HIGH LEVEL OVERVIEW OF COMBINED HEAT & POWER (CHP)

WHAT IS CHP AND WHY CONSIDER IT?

Distributed Generation

DG is …

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

DG Technologies …..

- Solar Photovoltaic
- Wind Turbines
- Engine Generator Sets
- Turbine Generator Sets
  - Combustion Turbines
  - Micro-Turbines
  - Steam Turbines
- Fuel Cells

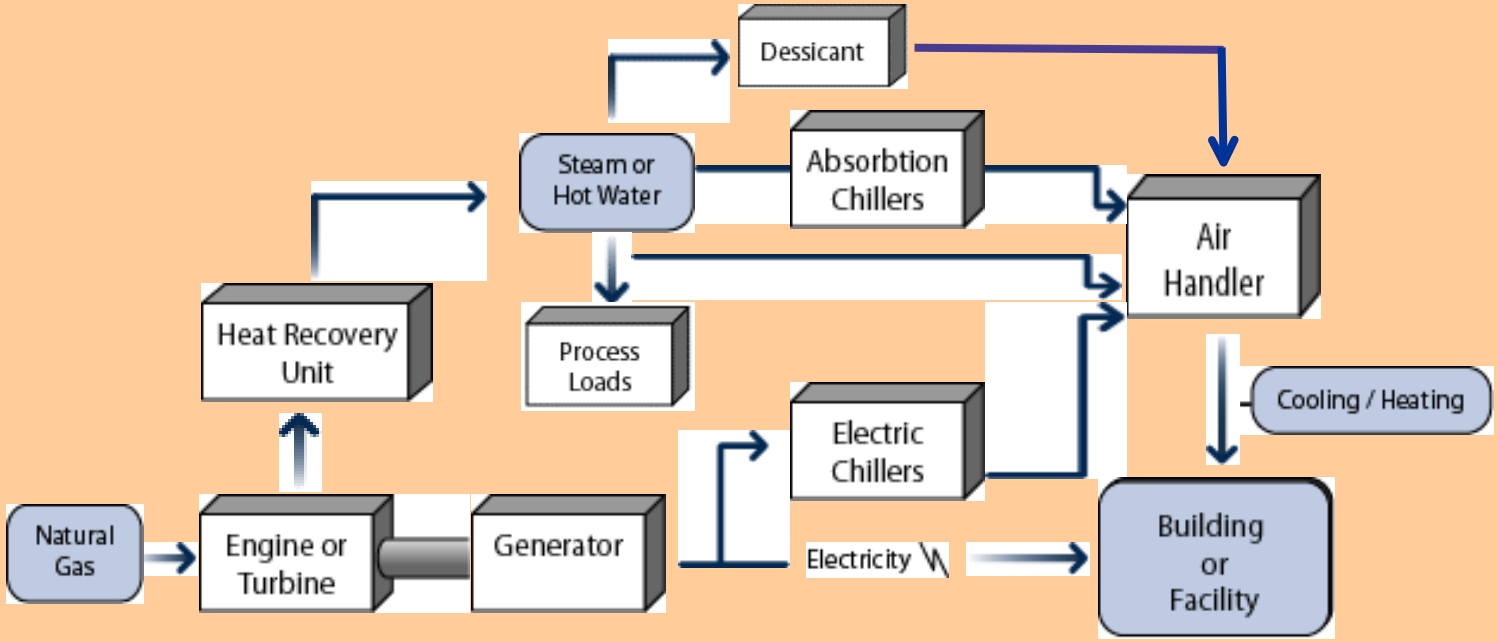
Combined Heat and Power
A Form of Distributed Generation

Combined Heat and Power (CHP) is …

- An Integrated System
- Located at or near a Building/Facility
- Providing a Portion of the Electrical Load

  and
- Recycles the Thermal Energy for
  - Process Heating / Cooling
  - Space Heating / Cooling
  - Dehumidification

