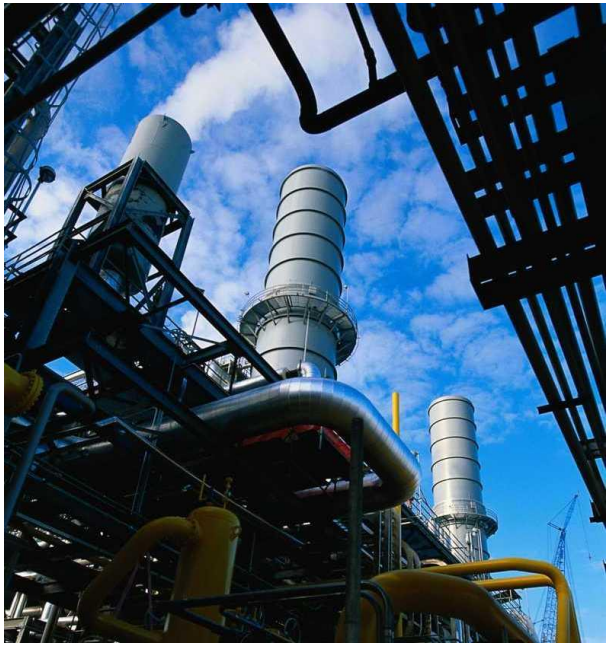


Texas
Large Industrial
Combined Heat & Power

Texas CHP Initiative

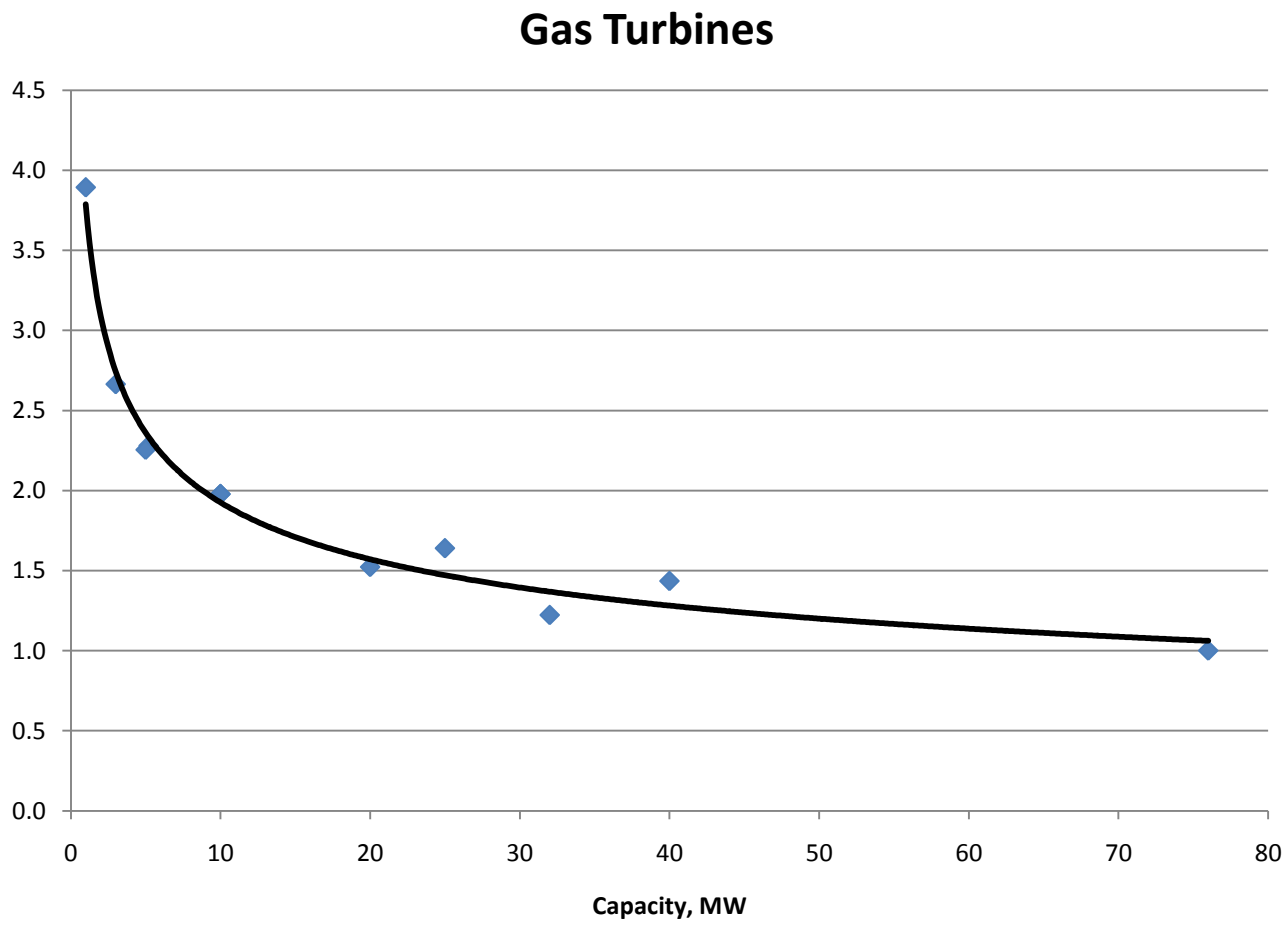
November 3, 2010

TX CHPI
HEAT POWER
TEXAS COMBINED HEAT & POWER INITIATIVE

Tommy John tjohn@indian-creek.net 830-796-7574

Relative Installed Cost per KW

Single Gas Turbine CHP Unit



