POWER EFFICIENCY PROJECT

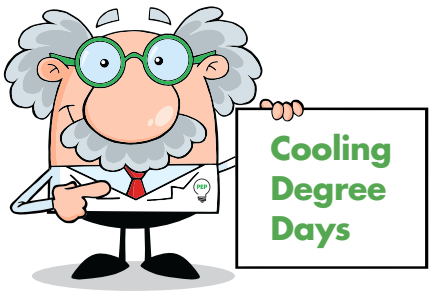
Professor Max Powers' Power Efficiency Project (PEP) is brought to you by the Kansas Corporation Commission and Kansas State University Engineering Extension. Funding provided by a grant from the U.S. Department of Energy.

Degree Days

Degree days are a measurement of how cold or warm a location is and reflect changes in climate. One of the most common uses for degree days is as an indicator of the energy demand for heating or cooling buildings when tracking energy use. Since around 1980, heating degree days have decreased and cooling degree days have increased relative to 20th century averages.[1,2] The shift in number of degree days tells us that temperatures have been on the rise.

Heating and Cooling Degree Days

Degree days compare the mean outdoor temperature (high temperature plus low temperature divided by two) to a standard temperature, usually 65° Fahrenheit (F) in the United States. The assumption is that homes do not need heating or cooling to be comfortable when the outside temperature is 65°F. More extreme outdoor temperatures will result in a higher number of degree days. If a location has a higher number of degree days, generally, there will be a higher level of energy use for space heating or cooling.



Cooling degree days (CDD) measure how hot the temperature was on a specific day or period of days. For example, the high temperature for July 1, 2019 in Manhattan, KS was 90.9°F, and the low temperature was 71.9°F.[3] The temperature mean for that day was:

$$(90.9°F + 71.9°F) / 2 = 81.4°F$$

Because the result is above 65°F:

$$81.4°F - 65°F = 16.4 \text{ Cooling Degree Days}$$

Here is another example: On July 17, 2019 in Manhattan, KS, the high temperature was 99.9°F, and the low temperature was 77.2°F.[3] The temperature mean for that day was:

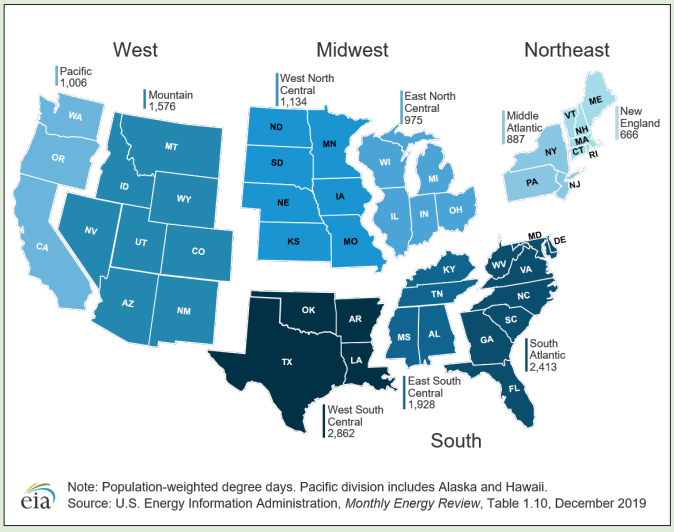
$$(99.9°F + 77.2°F) / 2 = 88.6°F$$

Because the result is above 65°F:

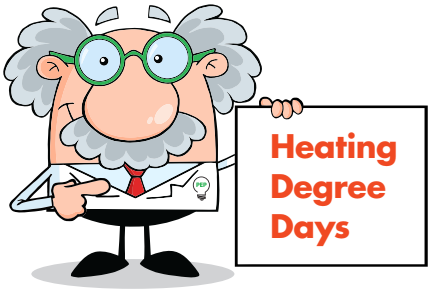
$$88.6°F - 65°F = 23.6 \text{ Cooling Degree Days}$$

The West South Central Census division had the largest number of cooling degree days in 2018 (see **Figure 1**).

