The Opportunity for CHP in the United States

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Energy Analyst
Need and Purpose of Project

- Enhance Industry Intelligence
- Determine the Size of the Opportunity
- Assess Policy Landscape
- Evaluate AGA’s Role and Resources
What We Will Cover Today

• A look at the current state of CHP in the United States and its impact on the natural gas industry
• Why CHP represents a potential growth market and why now
• The results of the technical and economic potential analysis for CHP
• A review of existing barriers for CHP and potential policies to overcome the barriers
• Possible next steps for AGA and its members
The Natural Gas Value Proposition

Highly Efficient Value Chain

**Electricity**

<table>
<thead>
<tr>
<th>Source Energy</th>
<th>Extraction, Processing &amp; Transportation</th>
<th>Generation</th>
<th>Distribution</th>
<th>Delivered to Customer</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 MMBtu</td>
<td>▼ 5% Energy Loss 95 MMBtu</td>
<td>▼ 61% Energy Loss 34 MMBtu</td>
<td>▼ 2% Energy Loss 32 MMBtu</td>
<td>32 MMBtu</td>
</tr>
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**Natural Gas**

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<td>100 MMBtu</td>
<td>▼ 7% Energy Loss 93 MMBtu</td>
<td>▼ 1% Energy Loss 92 MMBtu</td>
<td></td>
<td>92 MMBtu</td>
</tr>
</tbody>
</table>

Source: Gas Technology Institute
The Impact of Value Chain Efficiencies on Overall Energy Consumption

U.S. Residential Energy Consumption

Source: U.S. Department of Energy, Energy Information Administration
Combined Heat and Power - A Solution for Reducing Energy Costs and Emissions

Conventional Separate Heat and Power Generation

- **Power Station Fuel**: Input Fuel 147
- **Boiler Fuel**: 56
- **Power Station Efficiency**: 33%
- **Boiler Efficiency**: 80%
- **Total Efficiency**: 51%

Combined Heat and Power

- **5 MW Natural Gas Combustion Turbine**: Combined Heat and Power (CHP)
- **Input Fuel**: 100
- **CHP Efficiency**: 75%

**Losses**:
- Power Station: 61
- Boiler: 11
- Combined Heat and Power: 25

**Usable Heat**
- **USABLE HEAT**
- **USABLE ELECTRICITY**
Existing Installed CHP

- 82 GW of installed CHP at over 4,100 industrial and commercial facilities (2012)
- Natural gas based CHP concentrated in Northeast, Gulf Coast, Midwest and California
- Northwest and Southeast have high concentration of sites in forest products and paper industries

71% is natural gas based, consuming an estimated 4.5 Tcf annually
Historical Growth in CHP (1970 – 2012)
CHP Annual Additions (1960 – 2011)
Current Market Drivers for CHP

- Growing recognition of CHP benefits by state and federal policymakers
- Opportunities driven by environmental regulations
- Changing natural gas outlook

Over 4,500 MW announced/under construction
Modest Gas Prices will Support Expanded CHP Markets

- Henry Hub natural gas prices are projected to average between $4 and $6 per MMBtu throughout much of the projection.
- Growth in gas demand will eventually apply upward pressure on gas prices.
- $4 to $6 gas prices are sufficient to support the levels of supply development in the projection, but not so high as to discourage market growth.

Source: ICF Estimates, 2013
Defining the Size of the Opportunity
Technical Potential and Economic Potential Analysis
Estimate of Technical Potential Serviceable by Natural Gas Utilities

• Evaluate industrial, commercial, and institutional facility data to identify potential sites that can utilize both electric and thermal energy

• Focus on markets likely to be served by local distribution companies
  • Less than 100 MW
  • Onsite use of electricity only – no power export

• For each state characterize this market by
  • Size range: 50-1,000 kW, 1-5 MW, 5-20 MW, 20-50 MW, 50-100 MW
  • Market type:
    • High Load factor heat only markets
    • High load factor heat and cooling markets
    • Low load factor heat and cooling markets
Technical Potential of 123,000 MW (CHP systems < 100 MW)
Economic Potential Analysis

CHP Technical Potential Database by Sector & Load Factor

Assumptions
- Natural gas & Electricity Prices
- Technology costs and performance

Site by Site Analysis

Determination of Payback

< 5 Year
- Strong Potential

5-10 Year
- Moderate Potential

> 10 Year
- Minimal Potential

Summary of Technical Potential by State & Payback
Industrial & Commercial
Energy Price Assumptions

• Natural gas - Industrial retail prices (2011)
  • Citygate plus $1/MMBtu adder used if < industrial rate.