Energy Conservation Steps

CHP

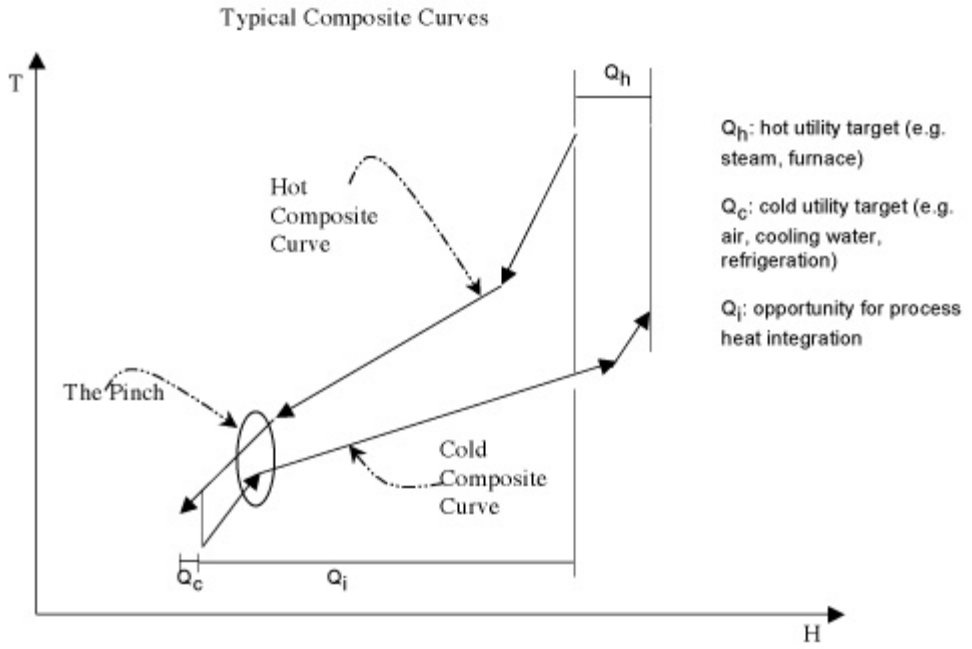
UTILITIES

CONTROLS

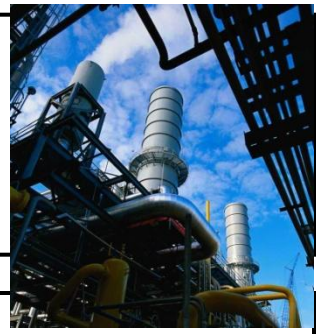
INTEGRATION

EQUIPMENT

PROCESS

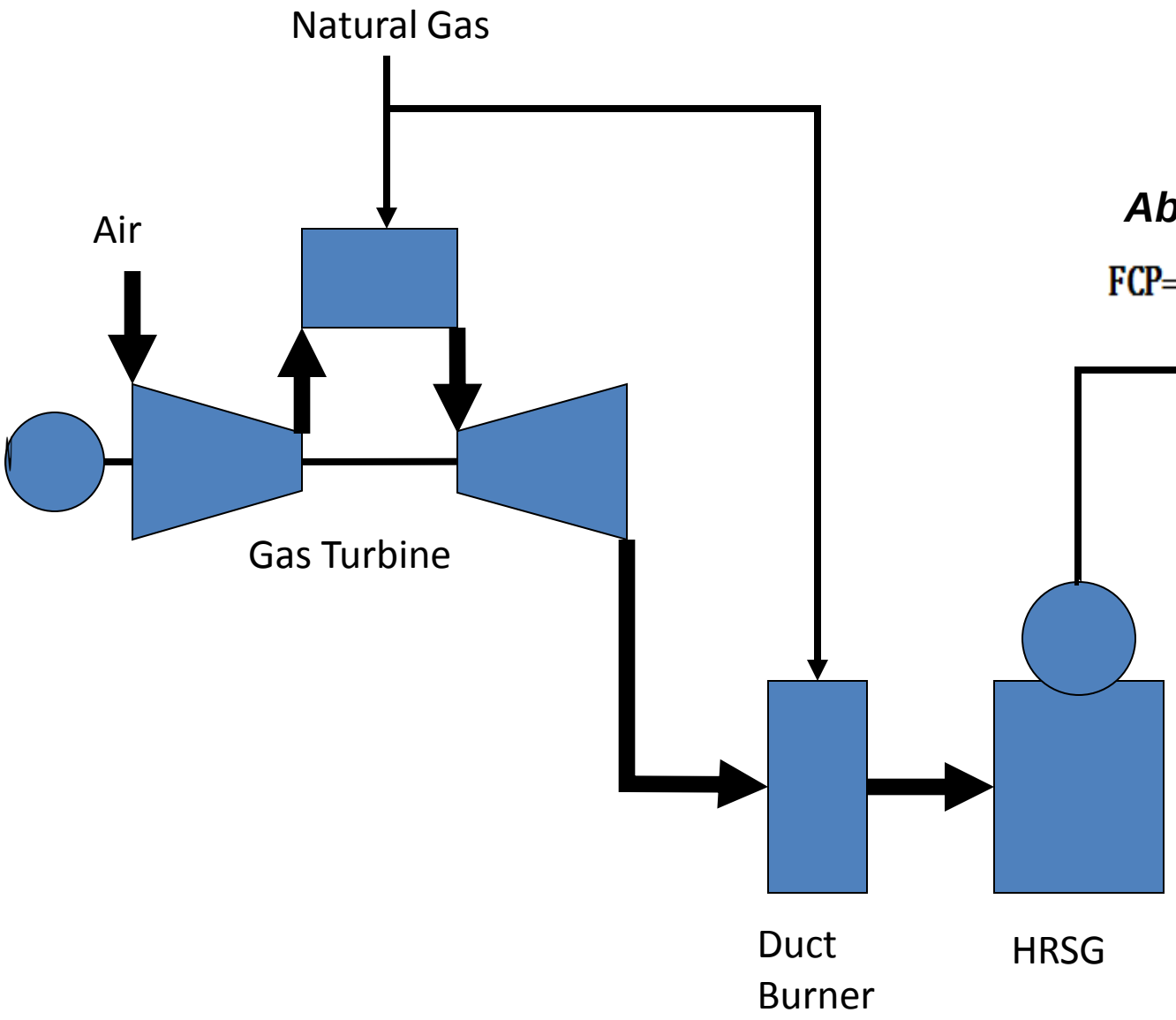

Typical Composite Curves
T
H
Q_h
Hot Composite Curve
The Pinch
Cold Composite Curve
Q_c
Q_i
Q_h: hot utility target (e.g. steam, furnace)
Q_c: cold utility target (e.g. air, cooling water, refrigeration)
Q_i: opportunity for process heat integration

CHP Benefits



- Aggressive energy conservation program can save 10 to 40%.
- Adding CHP can save up to 3 times as much energy considering grid savings.
- Improves reliability
- Reduces emissions
- Saves water

