Compact Gasification System
Development Status

Leveraging 50 Years of Rocket Engine Experience
to Reduce Cost and Improve Plant Performance
Key Design Features of the Compact Gasification System

- Low Pressure Hopper
- Dry Solids Pump
- Compact Gasifier
- High Pressure Hopper
- Particulate Removal (Cyclone + Candle Filter)

- Yellow Items are Key Development Items
- Other Items are Commercially Available
Advantages of the Compact Gasification System

Current Market Leaders


Compact Gasification System

- 90% size reduction (gasifier)
- 50% lower cost (gasification system)
- 99% availability (gasification system)
- 99% carbon conversion
- 80% to 85% cold gas efficiency
- Dry feed system
  - Low oxygen consumption
  - Gasify all ranks of coal, petcoke, and biomass blends
- High pressure / water spray quench
  - Ideal for \( \text{H}_2 \) production
  - Low cost \( \text{CO}_2 \) sequestration

Source: DOE paper (2006)
Joint Development Agreement Signed with ExxonMobil

• PWR has teamed with ExxonMobil Research and Engineering (EMRE) to develop and commercialize the technology

• Objective of this collaboration is to substantially reduce the cost of gasification
  • Enable cost-competitive production of clean fuels, electricity, hydrogen, and chemicals

• ExxonMobil is sharing development cost and collaborating with PWR to develop, demonstrate, and license the technology

• Joint Program Management Team (PMT) and Steering Committee (SC) formed to manage the program
Technology Roadmap


**Proof of Concept Test (1975-1980)**

**Pilot Plant at GTI (2009 startup)**

**Demonstration Plant**

**System Validation in a Commercial Environment**

**Feed System Test Facility at EERC (2007 startup)**
PWR Business Model

PWR Licenses Technology & Provides Key Components

EPC Contractors Design & Construct Plants

End Customers Own & Operate Plants

- Oil Companies
- Electric Utilities
- Industrial Gas Suppliers
- Chemical Companies

Compact Gasifier
Dry Solids Pump

License Technology to:
- End Customers
- EPC Contractors
- Gasification System Providers

Provide Licensees with:
- Key Components
- Integration Support
- Aftermarket Services

Team with Industry Leaders

Pratt & Whitney Rocketdyne
Licensing Agreement Signed with Zero Emission Energy Plants, Inc.

- Zero Emission Energy Plants, Inc. (ZEEP) has purchased a global license to use the technology
  - As part of this licensing agreement, ZEEP will construct several gasification plants (including a demo plant)
  - ZEEP is evaluating candidate sites & partners for the demo plant (with PWR support)
  - ZEEP vision is to team with other companies and construct large energy centers to produce clean, inexpensive fuels throughout the world
Pilot Plant Under Construction at GTI (Gas Technology Institute)

Test Objectives
- Demonstrate performance
  - Carbon conversion
  - Cold Gas Efficiency
  - Protective slag layer
  - Multiple feedstocks
- Verify operating environments
- Validate computer models
- Obtain life data (time & cycles)
- Refine operating procedures

Objective is to obtain data for larger scale gasification plants

- Pilot Plant at GTI
- 18 TPD
- Startup in 2009

Pilot Plant Gasifier

Pratt & Whitney Rocketdyne
Test Objectives

• Demonstrate performance
  • Ultra-dense flow (no plugging)
  • Flow splitters (uniform flow distribution)
  • Dry solids pump (to 1200 psia)
  • Multiple feedstocks (standard utility grind)
• Validate computer models
• Obtain life data (erosion rates)
• Refine operating procedures

Objective is to obtain data for the commercial scale demo plant
Flow Splitters Tested at EERC

1x6 Flow Splitter 1x18 Flow Splitter

- 12 test cases completed
  - 400 TPD
  - 2 Flow Splitters
  - 2 Types of Coal
  - 3 Pressures
- 19 additional tests underway
  - Other Feedstock
  - Up to 1200 TPD

- Tested ultra-dense phase feed system
- Achieved uniform flow splitting
• PWR is developing a Dry Solids Pump with support from our development partner (ExxonMobil)

• DOE is cost-sharing development of this pump under a Cooperative Agreement

• Engineering tests were initiated early 2008 to establish a robust data base to optimize the design and reduce risk
  • Will complete these tests and the pump design in 2009

• Expect to begin testing a pump with 400 TPD capacity at EERC in early 2010
Defining a Demo Plant for an Alberta Location

- AERI (Alberta Energy Research Institute) is cost-sharing definition of a demo plant for an Alberta location
  - This project is part of the AERI Hydrocarbon Upgrading and Demonstration Program
  - Primary focus is hydrogen production from pet coke for oil sands extraction and upgrading
- PWR is working with Jacobs Engineering to define this demo plant
  - Decision to construct demo plant will not be made until after pilot plant is operational
- Long-term goal is to substantially reduce the cost and environmental impact of oil sands production and upgrading
• Development of the Compact Gasification System is supported by ExxonMobil, the U.S. Department of Energy, and the Alberta Energy Research Institute

• However, the opinions, findings, and conclusions expressed herein are those of the authors

Questions?