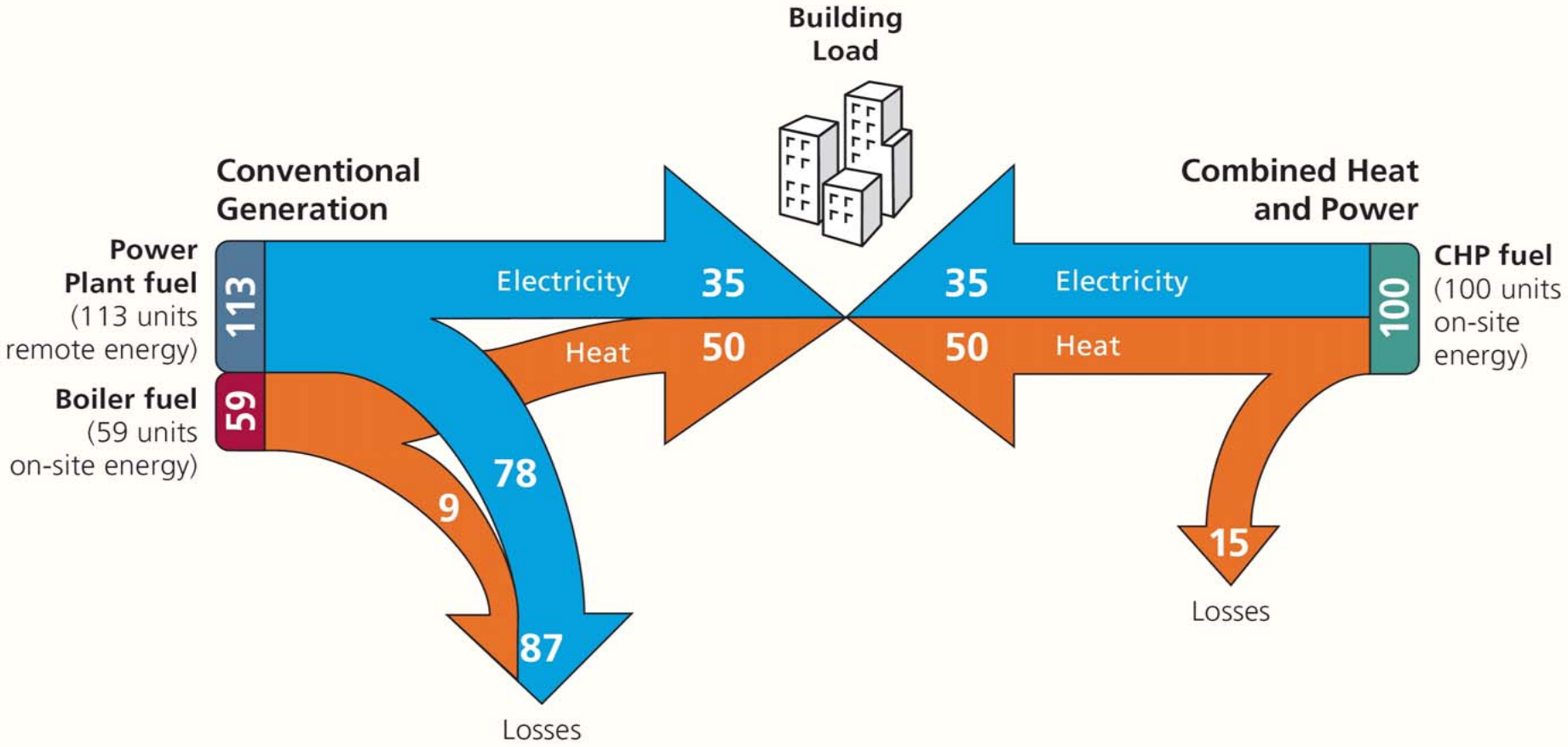
Typical Commercial CHP Configuration



Typical CHP 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
- Recycled Heat From the Prime Mover Used for:
  - Space Heating (Steam or Hot Water Loop)
  - Space Cooling (Absorption Chiller)
  - Process Heating and/or Cooling
  - Dehumidification (Desiccant Regeneration)

Conv. Generation vs. CHP

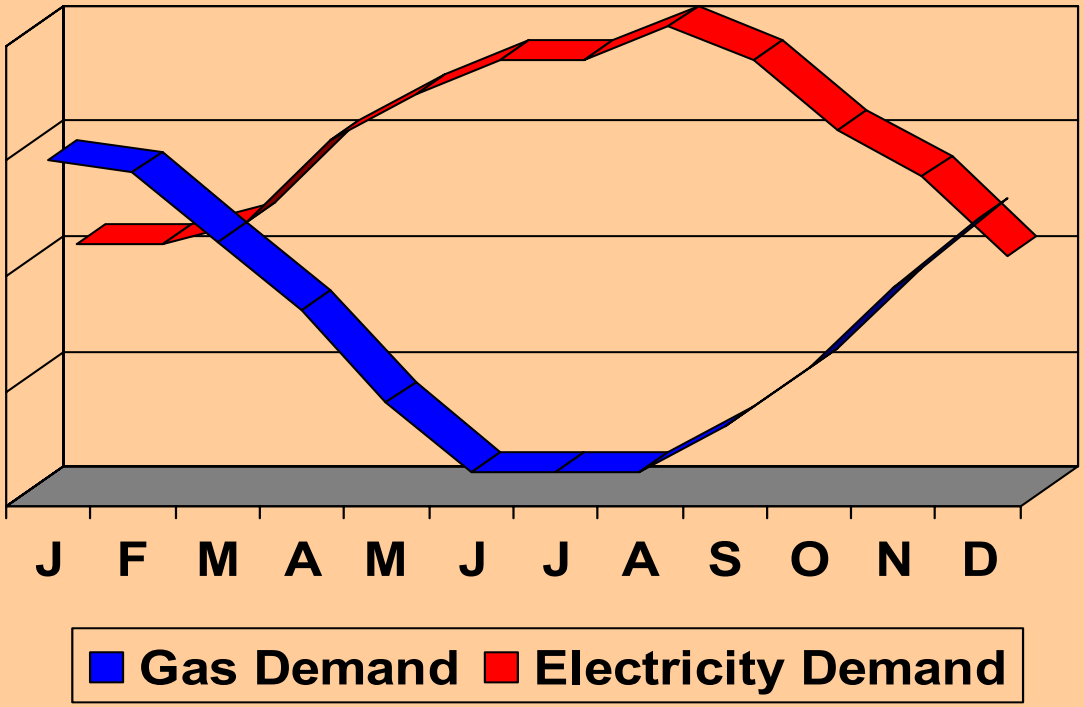


What Makes A Good CHP Application?

