Combined Heat and Power Applications

Considerations for Institutional and Commercial Facilities

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Advantages CHP can Provide

- Reliable On-Site Power Generation
- Economic Benefits
- Environmental Benefits

Reliable On-Site Generation

- CHP allows an owner to provide electricity on their site without relying on a utility provider.
- Utilizing waste heat recovery, thermal utilities such as steam and chilled water can also be produced without relying on electricity from utility.

Economic Benefits

- Improved Cycle Efficiencies, resulting in lower fuel costs.
- Reduced demand charges associated with lower peak electric demand.
- Revenue stream possible if exporting electricity to the grid.

Environmental Benefits

- Reduced greenhouse gas emissions and carbon footprint.
- Reduced Global Warming Potential (GWP) using absorption chillers compared to centrifugal machines with HFC’s and HCFC’s.

Some Barriers

- Economic Feasibility – What is the Spark Spread?

- Owners may be hesitant to change current operating parameters.
- Environmental Permitting Concerns

Commercial Building in Houston, TX

- 378,000 sf Office Space
- Energy Futures Trading floor
- Future Data Center on Campus
- LEED Platinum Certification

Commercial Facility

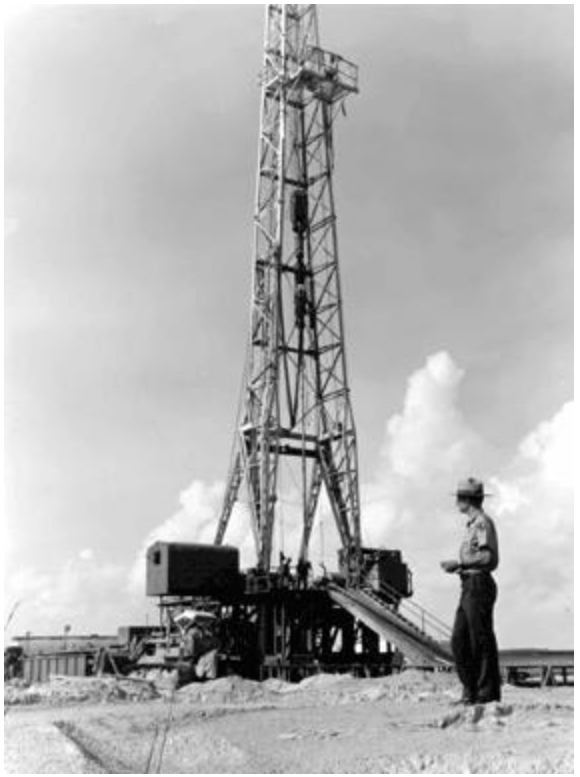
- Combined Heat and Power Equipment
  - 4.4 MW Gas Turbine
  - 14.1 MMBTUH Hot Water Recovery Coil
  - 1350 Ton Single Effect Absorption Chiller
  - 400,000 gal Thermal Energy Storage (TES) Tank
    - 4,000 Ton-Hr refrigeration capacity

Thermal Utility Savings

- Annual facility demand of 3,975,000 ton hrs.
  - Use of Absorption Chiller provides 1,600,000 kWh savings compared to electric centrifugal chiller.
    - $96,000 Operating Cost Savings
- CHW demand peak shaving utilizing Thermal Energy Storage System

Reduced Fossil Fuel Usage

- Peak cycle efficiency approximately 73% with absorption chiller utilizing Hot Water Recovery at Peak Demand Conditions
  - Fuel input 39.09 mmBTUH at 4215 kW output of turbine



Plan for the Unknown

- Landfall of Hurricane Ike on September 13, 2008.
- In addition to storm damage of buildings, Utility outages for extended period

Hospital Applications

- Health Care Provider with Facility in the Texas Medical Center
- 40+ Operating Room Suites
- 35-60 Procedures Daily without Stoppage

Central Utility Plant Upgrade

- CUP Expansion included these upgrades
  - 4.3 MW gas turbine
  - 50,000 pph HRSG
  - 2,800 ton steam driven centrifugal Chiller
  - 30,000+ gal emergency water storage vault

Reliability Concerns

- Emergency Water Well functions as Makeup Water Source for CUP during loss of domestic water from Municipality.
- Testing of CHP systems and equipment coordinated around procedures for major Health Care Facility without interruption of services.

Energy Efficient

- Fuel input 49.46 mmBTUH at 4047 kW output of turbine
  - Peak cycle efficiency approaches 83% utilizing 2800 ton steam driven centrifugal chiller at Peak Demand Conditions
  - Additionally, 24,000 pph steam available for facility process loads