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Test reference year 2012 for building energy demand and impacts of climate change

Abstract
The ongoing climate change is expected to affect the energy demand for heating and cooling of buildings. Building energy consumption is often assessed by simulation algorithms that require hourly meteorological data. For this purpose, weather observations from the year 1979 have previously been used in Finland as a reference. Here, we describe a new test reference year, TRY2012, that was constructed by using weather observations at three measurement stations (Vantaa, Jyväskylä and Sodankylä) during 1980–2009. TRY2012 consists of weather data for twelve months that originate from different calendar years, each month having weather conditions close to the long-term climatological average. The months for TRY2012 were selected using Finkelstein-Schafer parameters for four climatic variables (air temperature, humidity, solar radiation and wind speed); these parameters were weighted depending on how important individual climatic variables are for the building energy consumption in Finland. Calculations for two example buildings, a detached house and an office building, indicate that the most influential climatic variable for annual energy demand is air temperature. In summer, solar radiation and air temperature are of broadly equal influence.

We also assessed the influence of human-induced climate change on typical weather conditions for the years 2030, 2050 and 2100. Multi-model mean estimates from 7 to 19 global climate models, together with the TRY2012 weather data, were used to construct artificial meteorological data for the future. The projected reference year TRY2030 is 1.2–1.5ºC warmer than TRY2012, with the lower end of the range corresponding to Vantaa in southern Finland and the higher value to Sodankylä in the north. Seasonal mean temperature is projected to increase by about two degrees in winter and by slightly less than one degree in summer. The variability in temperature will diminish in the winter half of the year by about 10 %. In addition, the projections include decreases in solar radiation in winter and spring, slight increases in wind speed in November-February, and small rises in relative air humidity in all seasons except summer.

Utilizing the reference years TRY2012 and TRY2030, we calculated the mean monthly and annual energy consumption for the two example buildings in the current and projected future climate. Based on the simulations, the heat energy consumption of spaces and ventilation will decrease by 10% for the detached house and by 10–13% for the office building, whereas space cooling electricity will increase by 17–19% for the detached house and by 13–15% for the office building. Because electricity for cooling relative to the total delivered energy is minor, the total energy consumption of the example buildings is projected to decrease by 4–7% by 2030.

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