Gas Turbine CHP



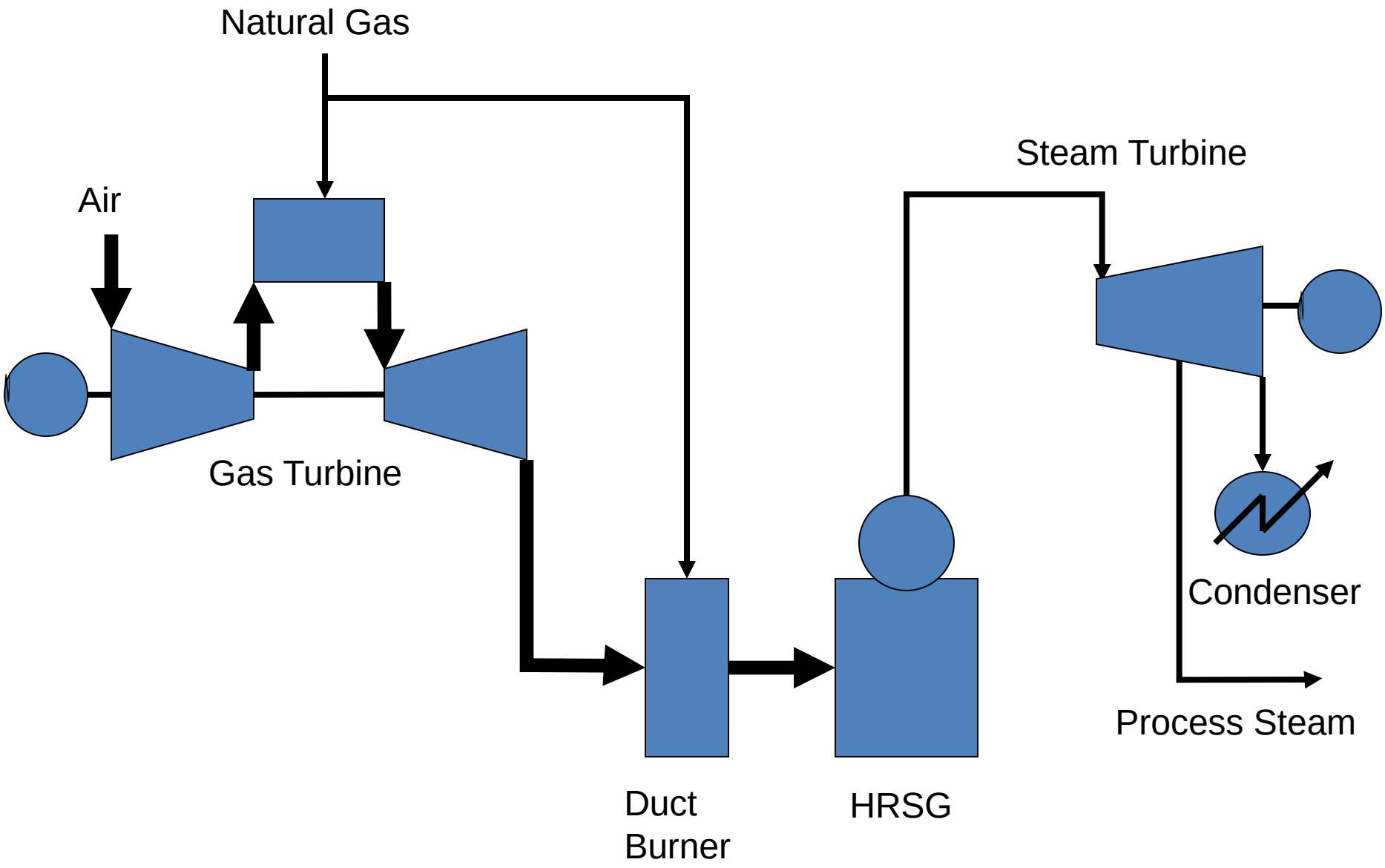
Absorption Cooling

FCP=Fuel/(Power+Cooling/COP)

