Utility Perspective and Work on Industrial Heat Pumps

Chase Cortner  7-11-2023
We provide clean, safe, reliable, affordable energy and customized solutions

- Approximately 44,000 MW of Generating Capacity
- Capabilities in 50 States
- 8 Electric & Natural Gas Utilities
- 9 Million Customers
- Approximately 29,000 Employees

In November 2018, Southern Power agreed to sell its combined-cycle facility in Mankato, Minnesota.
Temperature Ranges of Process Heat Used

- Temperature Ranges:
  - 500°C - 1,000°C
  - 1,000°C - 1,500°C
  - 1,500°C - 2,000°C
  - 2,000°C - 2,500°C
  - 2,500°C - 3,000°C
  - 3,000°C - 3,500°C

- Process heat, TBr/year:
  - <80
  - 80-150
  - 150-300
  - 300-550
  - 550-1,100
  - >1,100


Data Source: McMillan 2019
# Low-Carbon Solutions for Process Heat

<table>
<thead>
<tr>
<th>Technology</th>
<th>Pros</th>
<th>Cons</th>
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<tbody>
<tr>
<td>Plant energy efficiency</td>
<td>Best first choice and most cost effective</td>
<td>Significant, but won’t provide total decarbonization</td>
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<tr>
<td>Electric steam boiler</td>
<td>Relatively simple fix by replacing fossil-fuel fired boiler</td>
<td>High capital cost</td>
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<tr>
<td></td>
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<td>High fuel (electricity) cost</td>
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<td></td>
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<td>Long lifetimes, few replacement opportunities</td>
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<tr>
<td>Solar thermal heat</td>
<td>Essentially carbon free heat</td>
<td>High capital cost</td>
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<td>Variable source (storage possible co-solution)</td>
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<td>Combined heat &amp; power (CHP)</td>
<td>Improves overall facility energy performance</td>
<td>Tied to carbon emission with natural gas</td>
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<td>Low carbon options (H2, biomass) are higher cost</td>
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<tr>
<td>Biofuels</td>
<td>Enables partial to full plant decarbonization</td>
<td>Higher cost &amp; variability vs. natural gas and electricity</td>
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<td>Carbon capture utilization &amp; storage (CCUS)</td>
<td>Enables partial to full plant decarbonization</td>
<td>High capital cost, long time to implement, infrastructure requirements</td>
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<tr>
<td>Heat pump</td>
<td><strong>Improves process energy efficiency</strong></td>
<td><strong>Limited demonstrations in US for industry</strong></td>
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<td><strong>Runs on electricity, or waste heat</strong></td>
<td><strong>Integration may require adjustments</strong></td>
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<td><strong>Energy &amp; nonenergy benefits</strong></td>
<td><strong>Limited service and supply capabilities in US</strong></td>
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<td><strong>GHG reductions</strong></td>
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Electric High-Temperature Heat Pumps

• Background
  - HTHPs offer the largest electrification opportunity to decarbonize the industrial sector
  - Fuel-fired boilers account for close to 100% of all industrial boiler and other process applications (except pulp mills where forest wood is used as fuel) in the US
  - Significant new revenue opportunity for Southern Company electric operating companies through increased kwh sales
  - Recent up-tick in interest shown by the industrial customers in order to meet corporate decarbonization goals

• Applications
  - High temperature (>180F) hot water and lower pressure steam production
  - Industrial process drying and curing (ex: lumber and food grain drying)
  - Waste heat recovery
Industrial Customer Feedback

- Various industries are under pressure to decarbonize their operations and aggressively developing decarbonization goals
- Limited vendor offerings in the USA
- Lack of awareness on industrial heat pumps and its applications
- Cost is a challenge due to higher installation cost and lower operational cost w/ natural gas
- International competition demand lower overall product cost
Southern Company Efforts

✓ Providing insight and knowledge to customers on current and upcoming IHP technologies and process applications

✓ Currently performing market study to understand current fossil fuel boiler loads and process temperatures in the service territory

✓ Partnering with various entities for developing:
  ✓ Steam generating heat pumps
  ✓ Ultra-high temp cascade industrial heat pump for waste recovery

✓ Pursuing field demonstrations to gather performance data as well as for education