- Good Coincidence Between Electric and Thermal Loads
- Large Cost Differential Between Electricity (Grid) and CHP Fuel --- “Spark Spread”
- Long Operating Hours
- Economic Value of Power Reliability is High
- Installed Cost Differential Between a Conventional and a CHP System

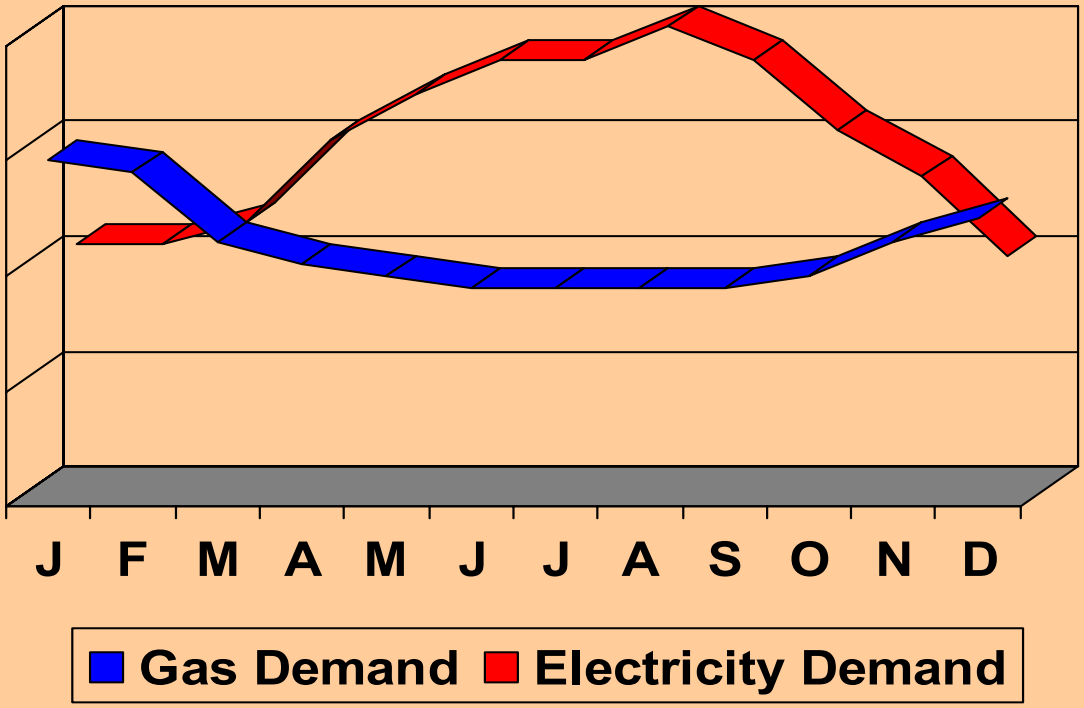