Process Steam

$$FCP = \frac{Fuel - \frac{Heat}{Eff}}{Power}$$

Combined Cycle CHP

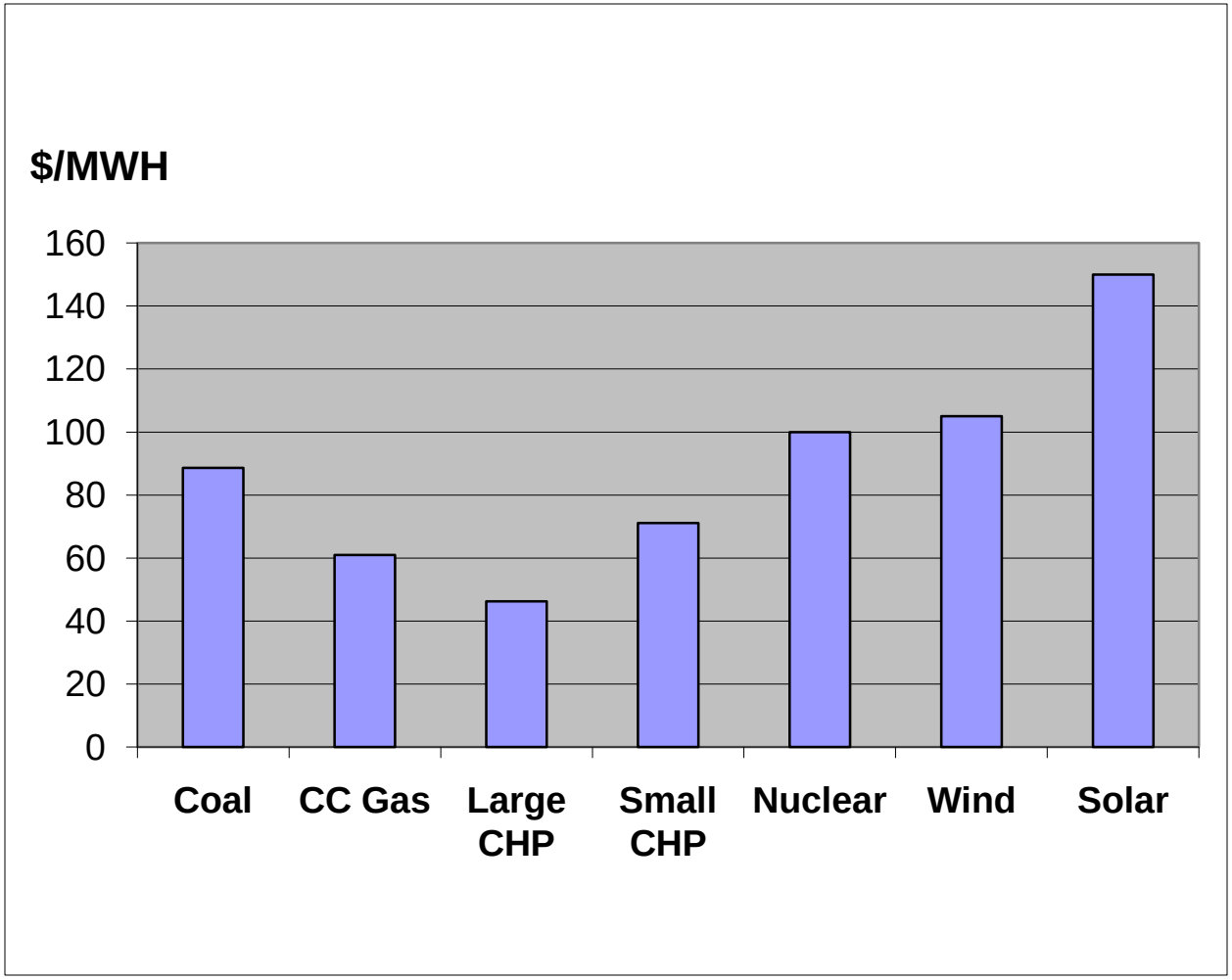


Natural Gas Heat Rate

BTU/KWH (HHV)

• Steam Plants & Peakers	9,500 – 15,000
• GE LMS 100 Simple Cycle	8,500
• Combined Cycle (F-Class)	6,900
• Combined Cycle (H-Class)	6,300
• Gas Turbine CHP (FCP)	4,300
• Gas Engine Jacket Water CHP (FCP)	3,900
• Gas Engine or Turbine Thermal Cooling (FCP)	9,000-14,500

Representative Base Load Power Costs (Not including incentives or emissions)



