Commercial Water Heating
Residential Combo Systems with
Gas Absorption Heat Pumps

Stone Mountain Technologies, Inc.
Johnson City, TN
www.stonemountaintechnologies.com

Michael Garrabrant, President

ACEEE Hot Water Forum
Nashville, TN
February, 2015
Topics of Discussion

- Technology Background and Status
- Commercial Water Heating Application
- Residential Combo System Application
GHP vs. GAHP

- Gas Heat Pump (GHP) = Gas Engine Driven Vapor Compression Cycle

- Gas Absorption Heat Pump (GAHP) = Gas Absorption Heat Pump
Stone Mountain Technologies, Inc.
Thermal Compressors for Sorption Heat Pumps

- Space Heating
- Water Heating
- Combo Systems
- Pool Heating
- Residential
- Commercial
Development Status

- Residential Water Heater – 6 Field Test Units Installed
- 80,000 Btu/hr GAHP – Alpha Prototype Under Test
- 140,000 Btu/hr GAHP – Lab Testing
How Does It Work?

\[ \text{COP}_h = \frac{Q_{\text{cond}}}{E_{\text{in}}} = 3.0-4.0 \]

\[ Q_{\text{heating}} = 1.0-1.3 \times Q_{\text{evap}} \]

\[ \text{COP}_h = \frac{(Q_{\text{cond}} + Q_{\text{abs}})}{Q_{\text{in}}} = 1.5-2.0 \]

\[ Q_{\text{heating}} = (Q_{\text{cond}} + Q_{\text{abs}}) \sim 2.5 \text{ times } Q_{\text{evap}} \]
GAHP vs EHP Performance

GAHP vs 13 SEER Electric Heat Pump

- Heating Capacity Ratio
- Ambient Temperature [deg F]

- EHP
- GAHP
From A Marketing Perspective....

Gas Absorption Heat Pumps:
Are NOT “Heat Pumps”

Are Very High Efficiency Furnaces or Boilers
SMTI Gas Absorption Heat Pump

**COP**<sub>HHV</sub> = 1.4 at 47/100°F (including parasitics)

- Gas-Fired, Air to Water Heat Pump
- Condensing
- 3:1 Modulation
- 80,000 / 140,000 Bth Heating Output
- 47 F Ambient
- 100 F Return
- 20 F Delta
- Outdoor Installation
Commercial Water Heating
“Planting Seeds from 5000 ft”

- System Configuration
  - Stand-Alone, Pre-Heat, Parallel
  - Impact of Return Water Temperature: Heat Pump & Conventional
  - Paired with Non-Condensing or Condensing

- Utility Cost Savings Estimate

- Simple Payback Analysis
Commercial Water Heating
Optional Simultaneous Space Cooling
Commercial Water Heating
*Stand-Alone Installation*

- Existing Installation 140,000 Bth or Less Input
- 140°F or Less Water Temperature Requirement
- 210 gph or Less @ 80°F Rise
### Commercial Water Heating

#### Stand-Alone Installation vs. Non-Condensing Storage

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<thead>
<tr>
<th>gpd</th>
<th>500</th>
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<td>$5,398</td>
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Gas = $1.20/therm    Electric = $0.12 kWhr

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## Commercial Water Heating

### Stand-Alone Installation vs. Condensing Storage

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<thead>
<tr>
<th>gpd</th>
<th>500</th>
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<td>Avg Ambient [F]</td>
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<tr>
<td>Avg HP COP_g</td>
<td>1.55</td>
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<td>Therms Saved/Yr</td>
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Gas = $1.20/therm    Electric = $0.12 kWhr

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Commercial Water Heating
Stand-Alone Installation Simple 3yr Payback Level

3 Year Utility Savings, Stand-Alone Installation

Gas = $1.20/therm   Electric = $0.12 kWhr

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Commercial Water Heating

*Pre-Heater Installation*

- Full Service Restaurant: 2000 – 3000 gpd
- Heat Pump Used As Pre-Heater (140,000 Btu/hr)
- Condensing or Non-Condensing Booster
# Commercial Water Heating