Typical Building Energy Profile

- High Summer Electric Demand
- High Winter Thermal Demand

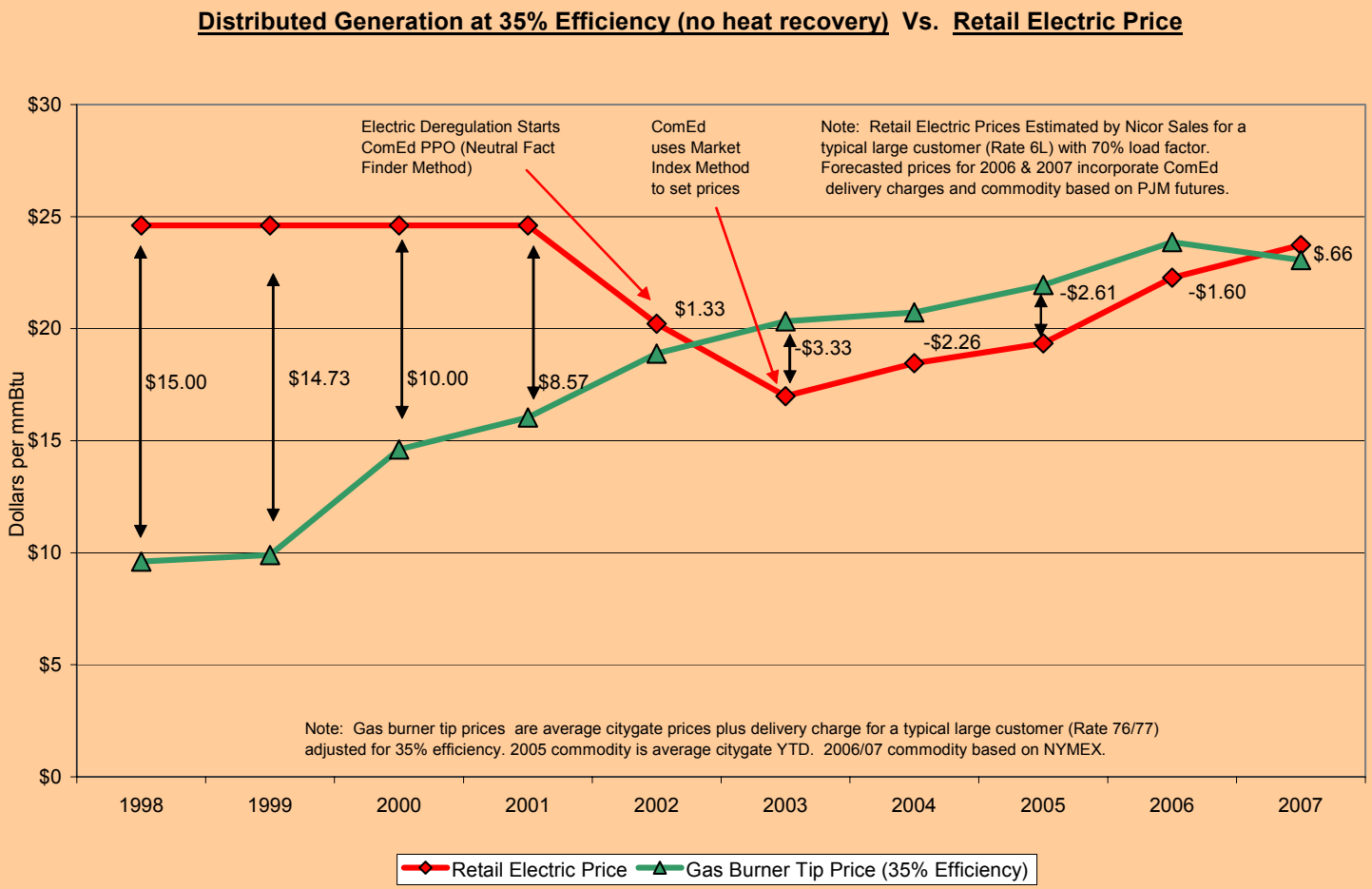


Ideal CHP Building Energy Profile

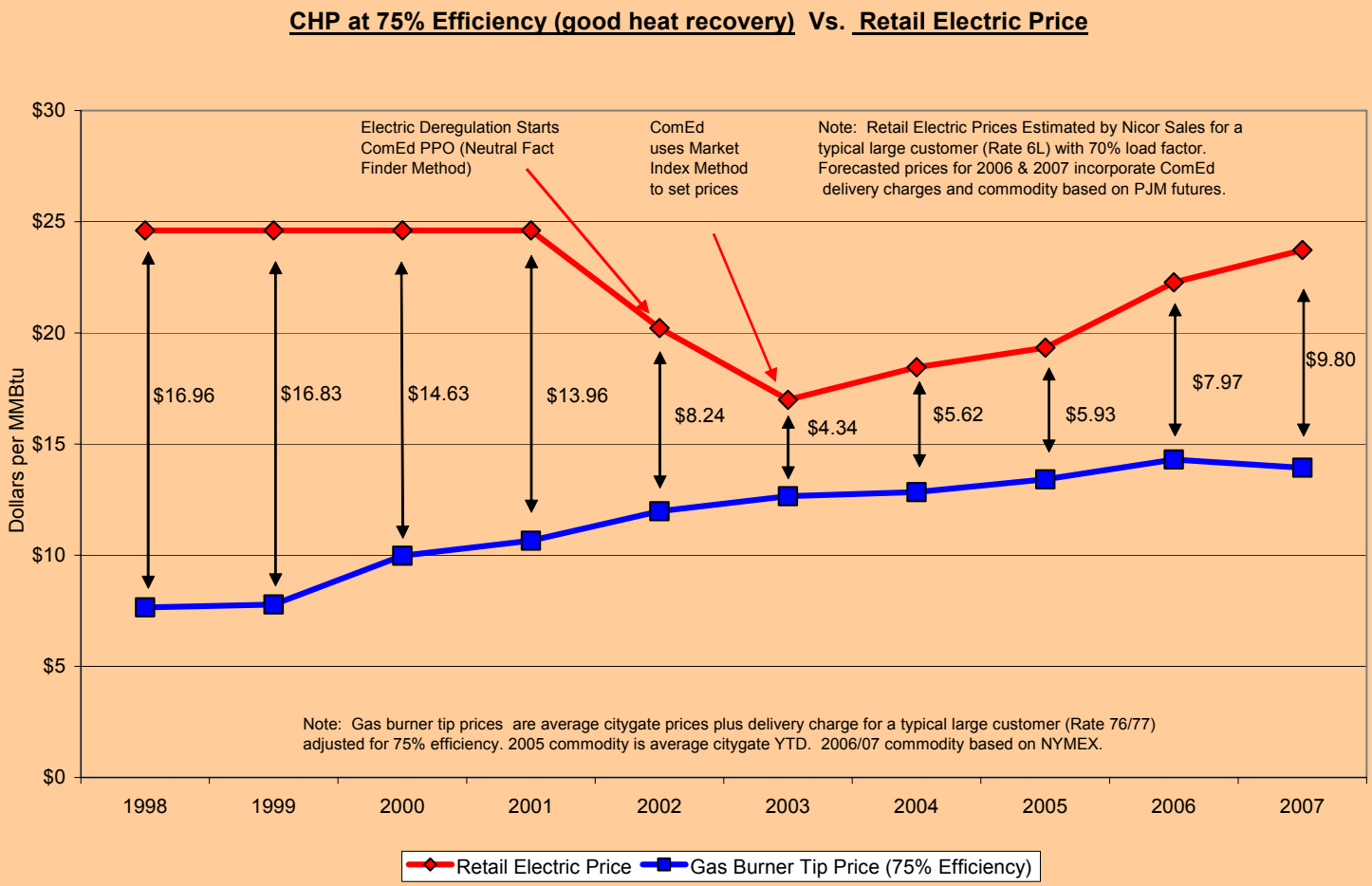
- High Summer Electric Demand
- High Winter and Summer Thermal Demand