NGL Fractionation Plant CHP

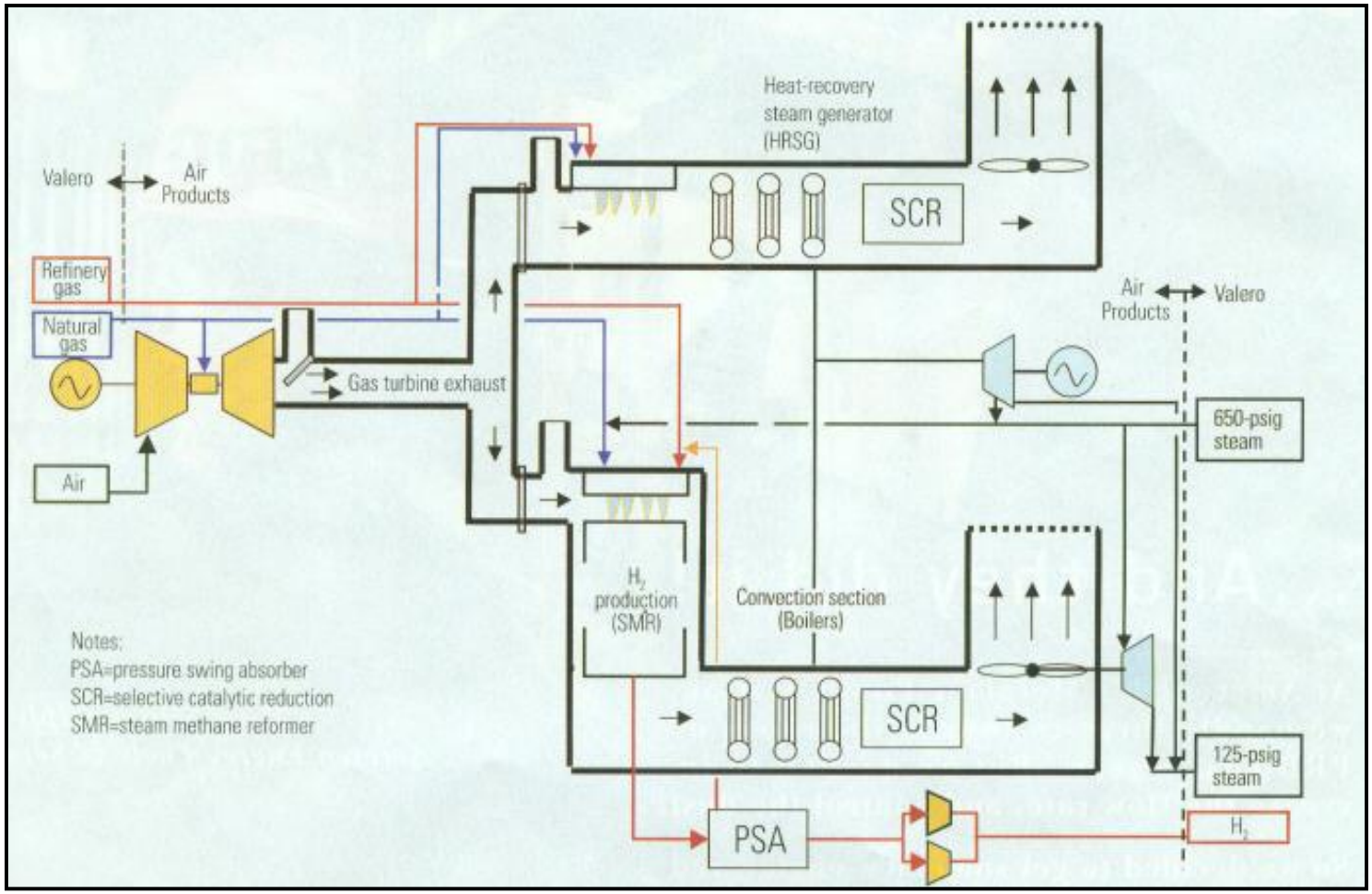
- Combustion Turbine Power Output, 14 MW
- Steam Output, 260 kpph of 450 psig , 635 F
- Supplemental Firing above 2700 F
- Fuel Charged to Power 3672 Btu/kwh

Design for Maximum Combustion Turbine Power

- Combustion Turbine Power Output, 60 MW
- Capital Cost 2.5X, ROI Higher
- Additional Fuel Savings 1.6TBtu/yr, $9.5 million @ $6/MMBtu
- Additional CO_2 reduction 93,000 tons per year

Air Products Hydrogen Cogeneration Plant

Port Arthur, TX



CHP Paradigms

- Optimize thermal energy use and temperature
- Size system to match optimized thermal load
- Maximize heat recovery
- Maximize efficient power output
- Design for flexibility including dispatching & ancillary services
- Maximize unit size
- Utilize available fuel

Large Industrial CHP Issues

- Site constraints
- Reliability of thermal energy supply
- Power marketing
  - Less flexibility to meet market dynamics
  - Sales limited sales to single on site customer
- Availability & cost of capital
  - Large capital requirement
  - Financial strength of counter parties
- CHP is more complex to develop
- Energy supply is secondary to core business activities

Conclusions

- CHP significantly reduces fossil fuel use and emissions
- Well proven technology
- CHP improves power reliability and is dispatchable
- Reduces cost and stimulates economic development
- Eliminates water use for cooling
- Opportunity for additional thermal sales from existing plants