Five Simple Steps to Immediately Determine Industrial CHP Viability

MAVEN POWER LLC
POWER GENERATION EXPERTS

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Overview

- Introduction
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- Market Conditions
- Viability Modeling
- Government Initiatives
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Introduction

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- Equipment & Services for On-site & Distributed Power Generation
- Thermal Power Generation (2-50MW)
- Engineering to Turn-key
- Cogeneration/CHP Projects
  - Prequalification
  - Techno-Economic Feasibility Studies
  - Basic/Detailed Engineering
  - EPC Support
- 5 Simple Steps a result of complex, costly Studies

Industrial CHP Motivations

- Combined Heat & Power (CHP) or Cogeneration
- Traditional Markets
  - Pulp & Paper
  - Bottling, Canneries, Breweries
  - Campuses (Hospitals, Universities)
  - Oil & Gas, Cement, Steel
- Industrial Sector is Large Market
  - 30% of all Consumed Power

Industrial CHP Motivations

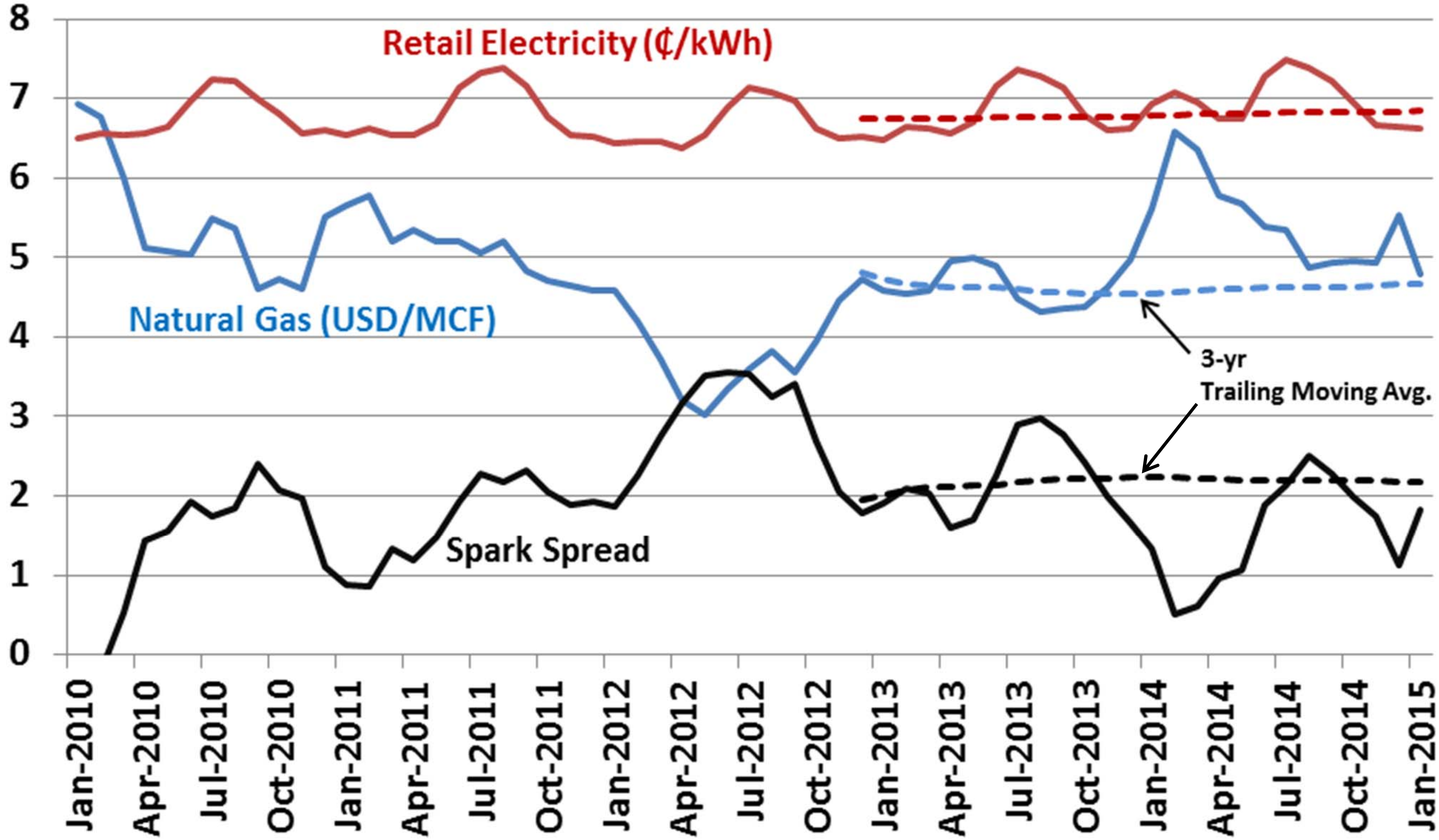
- Abundant & Low Cost Natural Gas
  - 120 year supply
  - Explosive new growth
  - Prices still at Historic Lows ($^1/_4 - {}^1/_6$ Diesel Price)
  - Clean (2 x coal)
- Spark Spreads Reasonable → Trending Higher?
- Aversion to Foreign Energy Sources
- Low Cost, Abundance of Capital
- Governmental & Regulatory Initiatives

