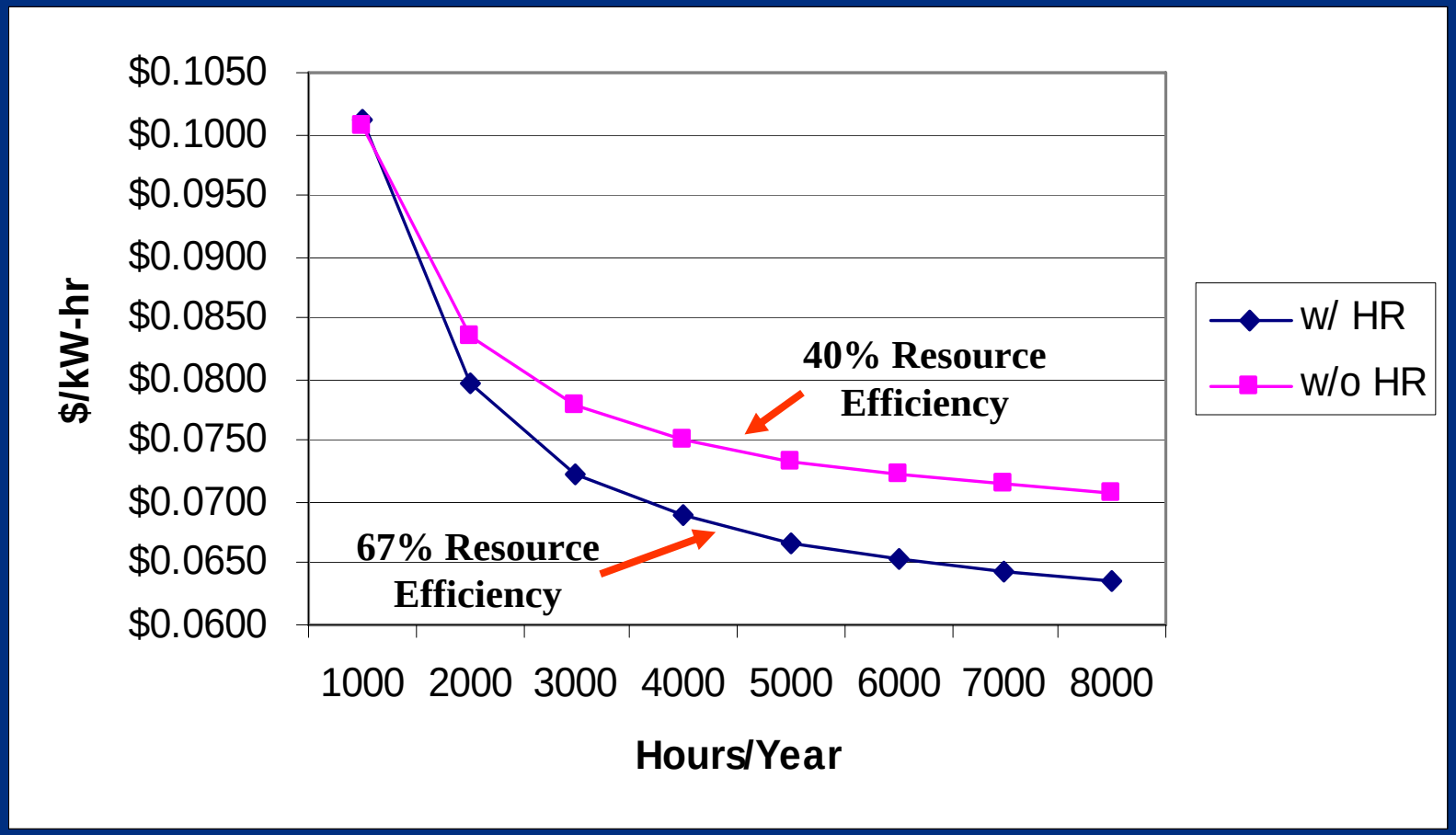
August 3-6, 2008

CHP is an Economic Decision

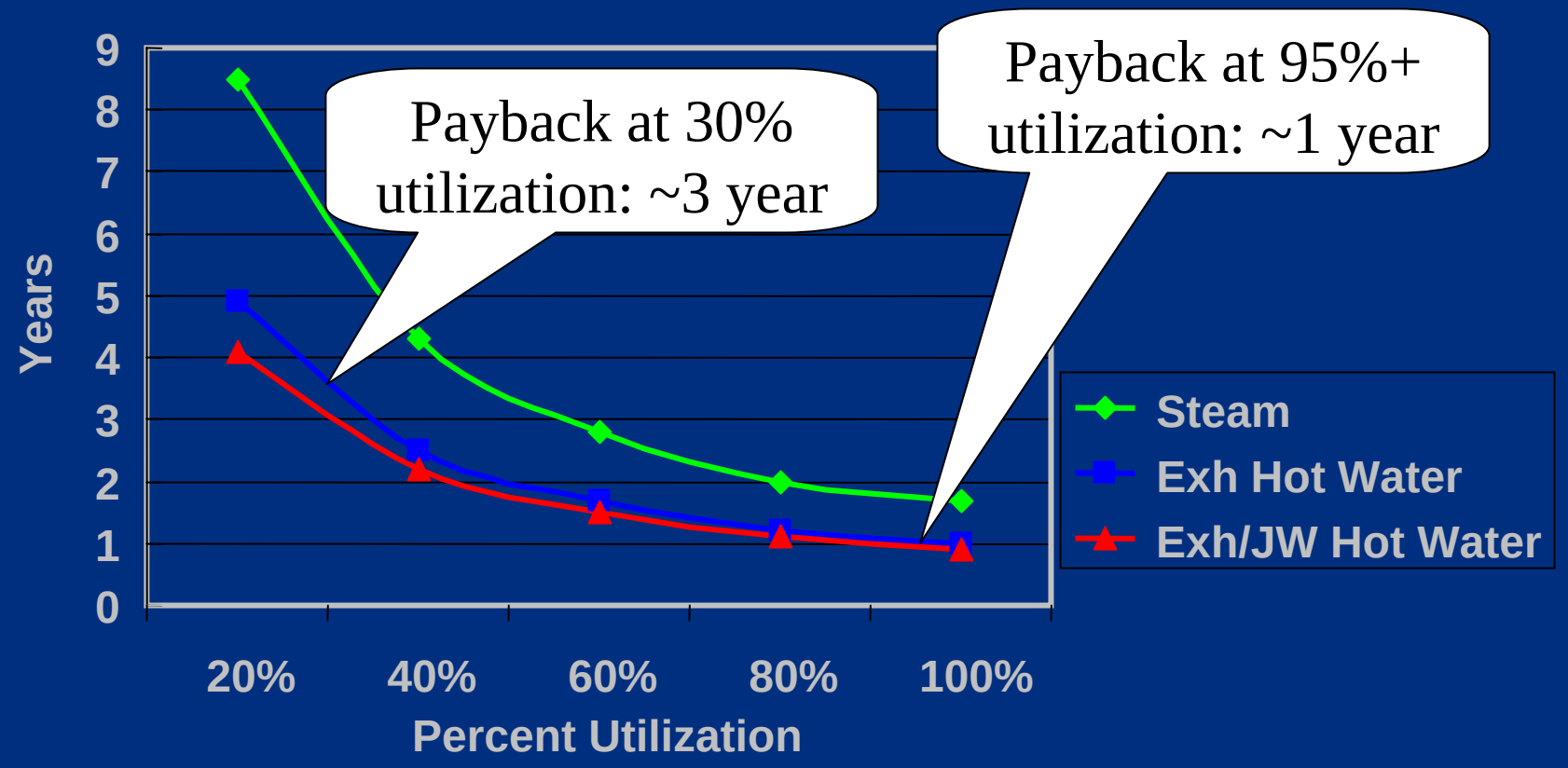
- Decide which is most important:
  Electrical power or heat recovery
  - Some electric power requirements are sized to meet heat load needs.
  - Some system run times are determined by electric load needs.

Bottom Line:
What is the $ value of the heat recovered
Vs. the cost associated with retrieving
and distributing the heat.

