Short-Term Energy Outlook: Weather Forecast

Concepts, Data Sources, and Techniques
Handbook of Energy Modeling Methods

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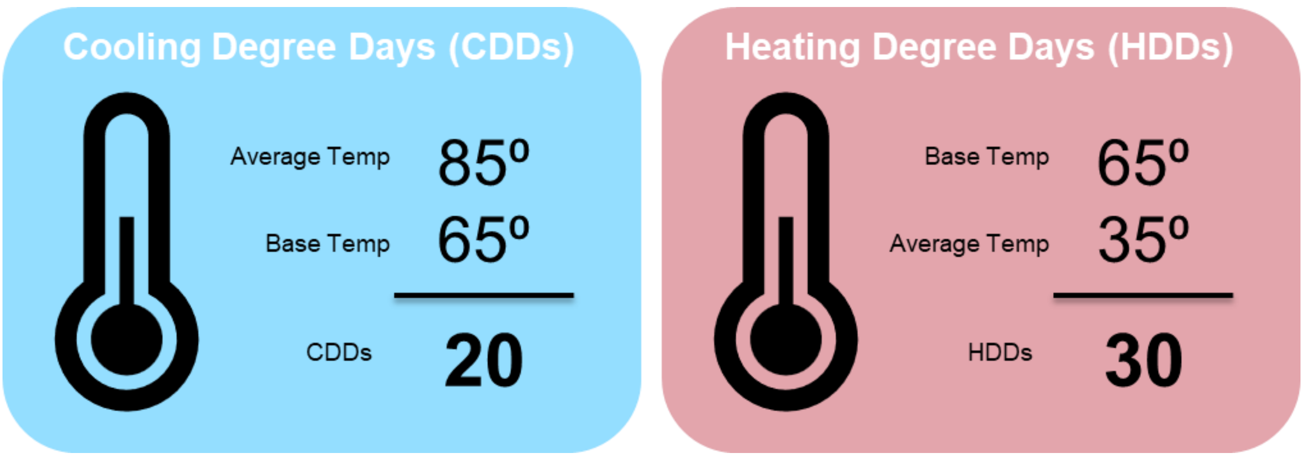
Table of Contents

1. Introduction

The *Short-Term Energy Outlook* (STEO) generates population-weighted heating degree day (HDD) and cooling degree day (CDD) forecasts for the nine Census divisions and the United States to analyze the relationship between temperatures and energy consumption for space heating and cooling.

Degree days are calculated as the difference between the average daily outdoor temperature (high temperature plus low temperature divided by two) and 65° Fahrenheit (°F). If the average temperature is above 65°F, we subtract 65 from the average and the result is CDDs. If the average temperature is below 65°F, we subtract the average from 65 and the result is HDDs. Each day's HDDs or CDDs are summed to create a HDD—or CDD—measure for a specified reference period.



2. Module Outputs

The weather module generates **regional** and **national** forecasts for the following outputs:

- Population-weighted heating degree days
- Population-weighted cooling degree days

3. Data Sources

Our data source for **historical** weather data is the National Oceanic and Atmospheric Administration (NOAA), which publishes heating and cooling degree day data at the local, state, regional, and national levels. NOAA's published data stems from:

- The National Climatic Data Center (NCDC): we collect monthly HDD and CDD data dating back to 1895
- The Climate Prediction Center (CPC): we collect weekly HDD and CDD data and monthly data for Alaska and Hawaii, which are not reported by NCDC

We also collect NOAA's degree day **forecast** data from both NCDC (monthly) and CPC (weekly and monthly).

We receive monthly state-level **population history and forecasts** from S&P Global.

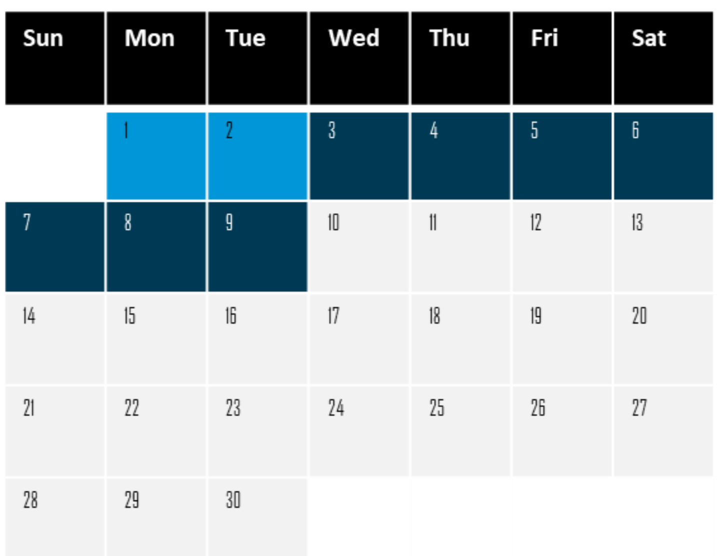
4. Linear Regression Model

The STEO weather module calculates current-year population-weighted weather forecasts using a combination of NOAA's state-level weather history/forecast data and a 30-year trendline.

> ***Population-weighted forecast***: To reflect both temperature changes and population migration, the STEO reports regional and U.S. degree day calculations based on dynamic population weights. To do this, we multiply state degree days by the state's share of the total population during the year in which the degree days were measured.

For the first STEO forecast month (for example, November weather data in the November STEO), we use NOAA's forecast. For each state:

- The model uses NOAA's actual data and weekly forecasts for the days that they are available.
- Given NOAA's monthly forecast of total HDDs and CDDs, the model estimates the HDDs and CDDs for the remaining days of the month as the average HDDs and CDDs per day multiplied by the remaining days in the month.
    - For example, the calculation for a 30-day month in which we have actual data for 2 days of the month and forecast data through day 9 of the month would be as follows:



	HDDs
Actual Data	8
Forecast (NOAA)	12
*Remaining days	42
STEO monthly total	**62**

$$HDDs\ per\ day = \frac{NOAA\ monthly\ forecast}{No.\ of\ days\ in\ month} = \frac{60}{30} = 2$$

$$^{*}Remaining\ days\ HDDs = Remaining\ days * HDDs\ per\ day$$
$$= 21 * 2$$
$$= 42$$

For the rest of the forecast period, the model first generates state-level regressions using annual degree day data.

- The regressions (using the ordinary least squares method) are a one-variable 30-year trend line represented by the following equation estimated using the previous 30 years of HDD and CDD data:

$$degree\ days_t = C + trend_t * \beta$$

where;
$C = constant$
$trend_t = independent\ variable\ representing\ time\ period\ t$
$\beta\ = slope/trend\ coefficient$

Two equations are generated for each state, one for HDDs and one for CDDs. The equations are then used to create annual HDD and CDD forecasts.

To create our monthly forecasts, we then create monthly seasonal factors using the average deviation of each month’s degree days from the 30-year annual HDD and CDD average.

U.S. and regional degree day forecasts are generated by weighing monthly state-level forecasts by monthly state-level population forecasts.