• Electricity – Industrial retail prices
  • Limitation: Does not reflect variations in price within a state.
  • Average electric prices are adjusted by load factor
Technology Assumptions

• Most appropriate technology was chosen for each size bin

<table>
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<tr>
<th>Market Size Bin</th>
<th>100 kW-1 MW</th>
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<td>Avg of 100/800 kW Recip Engine</td>
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<td>10 MW Gas Turbine</td>
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• Cooling costs and performance
  • Recip engines use single effect absorption chiller
  • GTs use double effect absorption chiller
## CHP Technology Cost and Performance

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<tr>
<td>Base Case Cost</td>
<td>$2,325</td>
<td>$1,700</td>
<td>$1,750</td>
<td>$1,350</td>
<td>$1,350</td>
</tr>
<tr>
<td>U.S. Average Capital Cost</td>
<td>$2,325</td>
<td>$1,700</td>
<td>$1,750</td>
<td>$1,350</td>
<td>$1,350</td>
</tr>
<tr>
<td>After-treatment Cost, $/kW</td>
<td>$150</td>
<td>$200</td>
<td>$180</td>
<td>$80</td>
<td>$80</td>
</tr>
<tr>
<td>Federal CHP Investment Tax Credit</td>
<td>$248</td>
<td>$190</td>
<td>$193</td>
<td>$54</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Total Capital Cost, $/kW</strong></td>
<td>$2,228</td>
<td>$1,710</td>
<td>$1,737</td>
<td>$1,376</td>
<td>$1,430</td>
</tr>
<tr>
<td>Cooling Cost Adder, $/kW</td>
<td>$596</td>
<td>$325</td>
<td>$258</td>
<td>$148</td>
<td>$127</td>
</tr>
<tr>
<td>Cooling Investment Tax Credit</td>
<td>$60</td>
<td>$33</td>
<td>$26</td>
<td>$15</td>
<td>$13</td>
</tr>
<tr>
<td><strong>Net Total Capital Cost w Cooling</strong></td>
<td>$2,764</td>
<td>$2,003</td>
<td>$1,969</td>
<td>$1,510</td>
<td>$1,544</td>
</tr>
<tr>
<td>Heat Rate, Btu/kWh</td>
<td>11,199</td>
<td>9,800</td>
<td>11,765</td>
<td>9,220</td>
<td>9,220</td>
</tr>
<tr>
<td>Thermal Output, Btu/kWh</td>
<td>5,500</td>
<td>4,200</td>
<td>4,674</td>
<td>3,189</td>
<td>3,189</td>
</tr>
<tr>
<td>Electric Efficiency, %</td>
<td>30.5%</td>
<td>34.8%</td>
<td>29.0%</td>
<td>37.0%</td>
<td>37.0%</td>
</tr>
<tr>
<td>CHP Efficiency</td>
<td>79.6%</td>
<td>77.7%</td>
<td>68.7%</td>
<td>71.6%</td>
<td>71.6%</td>
</tr>
<tr>
<td>O&amp;M Costs, $/kWh</td>
<td>$0.020</td>
<td>$0.016</td>
<td>$0.009</td>
<td>$0.005</td>
<td>$0.005</td>
</tr>
<tr>
<td>Cooling Heat Rate, Btu/ton</td>
<td>17,000</td>
<td>17,000</td>
<td>10,435</td>
<td>10,435</td>
<td>10,435</td>
</tr>
<tr>
<td>Avoided AC Electricity, kW/kW gen</td>
<td>0.220</td>
<td>0.168</td>
<td>0.305</td>
<td>0.208</td>
<td>0.208</td>
</tr>
<tr>
<td>Avoided Boiler Efficiency</td>
<td>80%</td>
<td>80%</td>
<td>80%</td>
<td>80%</td>
<td>80%</td>
</tr>
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</table>
Economic Potential of 41.6 GW (Potential With Less Than 10 Year Payback)

