



9

Building Energy Systems Design: Data, Standards & Practices

Case Study on Building Energy Systems Design

Martha Brook, P.E.
Technical Advisor, Commissioner Andrew McAllister,
July 2018

Building Energy Systems Design: Data, Standards & Practices

Engineered systems provide heating and cooling in buildings for indoor comfort and also ventilation for indoor air quality. These systems are designed to work within specific outdoor climate regimes. The data that characterizes these climate regimes is typically based on actual weather observed and recorded over time. Outdoor temperatures, humidity, solar radiation, wind speed and wind direction are recorded at weather stations around the globe.

National design standards and guidelines include statistics on temperature and humidity data and how to use this data to size heating and cooling systems. National standards also specify indoor temperature and humidity conditions that must be met for general human comfort. Buildings in California must adhere to the Energy Efficiency Standards, which include requirements to estimate the expected energy usage of the building design as part of the permitting process. This approach uses hourly weather data that is representative for the proposed building location. Further, national equipment energy efficiency standards include test procedures that must be completed and published by manufacturers before products can be sold in the U.S. These procedures specify the outdoor temperature and humidity levels that the equipment must be tested at, based on average weather conditions.

Typical engineering practices for building energy systems use historical weather data that will likely not be representative of the future climate conditions over the life of the buildings being designed, constructed and later renovated. Using climate patterns experienced in the past to design energy systems operating in the future limits the ability of these systems to provide critical building services in a future of climate change.

Changes Needed to Address Climate Resiliency

The building design community is beginning to acknowledge that past practices cannot be used to provide climate resilient building energy systems. Much more attention is needed from state and national standard setting bodies to establish design guidance and requirements that include attention to future climate expectations and levels of uncertainty.

System Design Data Should Capture Future Climate Conditions

An important first step is to establish weather data used in energy system design that reflects future climate expectations. Design data should reflect expected changes in magnitudes, such as extreme temperatures, and changes in patterns, such as diurnal and seasonal fluctuations. Data on outdoor temperatures, solar radiation, wind speed and wind direction should reflect climate change futures.

Scientists have modeled global climate change over a broad range of scenarios and also downscaled these models for use by sub-national governments, such as California. The chart below exemplifies the climate projections that should be translated into energy system design guidance. The charted data is from the Cal-Adapt data portal, which has the objective of sharing scientific research on how climate change may affect California.

Designing For Uncertainty

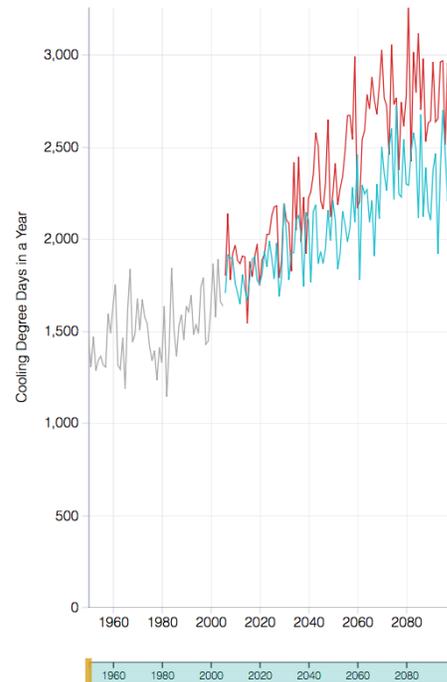
Climate change promises an uncertain future. Therefore, building energy systems must be designed to perform well over a wider range of climate conditions. Engineers and other design professionals should select equipment and specify system controls to provide heating, cooling and ventilation efficiently over a broad range of possible climate futures. This will require scenario modeling of the energy systems, analogous to what has been done by climate scientists for critical climate variables.

Cooling Degree Days JANUARY 01 TO DECEMBER 31

Grid Cell (37.28125, -120.46875)

Emissions peak around 2040, then decline (RCP 4.5)

— Observed Data (1950–2005) Modeled Data (2006–2099)
■ HadGEM2-ES
■ CNRM-CM5



Number of cooling degree days in a year for the Merced region under the RCP 4.5 scenario. These data are available via Cal-Adapt (<http://cal-adapt.org/>), used with permission.