Spark Spread: DG vs. Retail Electric



Spark Spread: CHP vs. Retail Electric



Application Rules of Thumb

- If > 50% of the available thermal energy from the prime mover can be used on an annual basis, CHP probably makes good $ense.
- Spark Spread > $12/MMBtu – application worth further evaluation
- CHP operating hours should be > 3,000 hrs/yr
- Doubling the capacity of the CHP system does not normally double the cost and reduces the installed "cost per kW".
- Larger sized facilities usually translates to a lower CHP installed cost differential and larger annual savings

Economic Value of Power Reliability

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

Industry	Avg. Cost of Downtime
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

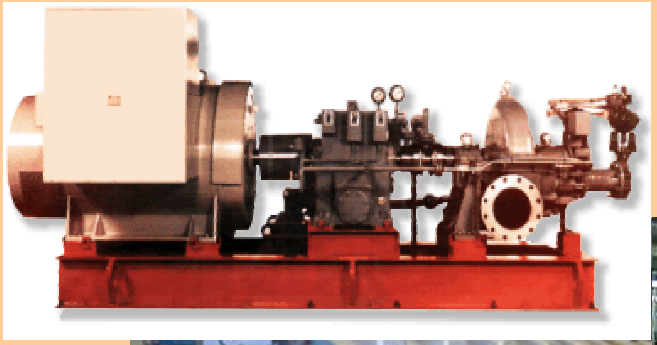
- Lower Energy Costs
- Reduced Energy Consumption
- Increased Electric Reliability
- Standby Power
- Improved Environmental Quality