Market Conditions

- Electric Prices Stable over Last Several Years (6.5 – 7.5 ¢ per kWh).
- Natural Gas Prices Down ~30% since Jan 2010
- Spark Spread Average more than doubled since early 2010.
  - Single Largest Indicator of CHP Viability

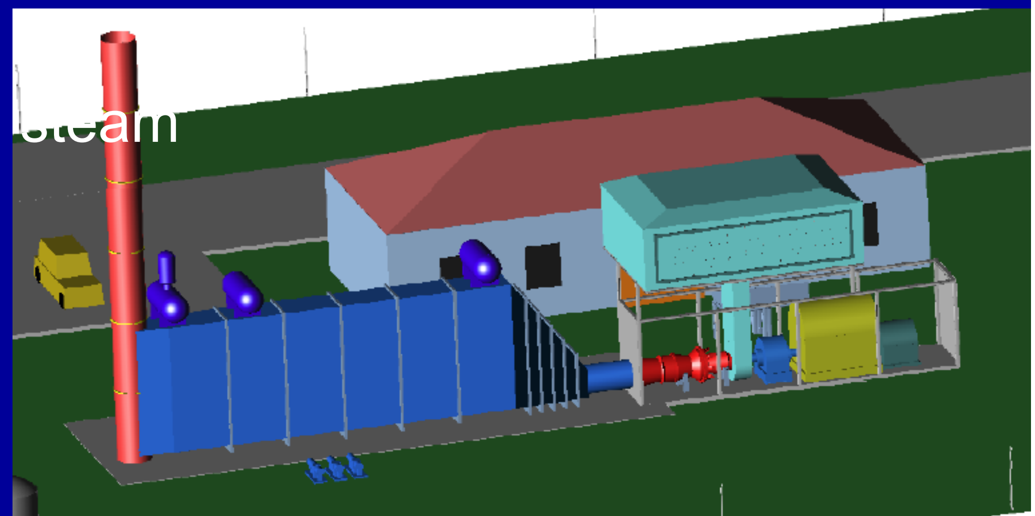
Market Conditions

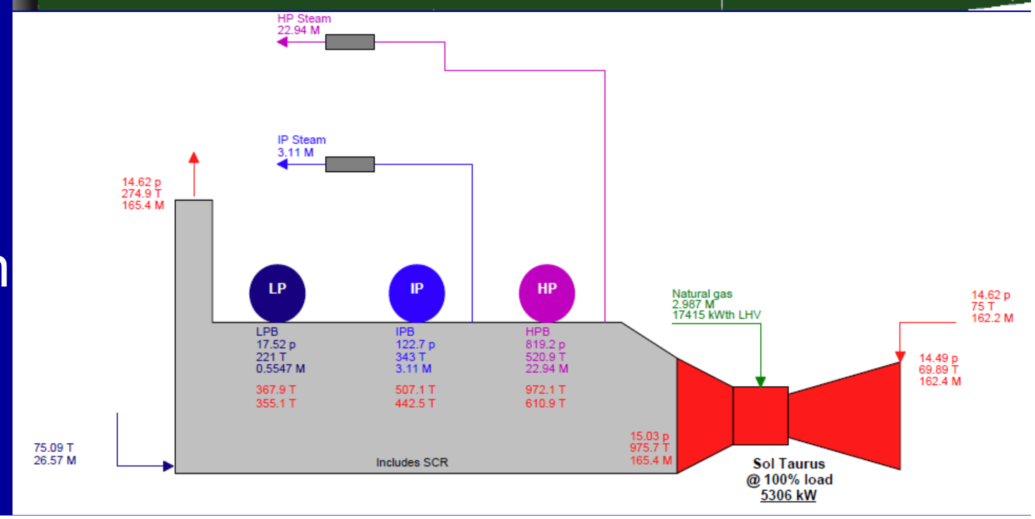
U.S. Industrial Spark Spread (2010 – 2015)



