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Ground Source Geothermal Heat Pump for High Performance Buildings

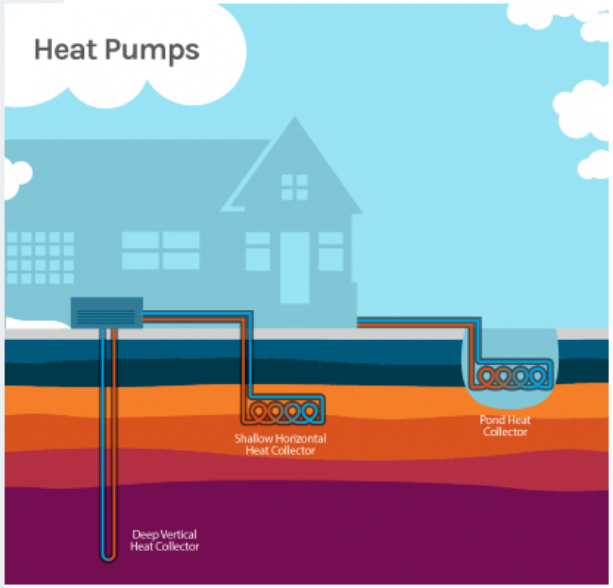
ASCEM October 2023

Outline

- Geothermal Heat Pump Systems
- District Energy Applications (4th and 5th Generation District Energy Plant Solutions
- Clemson Lee Hall Addition (Lee III) – Ground Source Heat Pump Case Study
- Clemson Lee Hall Addition – Radiant Slab
- Energy Intensity
- Questions

Geothermal Heat Pump Systems

What is in a Geothermal Heat Pump System?



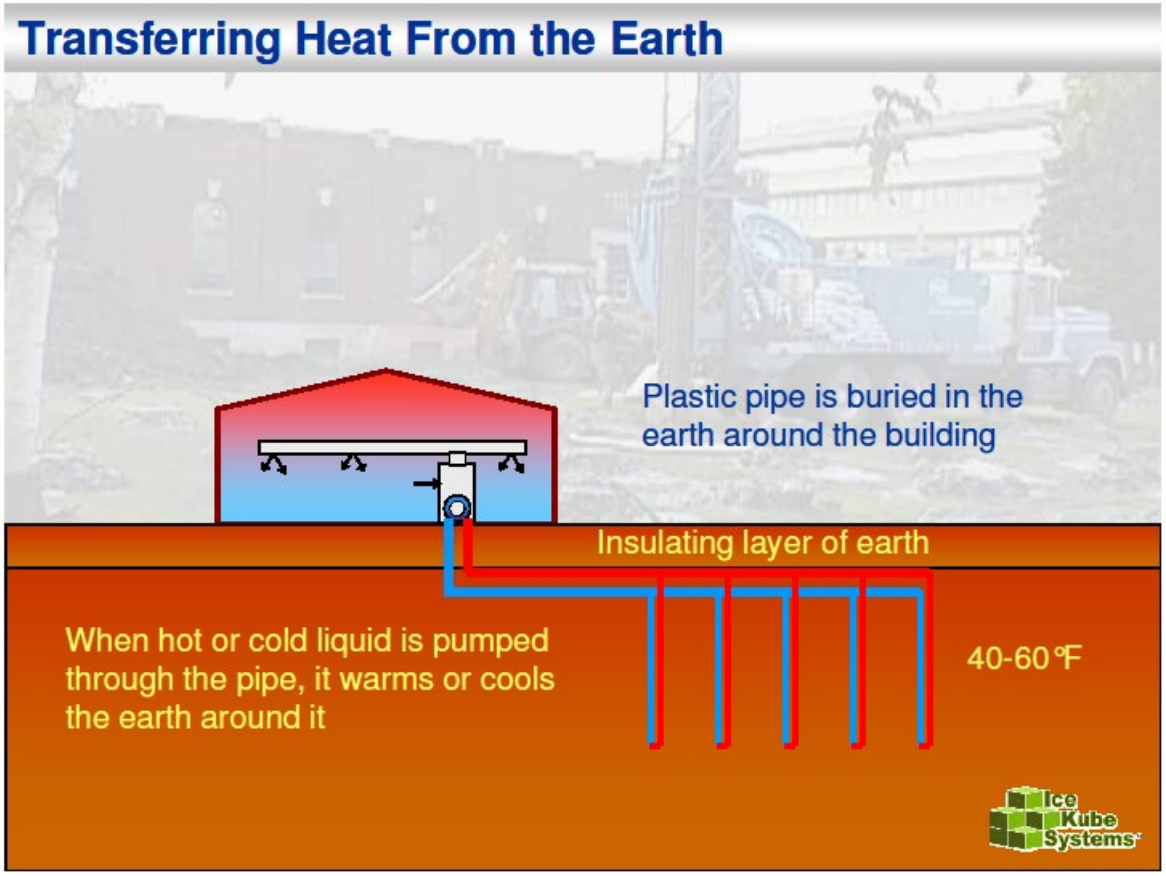
Geothermal heat pumps use the constant underground temperatures of the shallow earth as thermal storage that enables efficient heating and cooling. Systems can vary in the type of collector and connections used.