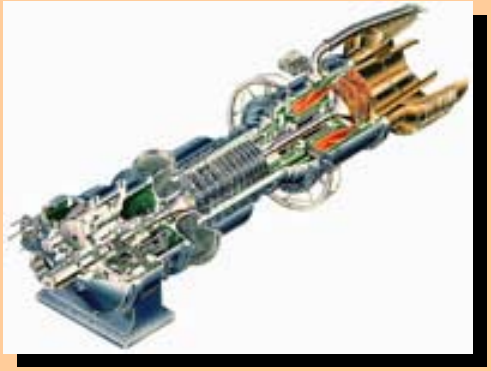
Market Challenges

- 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

CHP Prime Movers

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





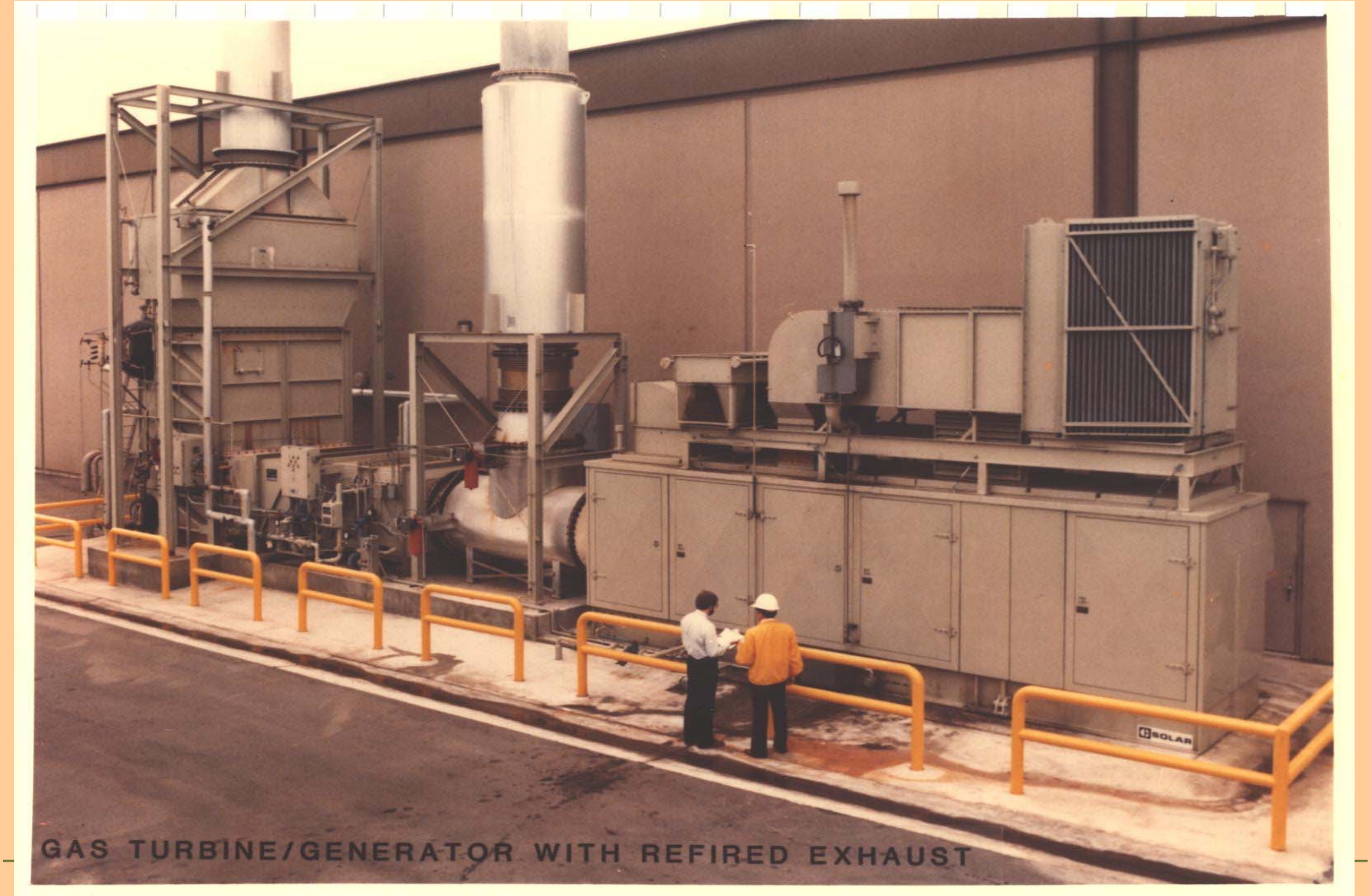
Which Prime Mover to Use

- Recip. Engine --- Hot Water / Low Pressure Steam
- Industrial Gas Turbines --- High Pressure Steam, Usually over 3 to 4 MW in Capacity
- Steam Turbines --- Large Industrials with Waste Streams, Large Pressure Drop Requirements
- Micro-Turbines --- Fuel Flexibility, Relatively Small Capacities Required
- Fuel Cells --- Extremely Clean, Very Expensive