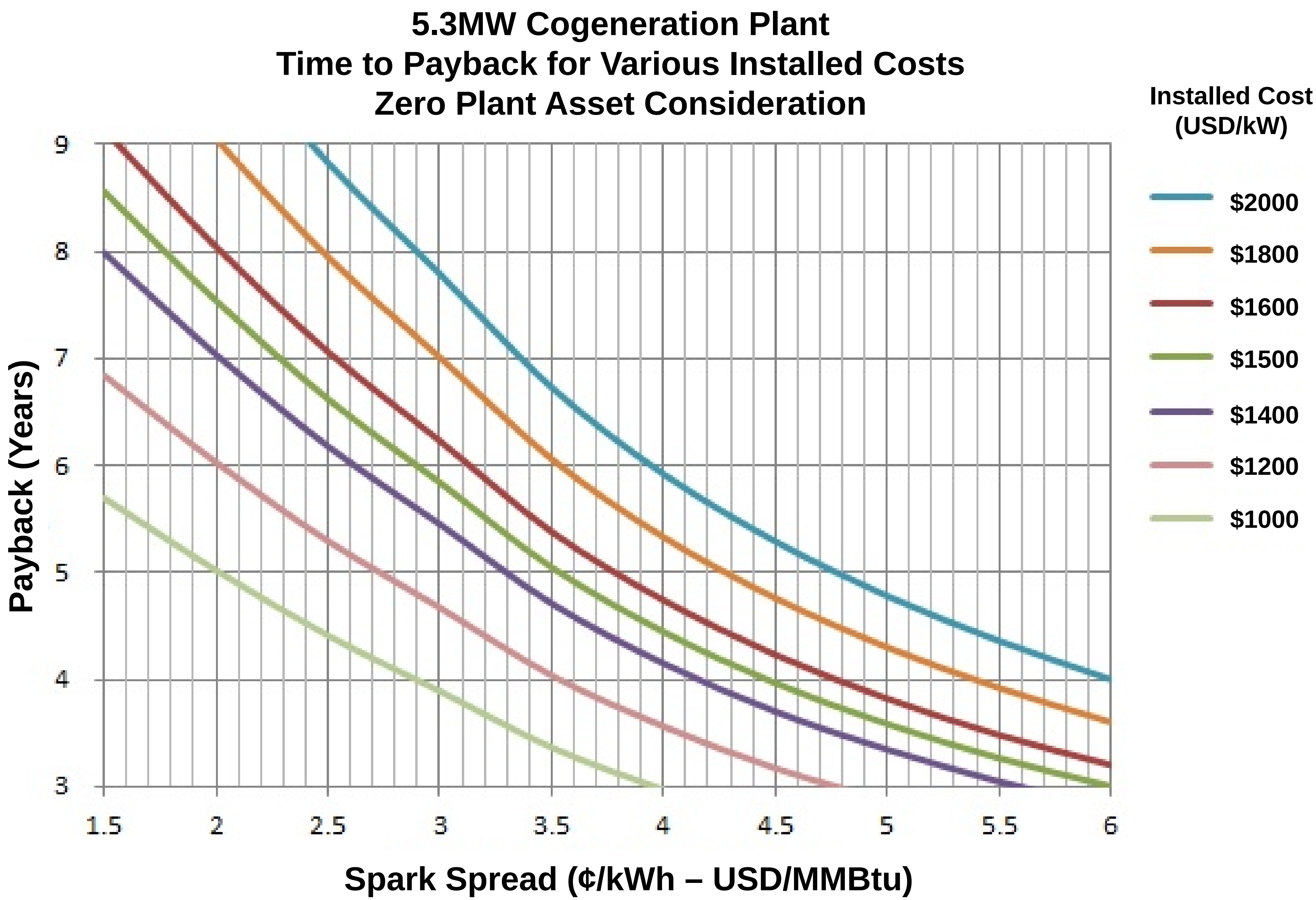
CHP Viability Modeling

- Gas Turbine (1 x 1 configuration)
  - 5.3MWe (CGT)
  - 24,000 pph saturated steam
  - 82% CHP Efficiency
  - 92.5% load factor
- Industrial User
  - Low or no land costs