A GHP system includes:

1. **An underground heat collector**—A geothermal heat pump uses the earth as a heat source and sink (thermal storage), using a series of connected pipes buried in the ground near a building. The loop can be buried either vertically or horizontally. It circulates a fluid that absorbs or deposits heat to the surrounding soil, depending on whether the ambient (outside) air is colder or warmer than the soil.
2. **A heat pump**—When ambient temperatures are colder than the ground, a geothermal heat pump removes heat from the collector's fluids, concentrates it, and transfers it to the building. When ambient temperatures are warmer than the ground, the heat pump removes heat from the building and deposits it underground.
3. **A heat distribution subsystem**—Conventional ductwork is generally used to distribute heated or cooled air from the geothermal heat pump throughout the building.

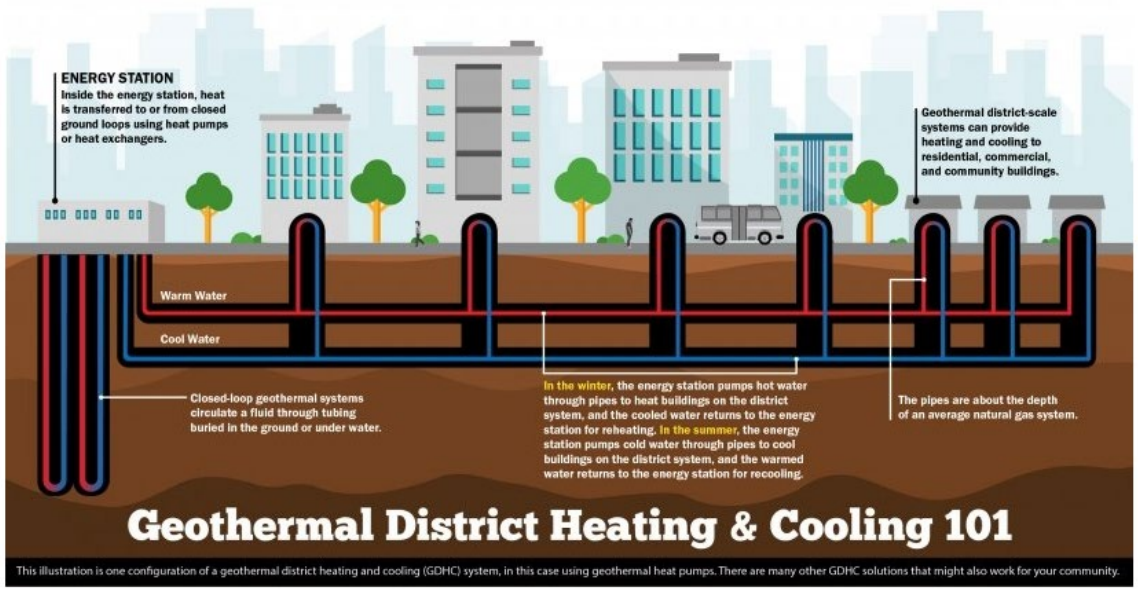
Courtesy of US Department of Energy , Office of Energy Efficiency and Renewable: https://www.energy.gov/eere/geothermal/geothermal-heat-pumps