Distributed Generation Resource Efficiency Costs

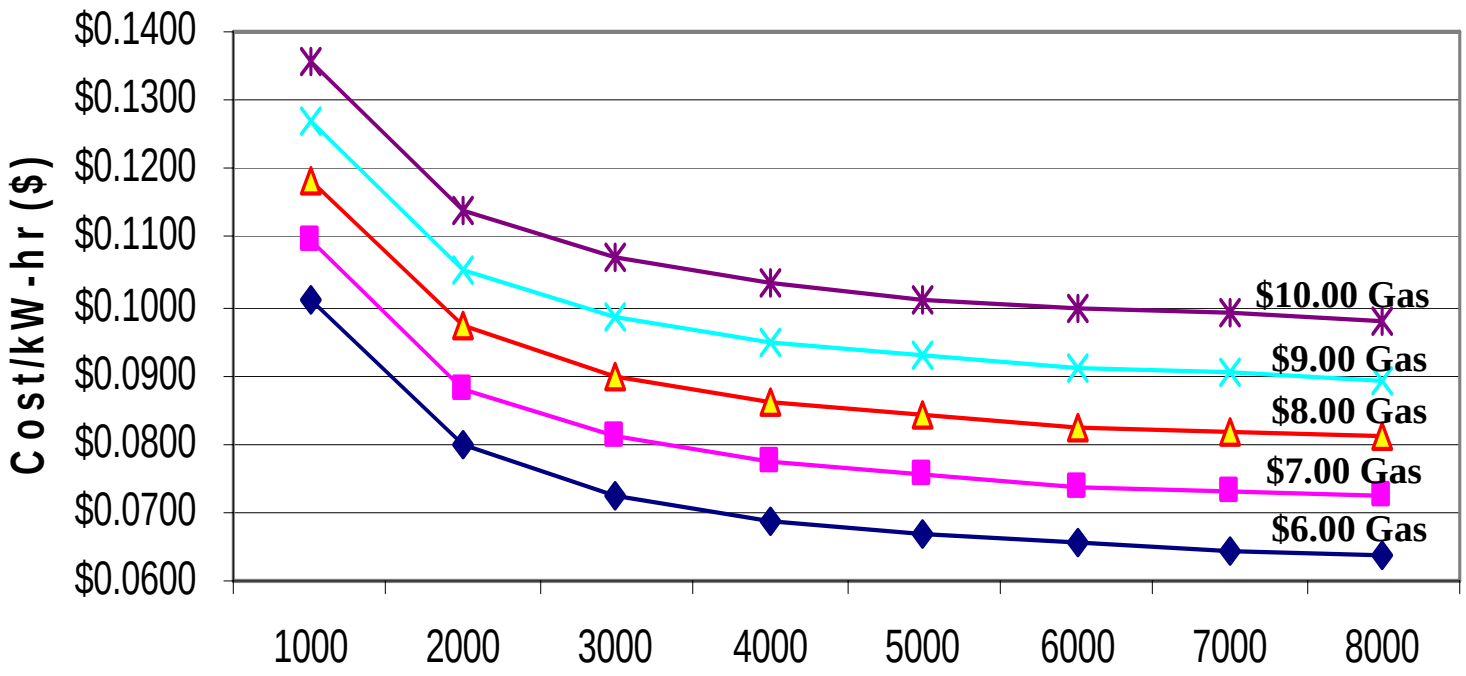


CHP Benefits



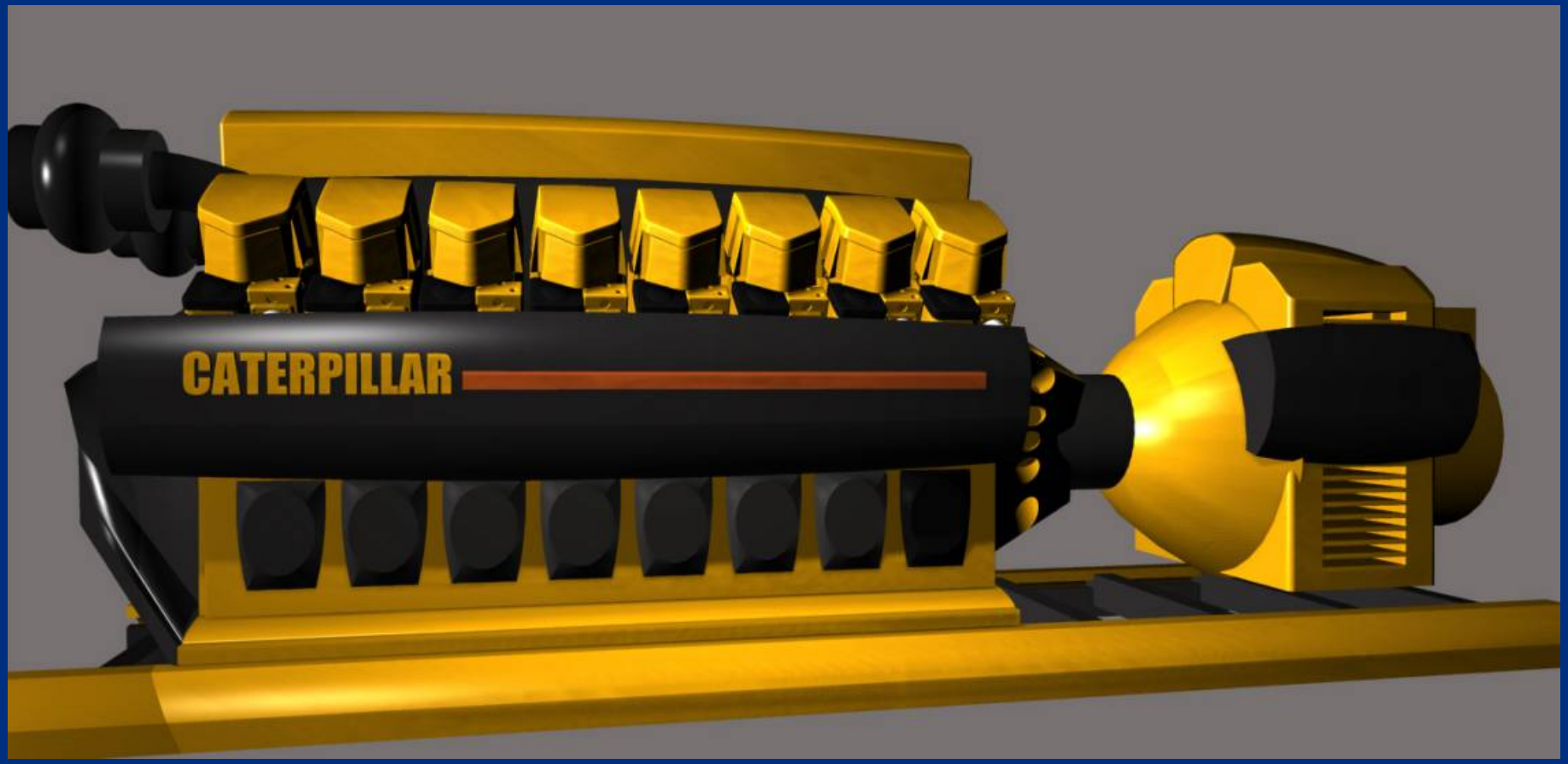
GovEnergy
www.govenergy.gov

Effects of Fuel Price on Generation Cost



2000 kW Gas Resource
Gas Price as marked
DG with 67% efficient CHP @ 30% Utilization

Advanced Reciprocating Engine Systems Program



Jeff Anderson

GovEnergy
www.govenergy.gov

August 3-6, 2008

ARES Program

A multiyear cooperative agreement between the US Dept of Energy and Industry to create a 50% efficient natural gas powered reciprocating engine system with a 95% reduction in NOx emissions by the year 2010

Integrated Aftertreatment

Enhanced Combustion

Improved Air Systems

Reduced Parasitics

Dedicated Control Systems

Jeff Anderson

GovEnergy
www.govenergy.gov

August 3-6, 2008

ARES Program

Objective:

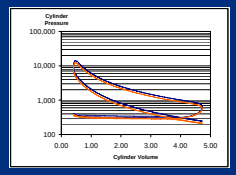
By 2010, create a natural gas powered reciprocating engine system with the following attributes:

- **50% thermal efficiency**
- **0.1 gram/bhp-hr NOx or less**
- **10% reduction in life cycle costs**
- **No loss of reliability or availability**

Engine Improvements

Leaner combustion with high energy spark initiation

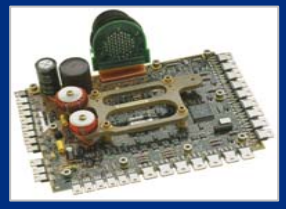
Cross-Flow cylinder head for improved engine breathing



