Resulting peak loads and energy use reductions

The energy use/peak loads for the proposed design are included in Figure 2 through Figure 5, which show that the selected measures resulted in reductions of 40-65% in annual energy use, 50-70% during peak months and peak days, 30-40% in peak heating loads, and 45-60% in peak cooling loads, when compared to the base case. The highest peak load reductions were from airtightness and window improvements.

With the selected measures, the peak daily loads for the solar thermal system were 534 kBtu in Minneapolis, 182 kBtu in Atlanta, and 72 kBtu in Phoenix. With appropriate thermal storage capacity, the sizing of solar thermal system can be reduced to provide average daily loads of 298 kBtu, 82 kBtu and 37 kBtu, respectively. The peak daily loads for the PV/wind electric system in these locations were 27 kWh, 33 kWh, and 38 kWh, which could be reduced to provide average daily electric loads of 19 kWh, 26 kWh and 33 kWh, respectively, by providing adequate electricity storage.

SUMMARY

This paper demonstrated a methodology to analyze building energy performance during different times of the year in view of available energy resources, aiming at minimizing the loads for renewable energy systems, which is very important for their sizing, usability and cost-effectiveness for off-grid, off-pipe application. The analysis showed how the daily and seasonal variations in the climate parameters impact the sizing requirements of various components of renewable energy systems. The results demonstrated that large reductions in the building energy use and peak loads can be achieved from the selected measures.

The next step for off-grid, off-pipe design is the sizing of renewable energy systems for critical periods. It is to be noted that critical periods may not always align with the periods of peak loads, since that depends on the energy use vs. energy harvested at different times of the year. Also, the availability of energy resources does not accurately represent the output of renewable energy systems, since the performance of systems is affected by other climate parameters and load conditions. These concerns are addressed in Malhotra (2009) by integrating the analysis of energy use and renewable energy system performance during different times of the year to obtain better estimates of loads for the systems.

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