Vertical Wells Geothermal



A District Energy Application

Community Geothermal Heating and Cooling Design and Deployment



Geothermal heat pumps can be scaled up to meet an entire community's heating and cooling needs on a single network, as depicted in this graphic (click to see a larger version). Other geothermal heating and cooling technologies such as district heating can also be used in a community system.

Courtesy of US Department of Energy , Office of Energy Efficiency and Renewable: https://www.energy.gov/eere/geothermal/geothermal-heat-pumps

Clemson Area Temperature

A properly engineered ground source geothermal heat pump system has the advantage of more stable ground temperatures ranging from 50 – 60 degrees versus outside air temperatures for cooling.

In cooling heat pump removes heat from the building

In heating (reverses) to remove heat from the ground to heat the building

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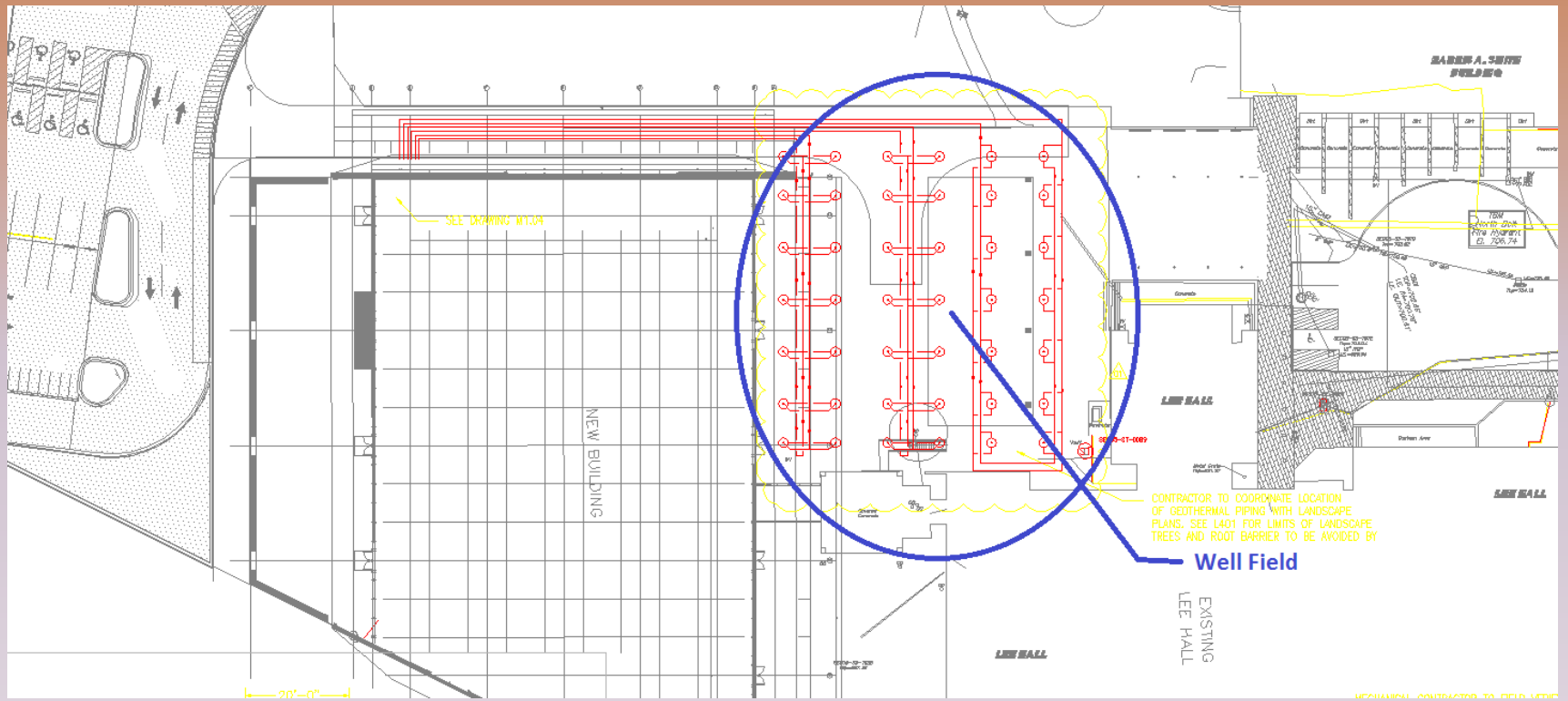
Lee Hall Addition Geothermal