## Pre-Heater Installation

Gas = $1.20/therm    Electric = $0.12 kWhr

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<tr>
<th>gpd</th>
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<tr>
<td>Direct Fired COP</td>
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<td>80%</td>
<td>88%</td>
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<tbody>
<tr>
<td>Avg Ambient [F]</td>
<td>50</td>
<td>50</td>
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<td>50</td>
<td>50</td>
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<td>Direct Fired Input [Bth]</td>
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| Water Temp Rise [F] | 80 | 80 | 80 | 80 | 80 | 80 | 80 | 80 | 80 |
| Avg HP COP | 1.47 | 1.47 | 1.47 | 1.47 | 1.47 | 1.47 | 1.47 | 1.47 | 1.47 |
| % GAHP | 80% | 75% | 70% | 80% | 75% | 70% | 80% | 75% | 70% |

| Therms Saved/Yr | 2187 | 2563 | 2870 | 2296 | 2733 | 3116 | 1349 | 1549 | 1695 |
| Hybrid System, $/yr | $4,902 | $6,307 | $7,783 | $4,784 | $6,123 | $7,518 | $4,784 | $6,123 | $7,518 |
| Savings, $/yr | $2,295 | $2,690 | $3,013 | $2,413 | $2,874 | $3,277 | $1,337 | $1,529 | $1,664 |
| 3-Yr Savings | $6,886 | $8,069 | $9,038 | $7,239 | $8,621 | $9,832 | $4,012 | $4,587 | $4,991 |

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Commercial Water Heating

Pre-Heater Installation

Gas = $1.20/therm

Electric = $0.12 kWhr
Commercial Water Heating

Parallel Installation

- Full Service Restaurant: 2000 – 3000 gpd
- 140,000 Btu/hr Heat Pump
- Condensing Peaking Water Heater
Commercial Water Heating

Parallel Installation

Hybrid Commercial Water Heating System - 3yr Utility Cost Savings

- Gas = $1.20/therm
- Electric = $0.12 kWhr

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Commercial Water Heating
Pre-Heat / Parallel Installation

- Full Service Restaurant: 2000 – 3000 gpd
- 80,000 Btu/hr Heat Pump
- Condensing Peaking/Booster Water Heater
Commercial Water Heating

*Pre-Heat / Parallel Installation, 80,000 Btu/hr GAHP*

Gas = $1.20/therm    Electric = $0.12 kWhr

Hybrid Commercial Water Heating System - 3yr Utility Cost Savings

- 80 kBth GAHP
- 50 F Avg Ambient
- FC-Hyb / NCS
- FC-Hyb/CS

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GAHP Commercial Water Heating

Conclusions & Thoughts

- Potential 2-3 yr Simple Payback for many applications
- 3-4 yr Simple Payback for most others
- GAHP / Storage Tank sizing important
- Method of Interface with Direct-Fired equipment critical
- Climate Zone Dependency Complex (ambient/water temperature)
- Application Modeling w/representative draw patterns to develop optimum system hardware by application.

- Capital Utilization System Design
Residential GAHP Combo Systems
GAHP Residential Combo System Analysis

Assumptions

- Region IV & V BIN: Heating Load/Ambient/GAHP COP
- 64 gpd, 55 / 50 F CWT (Region IV / V)
- Summer COP_gas 1.6 / 1.5 for Region IV/V
  - 3,000 Btu per day standby loss
- Low & High Efficiency Baseline
  - 80% Gas Furnace / 0.60 EF Gas Storage Water Heater
  - 95% Gas Furnace / 0.63 EF Gas Storage Water Heater
# GAHP Residential Combo System Analysis

## High Level Results

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<tr>
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<th>Region 5</th>
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<td>Baseline COP</td>
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Acknowledgements

- U.S. Department of Energy
- Gas Technology Institute
- Oak Ridge National Laboratory
Thank You!

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(423) 735-7400

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