  - Low cost of money
  - Near all-in analysis
    - Capex, Siting, Finan
    - O&M, Overhauls
    - SCR





CHP Viability Modeling



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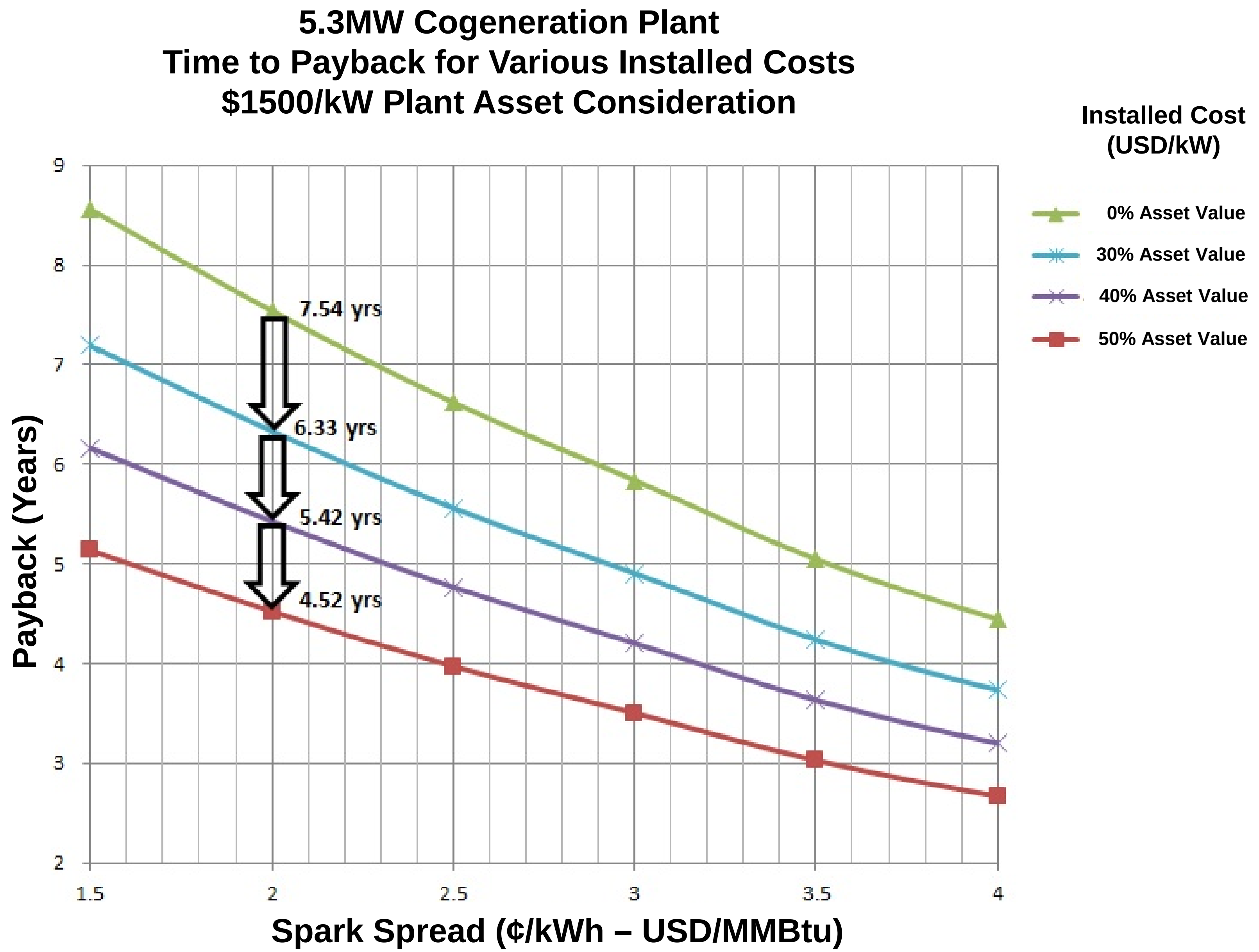