Post construction photo courtesy of Senior Lecturer Annemarie Jacques, Clemson University

42 vertical 4-inch diameter wells. ~400 feet capable of provide approximately 110 tons of equivalent air conditioning – typical home has a 3-ton a/c or heat pump unit.

Lee Hall Well Field



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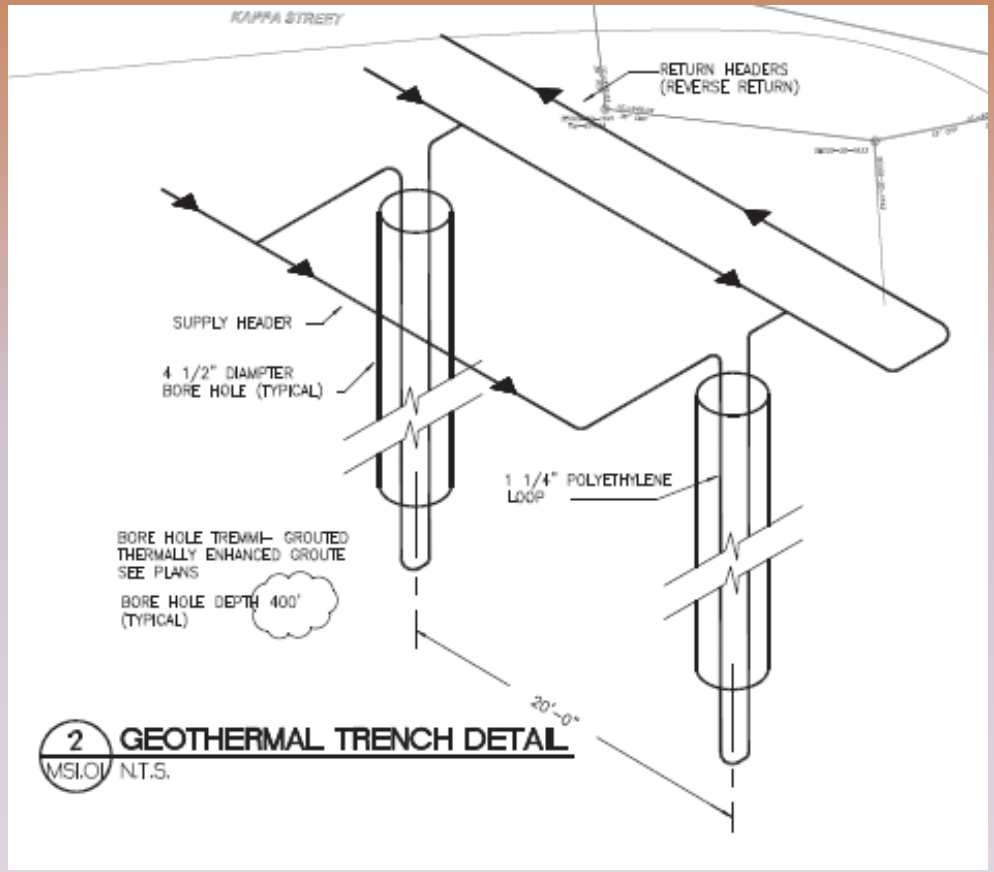
Lee Hall Well Detail