Reciprocating Engine

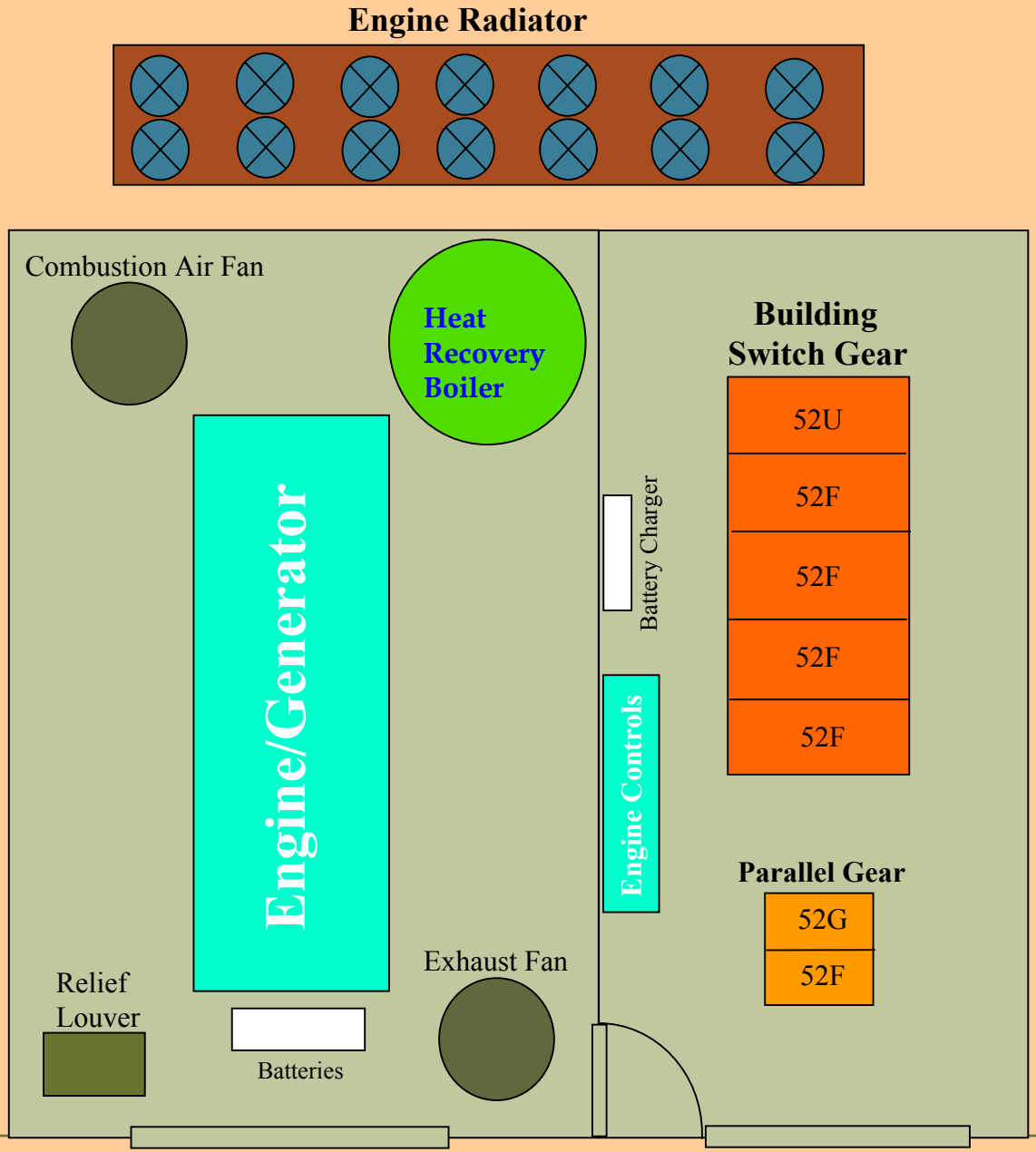
Waukesha 1050KW

Turbine Installation



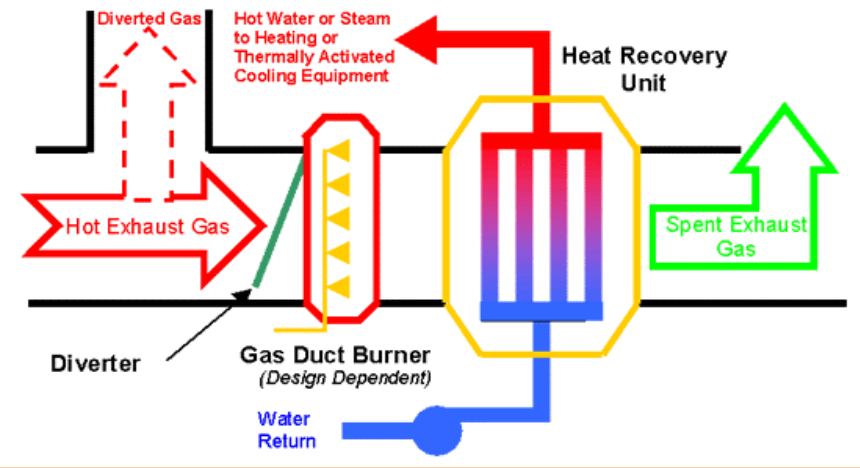
GAS TURBINE/GENERATOR WITH REFIRED EXHAUST

CHP Facility Layout



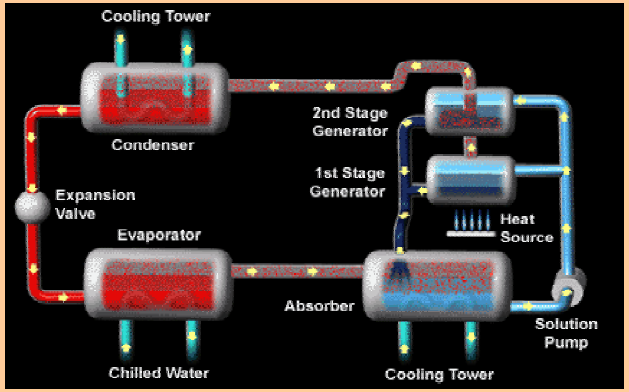
Heat Recovery (Recycled Energy)

