Utility Perspective and Work on Industrial Heat Pumps

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Southern Company

Research & Development

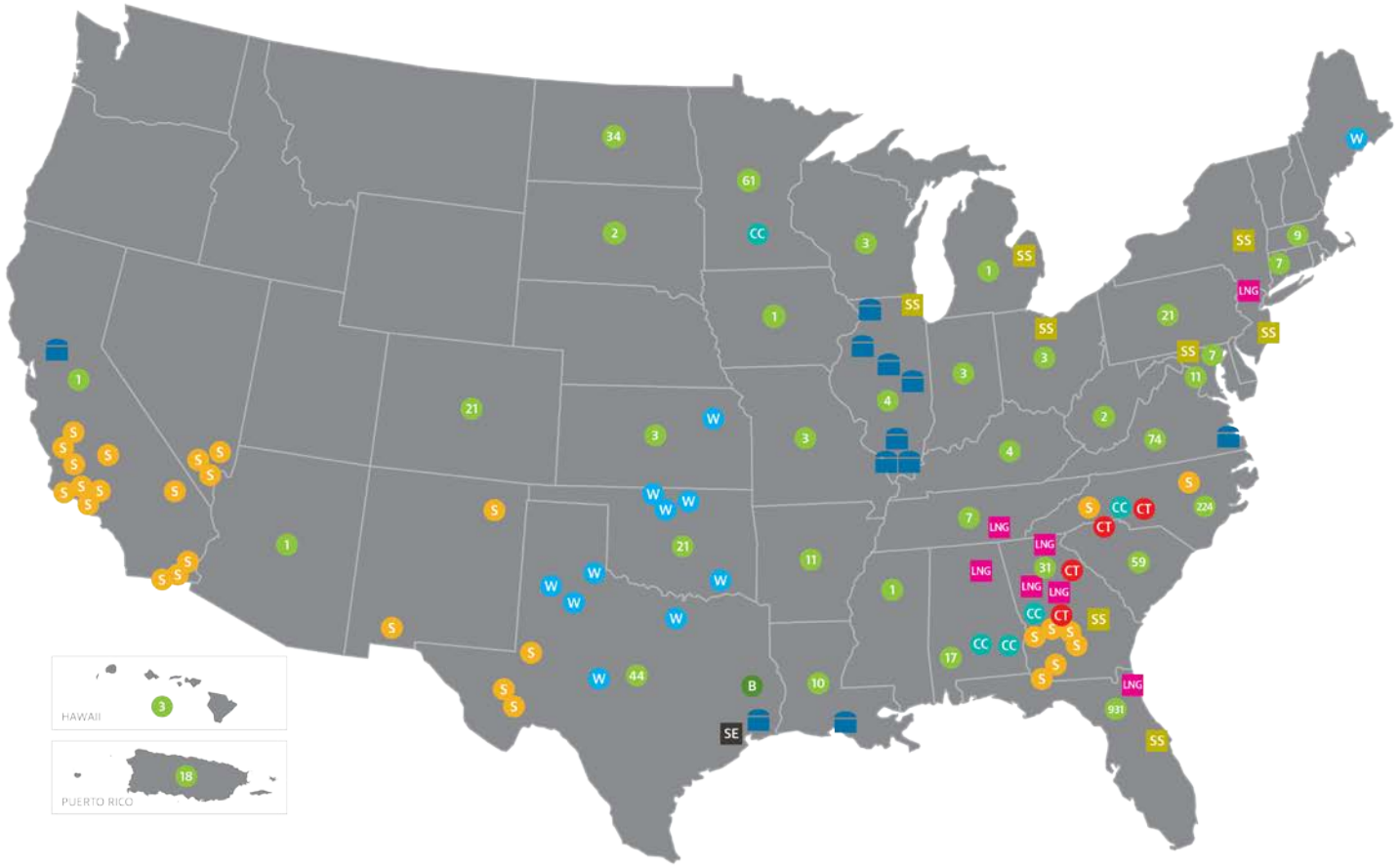
We provide clean, safe, reliable, affordable energy and customized solutions

Service territories

- Electric
- Gas

Gas pipelines

- Southern Natural Gas
- Southern Company Gas
- Pipeline projects



Southern Power

- Combined-cycle facility[1]
- Peaking facility
- Biomass facility
- Solar facility
- Wind facility

Southern Company Gas

- LNG facilities
- Sequent Energy Management
- SouthStar
- Natural gas storage

PowerSecure

- Owned and managed sites per state

[1]In November 2018, Southern Power agreed to sell its combined-cycle facility in Mankato, Minnesota.