Optimized valve events for efficiency improvement

Patented air/fuel and emission controls

Integrated control of timing, speed, and combustion



Increased power density for more efficient fuel utilization

Efficiency

44%

37%

2000

2004

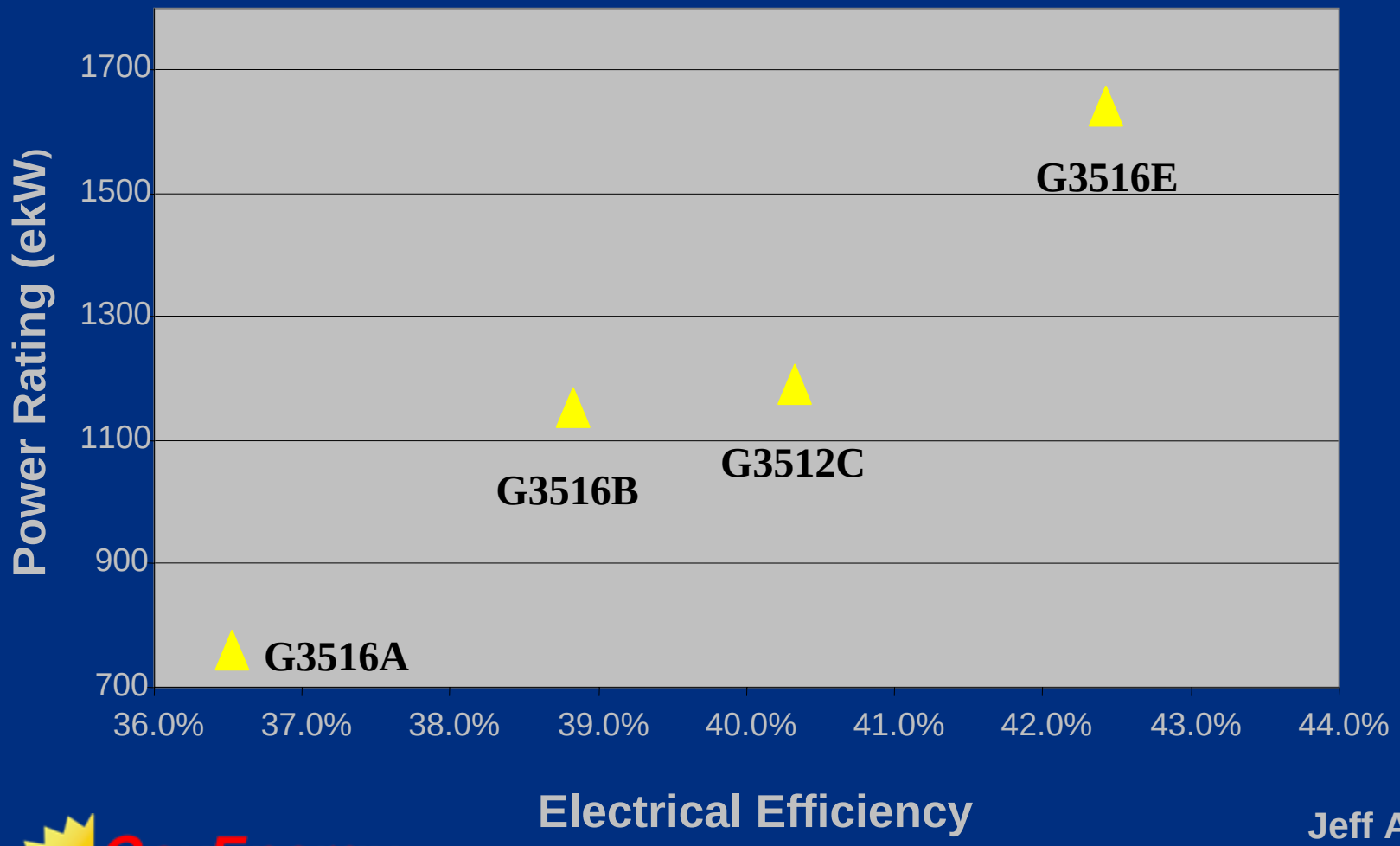
ARES – Advanced Reciprocating Engine Systems