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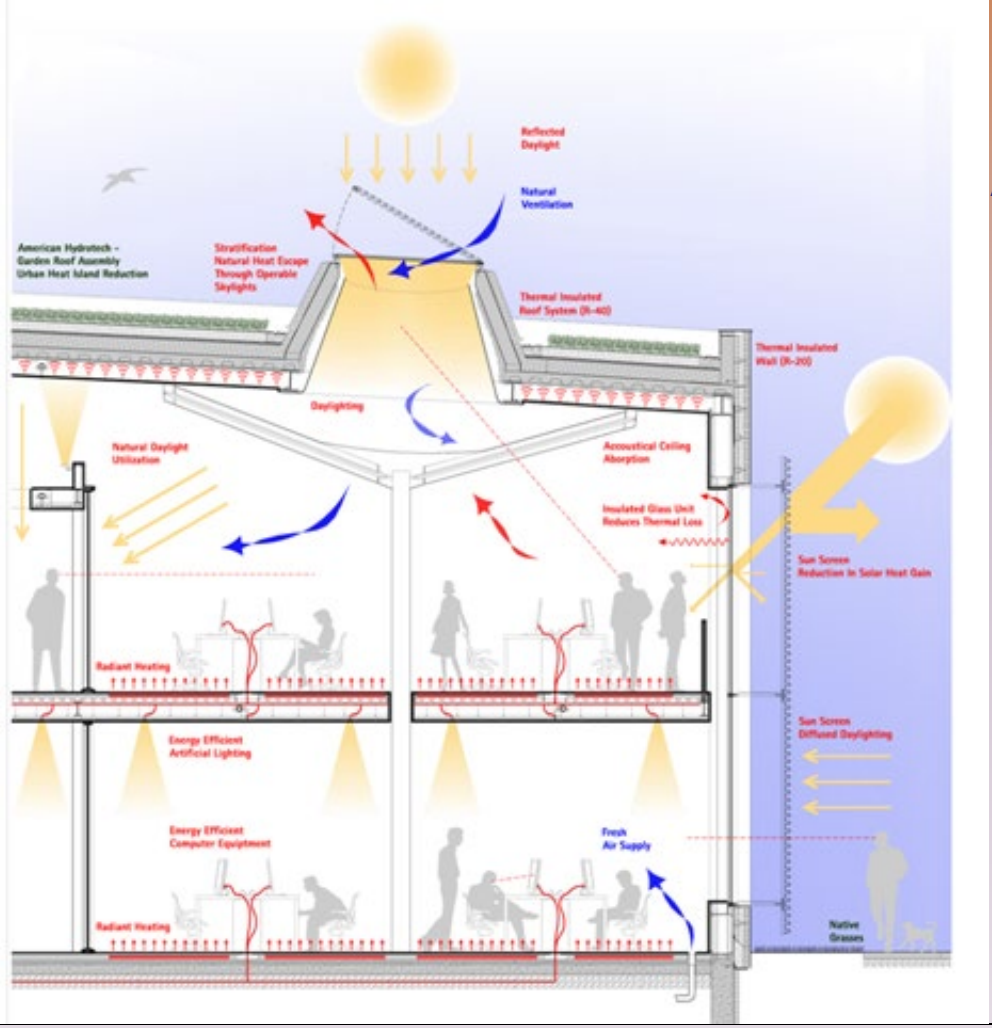
Lee Hall Addition Radiant Slab

LEE HALL ADDITION RADIANT SLAB



ANNUAL ENERGY INTENSITY

SC Residential Colleges & Universities: 113 K-Btu/sq.ft.

Clemson University Avg. Bldg: 118 K-Btu/sq. ft.

LEE HALL Addition Energy Model Projection: 35 K-Btu/sq.ft.