Capabilities in **50 States**

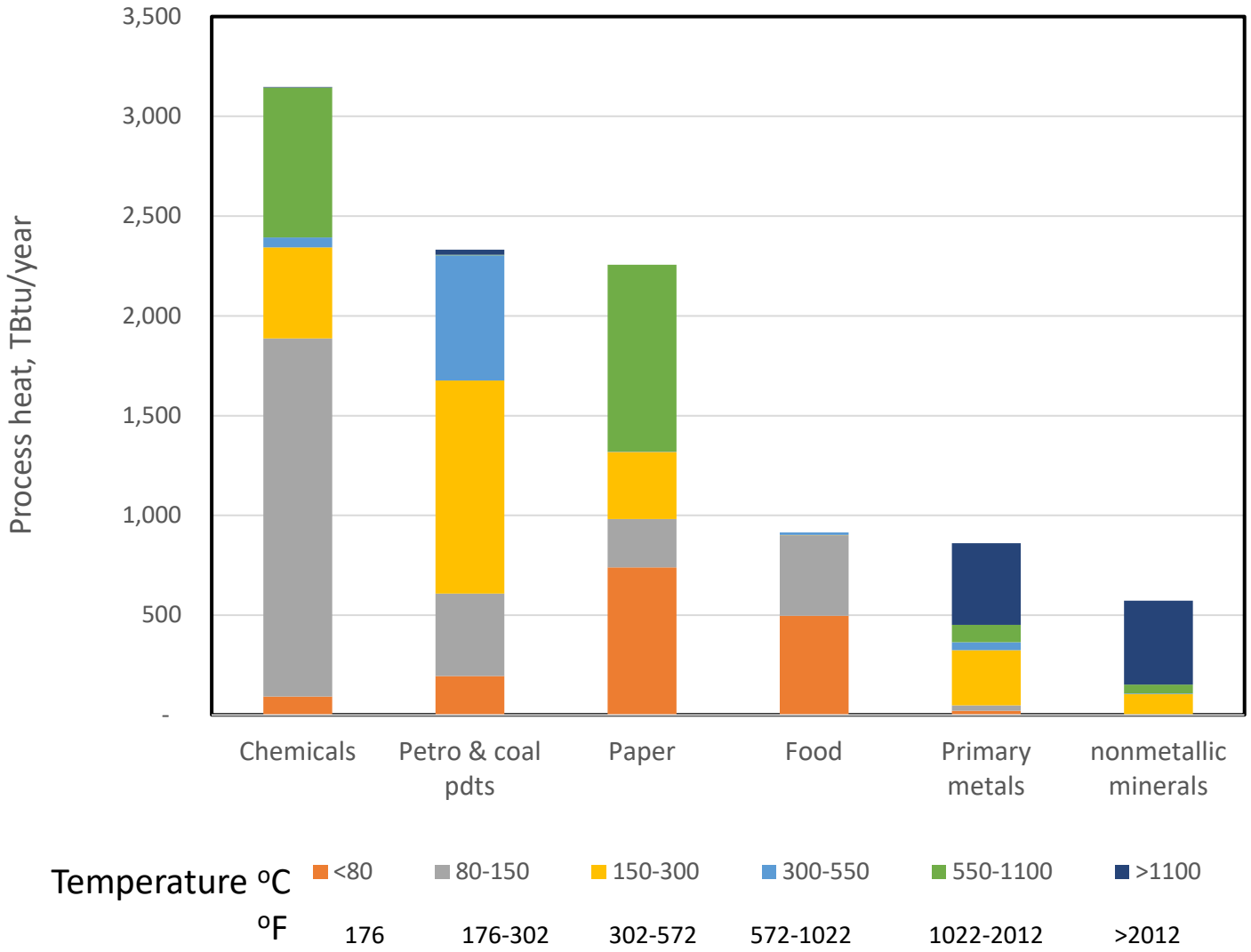
8
Electric & Natural Gas Utilities

9 Million
Customers

Approximately **29,000**
Employees

Approximately **44,000 MW**