Jeff Anderson

GovEnergy
www.govenergy.gov

August 3-6, 2008

ARES Program

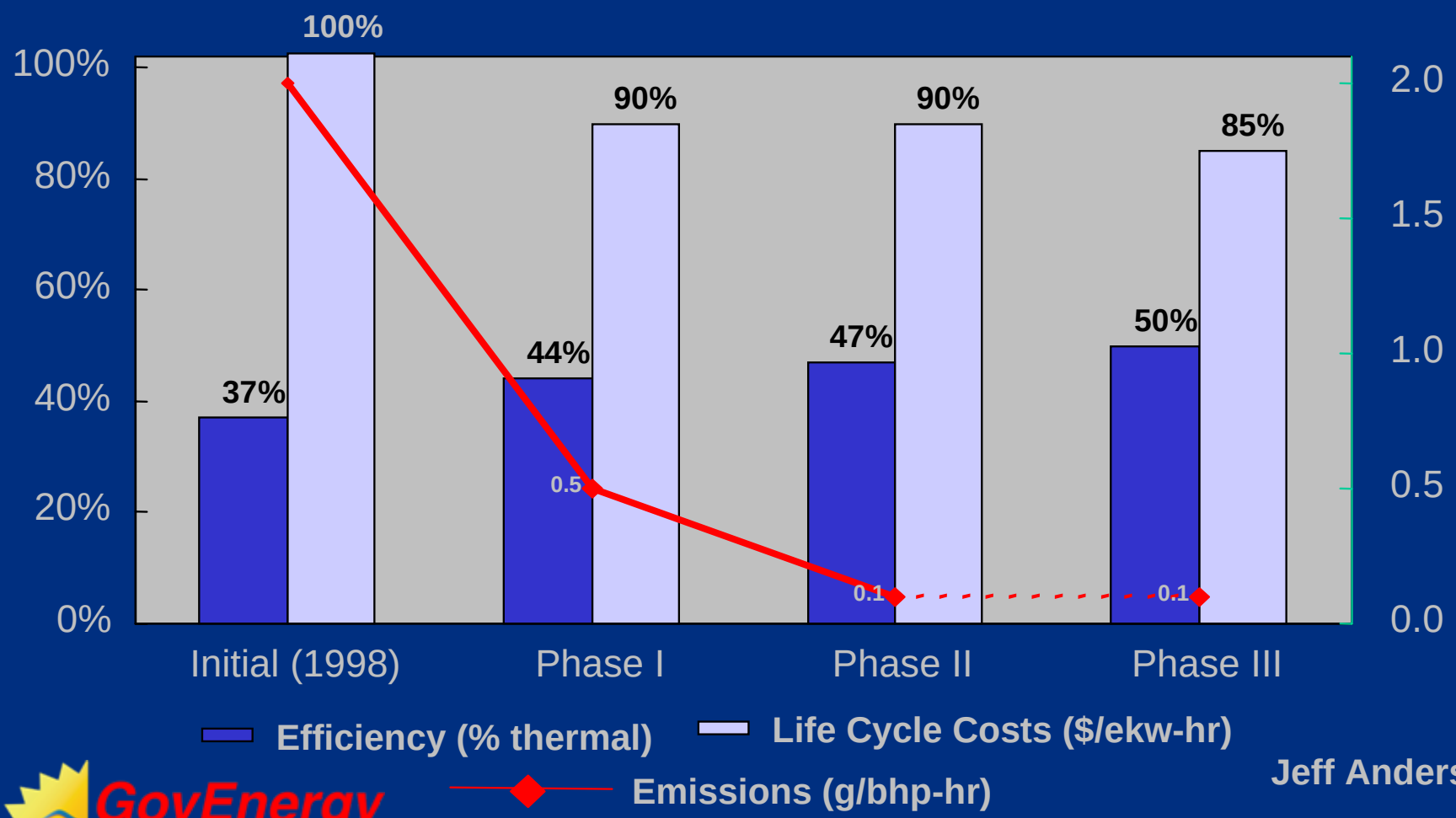


GovEnergy
www.govenergy.gov

Jeff Anderson

August 3-6, 2008

ARES Next Steps

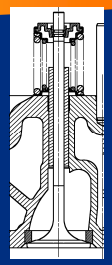


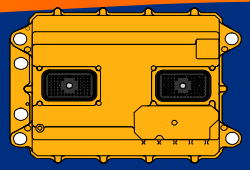
GovEnergy
www.govenergy.gov

Jeff Anderson

August 3-6, 2008

ARES Phase II Building Blocks





Active Combustion Controls for In-Cylinder Stability

47%