Figure 1: Cooling degree days by Census division in 2018



Note: Population-weighted degree days. Pacific division includes Alaska and Hawaii.
Source: U.S. Energy Information Administration, *Monthly Energy Review*, Table 1.10, December 2019



Heating degree days (HDD) measure how cold the temperature was on a specific day or period of days. For example, on December 11, 2019 in Manhattan, KS, the high temperature was 51.4°F, and the low temperature was 18.2°F.[3] The temperature mean for that day was:

(51.4°F + 18.2°F) / 2 = 34.8°F

Because the result is below 65°F:

65°F – 34.8°F = 30.2 Heating Degree Days

Here is another example: On January 20, 2020 in Manhattan, KS, the high temperature was 23°F and the low temperature was 7.9°F.[3]

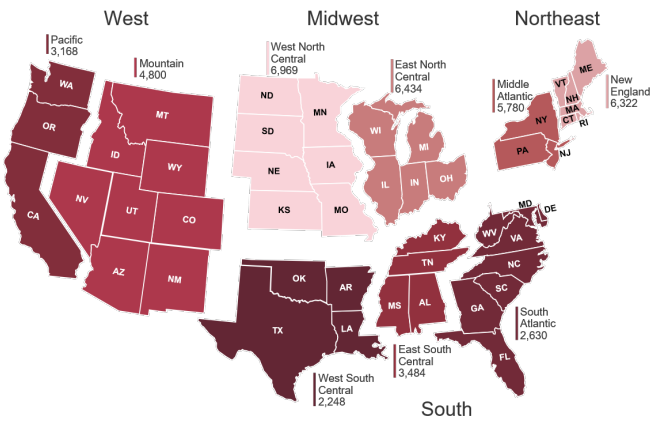
(23°F + 7.9°F) / 2 = 15.45°F

Again, because the result is below 65°F:

65°F – 15.45°F = 49.55 Heating Degree Days

The West North Central Census division had the largest number of heating degree days in 2018 (see **Figure 2**).

Figure 2: Heating degree days by Census division in 2018



Note: Population-weighted degree days. Pacific division includes Alaska and Hawaii.
Source: U.S. Energy Information Administration, *Monthly Energy Review*, Table 1.9, December 2019

Using Degree Days

When comparing energy use, other energy uses that are not impacted by weather (e.g., lights, appliances, etc.) should also be considered. The energy used for these purposes can be estimated by examining energy use during more mild months such as May and October when there is little need for heating or cooling. The energy use during these months generally reflects the baseline monthly consumption. Subtracting the baseline use from overall consumption during a winter month will give an estimate of the energy used just for heating. The usage period is also important to consider. Utility meters are rarely read on the first day of each month and will therefore be a different time period than the degree day totals. The difference can be overcome by comparing data over a longer period, such as an entire heating season or several months.

Degree data can be found in the weather section of newspapers, utility websites or bills, and other weather data-related websites. The Kansas Energy Program typically uses the Weather Library at Kansas State University and Weather Data Depot. Degree days are an important factor when comparing energy use with changes in weather and climate. Without degree days, comparing energy use over two periods would be similar to calculating the miles per gallon of a vehicle without knowing how many miles you had driven.

References

- [1] https://www.nesdis.noaa.gov/content/heatingcooling-degree-days
- [2] https://www.globalchange.gov/browse/indicators/
- [3] http://mesonet.k-state.edu/weather/historical/
- https://www.nesdis.noaa.gov/content/heatingcooling-degree-days
- https://www.weather.gov/key/climate_heat_cool
- https://www.weatherdatadepot.com/degree-day-comparison
- https://www.eia.gov/energyexplained/units-and-calculators/degree-days.php

Additional Activities

Using weatherdatadepot.com (for locations outside of Kansas) or mesonet.k-state.edu, students should research the weather station closest to their birthplace. Based on data from the weather station, students will calculate the number of degree days for the year/month they were born and compare it to the number of degree days for the current year/month. What is the percentage change in number of degree days? This percent is generally equivalent to the percentage change in amount of energy needed to heat or cool a building. What are some ideas to improve energy efficiency if degree days have increased?

Navigate to the Kansas Mesonet website and locate the weather station nearest you or your school. Look at that station's metadata page (link in references) and learn about it. When was it established? What is the station type? What is the elevation? What type of instrumentation does it use?

For more information on degree days, contact Kansas State University Engineering Extension at 785-532-4998 or dcarter@ksu.edu.