Government & Regulatory Initiatives

- Executive Order "Accelerating Investment in Industrial Energy Efficiency"
  - 40GW of NEW Industrial CHP by 2020
  - Workshops to review investing models and barriers to CHP
  - Incentives for deploying CHP
    - Emissions Trading Programs
    - Grants & Loans
    - Compliance Options which recognize emissions benefits of CHP.
  - Effective Aug. 31, 2012.

Government & Regulatory Initiatives

- State Level – Texas
  - TCEQ (TX Commission on Environmental Quality) Permit by Rule 106.513
  - Cuts red tape associated with Environmental Air Permits
  - Two Industrial CHP Size Ranges
    - Up to 8MWe
    - Up to 15MWe

Government & Regulatory Initiatives

- State Level – Texas

Plant Size Range (1 Unit or Combination)	Emission Type	Emission Limit (lb/MWh)
20kw to 8MW	NO_X	1.0
	CO	9.0
8MW to 15MW[1]	NO_X	0.7
	CO	9.0

Table 1. TCEQ Permit by Rule Emissions Limits

  - Values DO NOT include CHP credit of 1MW per 3.4MMBtu of Recovered Heat
  - Some Standard Industrial DLE Turbine Units Qualify, Unmodified

[1]CHP Plants in this size range require an oxidation catalyst device to ensure compliance with NAAQS PM_{25} requirements.

Government & Regulatory Initiatives

- 5.0 MWe Example Calculation - Texas PBR

NO_x = 5.8 lb/h, for one hour --> 5.8 lb NO_x

5.8/5.0MWe = 1.16 lb/MWh (FAILS the 1.0 lb/MWh NO_x requirement)

Exhaust Heat = 24.1 MMBtu/hr. Assume 80% HRSG efficiency and 25% recovery[2] → 24.1 x 0.8 x 0.25 = 4.82 MMBtu/hr

Credit → 1MWh per 3.4MMBtu

4.82/3.4 = 1.41

So, 5.0 + 1.41 = 6.41MWe

New, Adjusted Requirement = 6.41 / 5.0 = 1.283 lb/MWh

1.16 lb/MWh now PASSES the NO_x requirement (1.16 < 1.283)

[2]PBR requires a minimum of 20% heat recovery to qualify.

The Five Simple Steps to Determine Industrial CHP Viability

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4. Sizing Correlation:
   - Steam Consumption >= 50% of Capacity
   - Electric Consumption = 100% of Capacity (plant sized for heat)

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5. Capacity Factor >= 60%:

The Five Simple Steps to Determine Industrial CHP Viability

1. Five Steps based on dozens of studies and executed projects.
2. Viability Defined?
   - Simple payback period used
   - Could use IRR, Cash Flow, Reliability Criteria
3. Sufficient but not Necessary for Feasible Project
   - Electrical Load < 5MW?
   - Steam Load < 50% Capacity?
   - Dramatic Capacity Factor Changes (Seasonal, Operational)?

Takeaways

- Industrial CHP continues to be attractive
  - Reasonable payback periods
  - Energy availability
- Worst Case scenario presented:
  - Single Unit, Small kWh & pph requirements
  - No subsidies or other gov't support
- 5 Simple Steps an easy pre-qualifier:
  - Good indicator prior to definitive feasibility studies
  - Helps determine plant size and energy requirements
  - Consider kWh, kW/kVAR demand and demand credits in a hybrid for the spark spread criteria.

Takeaways

- Industrial CHP doesn't have to be a large Capital Expenditure consideration for end user.
  - Abundance of money on the sidelines
  - 3rd Party BOO projects could reduce power costs by 15% or more.

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