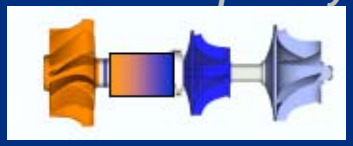
Efficiency

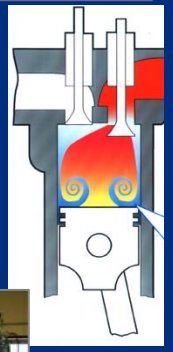
44%

Prechamber / Open Chamber Selection and Integration

High Efficiency Air Systems for Improved Breathing

Patented HEAT™ Turbo for higher turbo efficiency and pressure ratio capability

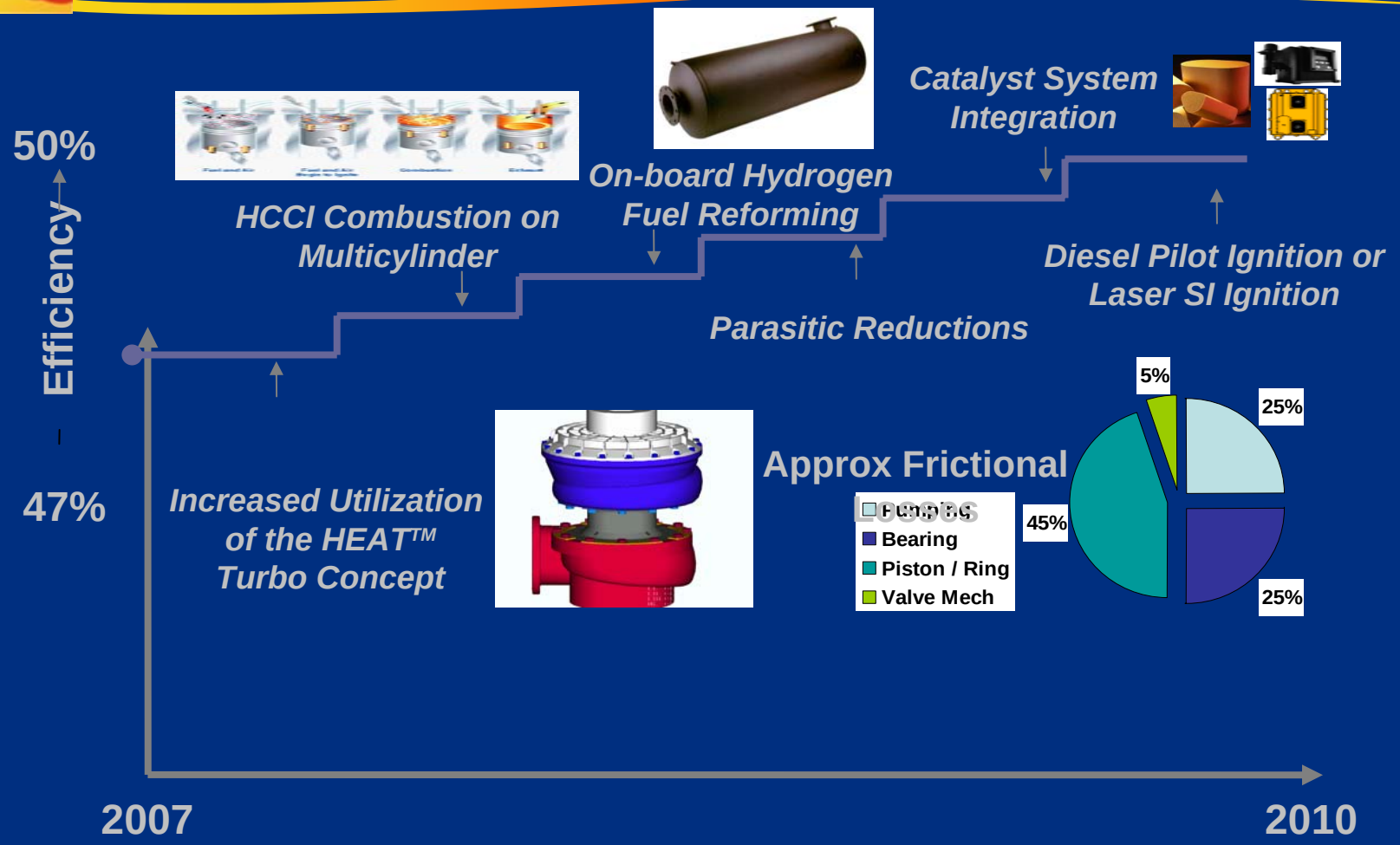




Advanced piston and liner concepts to
- *reduce friction*
- *reduce heat loss*
- *improved combustion efficiency*