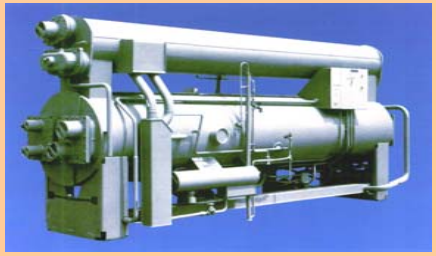
- Hot Exhaust Gases
  - Direct
  - Steam, Hot Water, Air

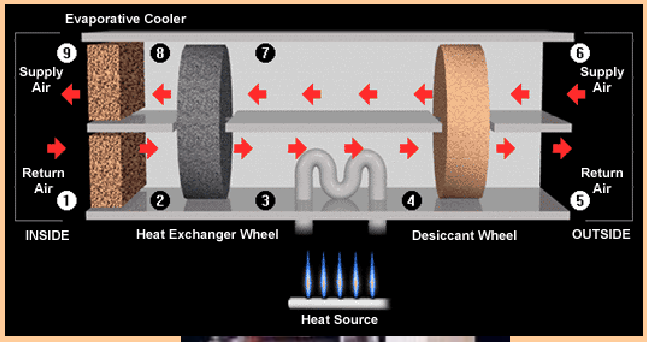


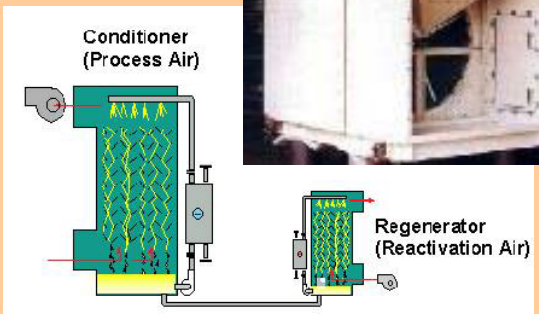
Thermally Activated Machines

- Space and Process Heat Systems
- Absorption Chillers / Refrigeration Systems
- Desiccant Dehumidifiers









System Configuration Rules of Thumb

- CHP systems normally interconnected “in parallel” to the grid (electricity supplied by the grid & CHP system simultaneously)
- CHP systems normally sized for the thermal load of the facility (excess power sold to the grid, shortage purchased from grid)
- Black Start Capability: Should the grid and the CHP go down, the CHP system can be restarted without grid support.

Emergency / Energy Assurance Plans

- Historically dealt more with energy shortages & response planning to those shortages
- Today, more emphasis placed on Critical Infrastructure Protection – losing energy services for prolonged periods of time due to:
  - Deliberate Attacks (man made)
  - Natural Disasters (weather related)
  - Accidental Disasters (technology failures)
  - Systemic Threats (physical inability of the delivery system to meet demands)

CHP Systems Configuration
(Energy Emergencies)

- Configured with synchronous generator
- Be grid connected with stand-alone capability
- Be sized to handle all or a major portion of the electric load
- Recycle the heat from the prime movers for space heating, space cooling, and possibly dehumidification
- Have “Black Start” capability
- Have a continuous source of fuel (usually natural gas or dual fueled natural gas and/or fuel oil)

Alternative Fueled CHP

- Landfill Gas (clean & pipe the gas)
- Anaerobic Digester Gas (food processors, farm manure, waster water treatment)
- Coal
- Industrial Waste
- Steam

How do I Know if CHP is Right for My Facility?

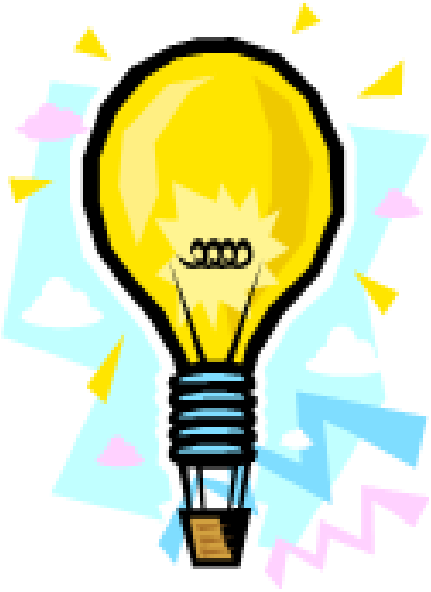
First Step

- 1. Perform an Energy Audit.
  - Evaluate utility systems such as:
    - Electric
    - Natural Gas
    - Steam
    - Process
    - Boiler Feedwater
    - Process Water
    - Hot Oil
    - Refrigeration
    - Cooling Water
    - Compressed Air
    - Building Envelope

Second Step

- 2. Develop a Comprehensive Energy Strategy:
  - Maximize waste heat recovery
  - Maximize equipment efficiency
  - Develop fuel flexibility
  - Improve utility distribution
  - Create a load shedding plan
  - Reduce operating/maintenance costs

Third Step

- Execute an Action Plan
  - Once your energy strategy has been determined:
    - Develop measurement tools and an implementation schedule based on your facility's business needs.
    - Train personnel to understand energy issues as they apply to your business.

Questions / Discussion