- < 100 MW
- 100 – 399 MW
- 400 – 999 MW
- 1,000 – 1999 MW
- > 2,000 MW
Economic Potential Impact Varies if Capital and Energy Costs Changes

- **Moderate Potential** - Project with Simple Payback at 5 – 10 Years
- **Strong Potential** – Project with Simple Paybacks < 5 Years
Potential Natural Gas Demand By Scenario

- CHP Gas Use – Gross Natural Gas Consumption From CHP
- Incremental Gas Use – Gross Consumption Less Displaced Thermal Consumption
Limitations of the Analysis

- Analysis was done without consideration of individual state CHP financial incentives, or individual site drivers (reliability, emissions).

- Analysis was based on state average electric and gas prices. Some states have wide variation in electric prices among utilities and state-wide averages could underestimate potential.

- Recent gas price reductions may not be fully reflected in the EIA historical data used in the analysis.
Summary

• Total Technical Potential 123 GW

• Base Case Economic potential of 41.6 GW (<10 year payback):
  • 35.2 GW Moderate Potential (5 to 10 years)
  • 6.4 GW Strong Potential (<5 years)

• Incentives for CHP will improve overall economics and increase the economic potential – 25 % reduction in capital cost increases economic potential to 54.4 GW:
  • 37.9 GW Moderate Potential (5 to 10 years)
  • 16.5 GW Strong Potential (<5 years)

• Spread between natural gas and electricity prices is a critical factor in economic competitiveness for CHP and could be positively affected by increased electricity prices – 15% increase in electric prices increases economic potential to 62.7 GW
  • 45.3 GW Moderate Potential (5 to 10 years)
  • 17.4 GW Strong Potential (<5 years)
What’s Next?

Leveraging the work of the study
Benefits of CHP to the U.S. Economy

Benefits identified in President Obama’s Executive Order establishing a national goal of adding 40 GW of CHP applications by 2022.

• Spur $40 - $80 billion in new capital investments in plants and facilities.
• Save American manufacturers and businesses $10 billion each year.
• Save 1 percent of all energy use in the U.S. (one quadrillion Btu’s of energy).
• Reduce emissions by the equivalent of taking 25 million cars off the road.

Source: U.S Department of Energy
Barriers to CHP

• Electric Grid Interconnection
• Limited CHP Supply Infrastructure
• Standby/Back-up Charges
• Market and Non-market Uncertainties
• Limited Recognition of CHP in Environmental Regulations
• End-use Awareness and Economic Decision Making
Policy Initiatives to Explore

- Possible federal policies
  - Investment tax credit
  - Clean energy standards
  - CHP as a solution for energy & emissions reduction targets
  - Financing mechanisms

- Possible state policies
  - Clean energy portfolio standards or electric utility energy efficiency resource standards
  - Standardized interconnection requirements
  - Specific incentives

- Electricity and natural gas price spread
  - Design of standby rates
  - Payments for CHP grid support
Next Steps

• Continued engagement with federal and regional policymakers and stakeholders
  ➢ DOE/EPA, SEE Action Network, NARUC
  ➢ Legislators (Shaheen-Portman, Franken)
  ➢ ACEEE, C2ES, Alliance to Save Energy

• Work with federal government agencies to advance CHP deployment in federal facilities (DOD, FEMP)

• Collect and disseminate to members innovative programs/policies developed at the state level to advance CHP deployment

• Utilize NARUC to gain support for advancing CHP by encouraging innovative regulatory schemes

• Work with individual companies interested in advancing CHP deployment in their service territories

• Continue to seek guidance from AGA Sustainable Growth Committee
Questions?
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