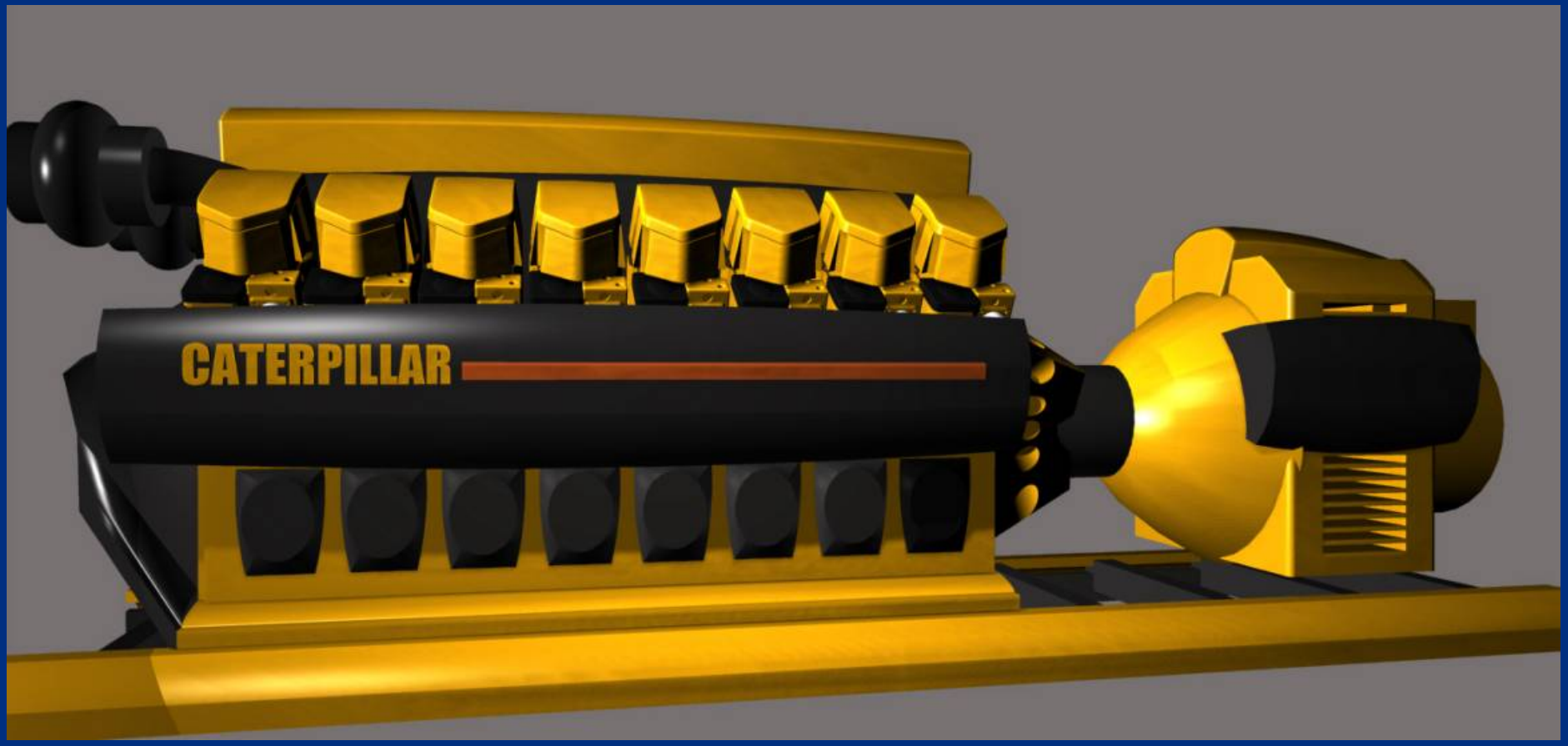
SC-3 Option for ultra-low NOx emissions

ARES III Building Blocks



Jeff Anderson

Advanced Reciprocating Engine Systems Program



Jeff Anderson

GovEnergy
www.govenergy.gov

August 3-6, 2008

For More Information

- Would you like to know more about this session?
- Jeff Anderson
- Caterpillar Inc.
  Defense & Federal Products
  Technical Center, Bldg. A
  P.O.Box 470
  Mossville, IL 61552-0470
- E-mail Address: anderson_jeffrey_a@cat.com
- Don’t forget to fill out and drop off your session evaluations!