of Generating Capacity

Temperature Ranges of Process Heat Used

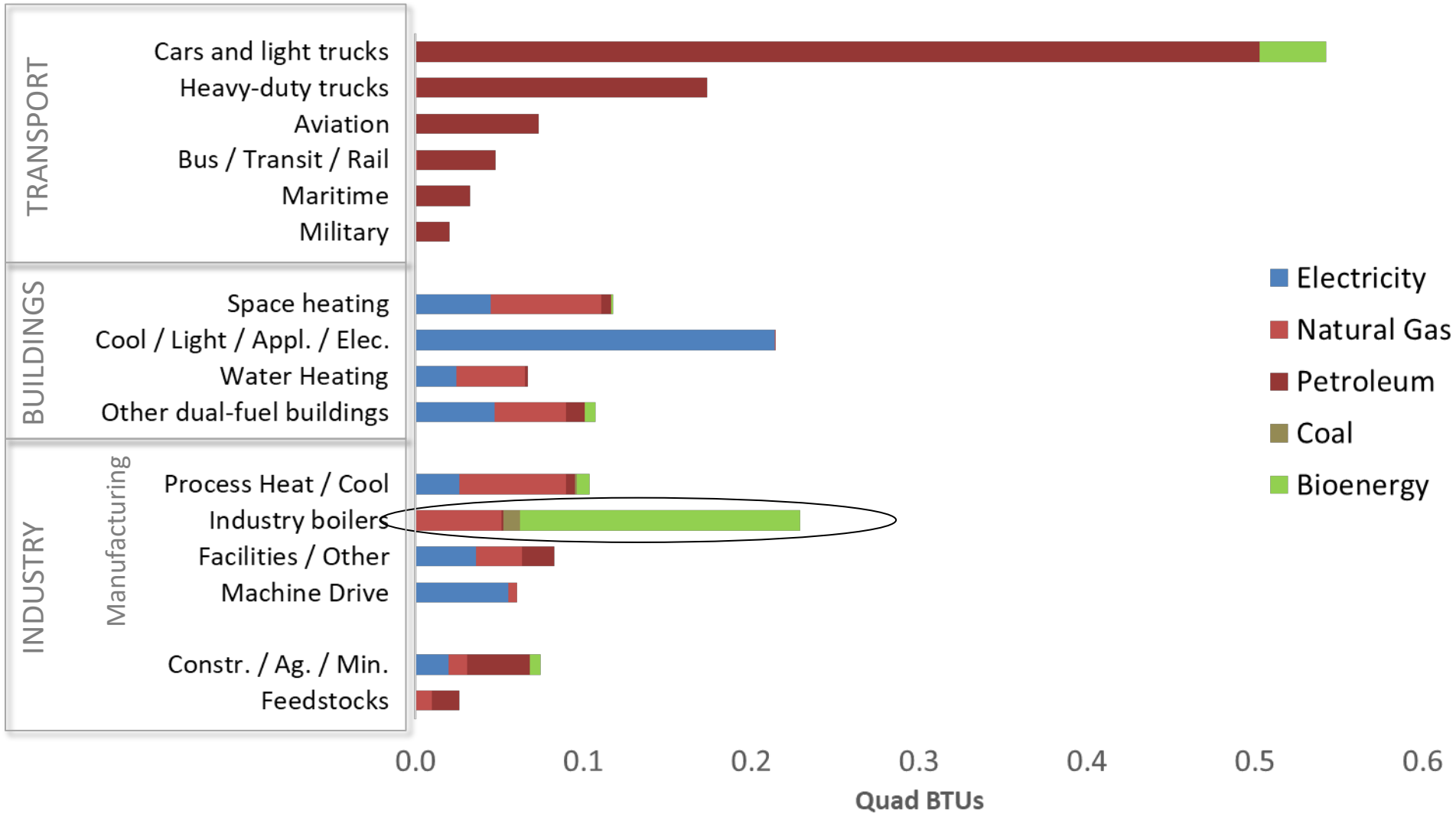


Data Source: McMillan 2019

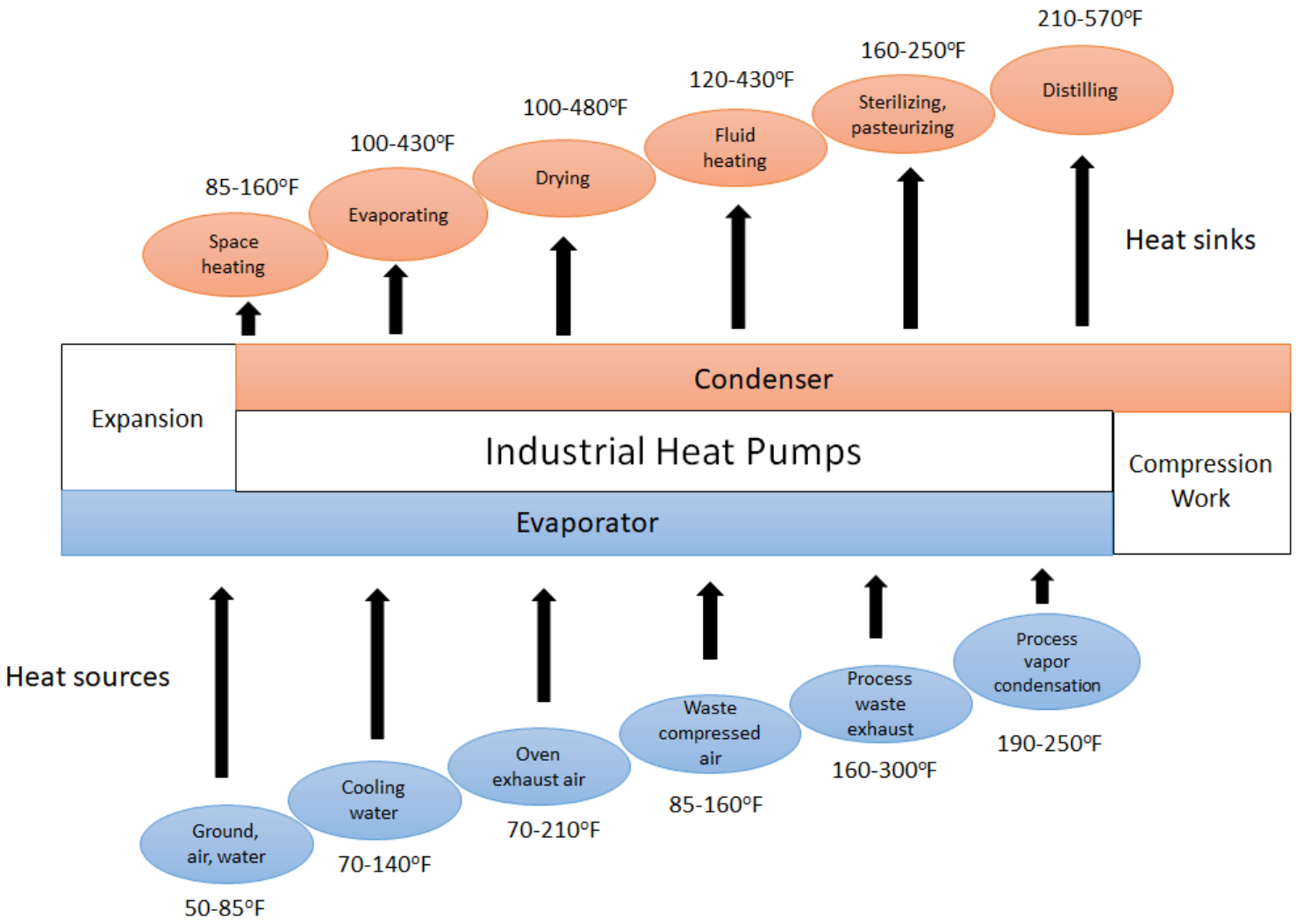
Low-Carbon Solutions for Process Heat

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

2015 Georgia Final Energy by Fuel/End-Use Application



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