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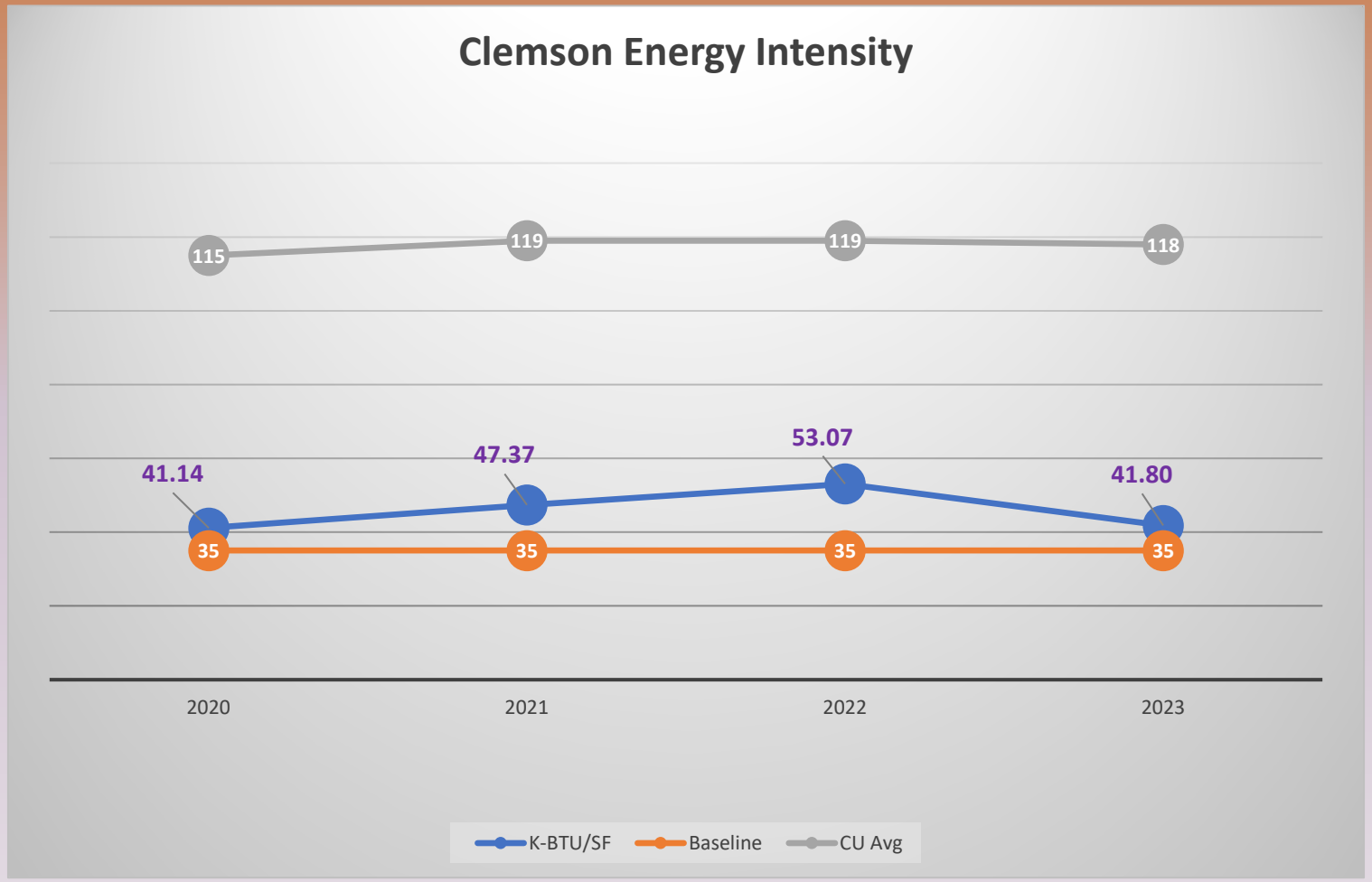
Energy Intensity



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Questions

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