THOUSAND HOME CHALLENGE

Ten Steps to Deep Energy Reductions

The following steps, listed in order of priority—but not necessarily in order of sequence—provide a framework for assessing and implementing a deep energy reduction for a specific dwelling. This process can be used to help define priorities or clarify whether interim measures support deep reductions or make it more difficult to achieve them. This document is continually evolving. Your comments are welcome.

Step 1. Assess Needs, Site, Goals, and Use of Space

This step is centered on the occupants, their use of space, and the house. What are the occupants' goals, needs, and priorities? These could include affordability, allergen reduction, sustainability, carbon neutrality, security, adaptability, passive survivability, safety, comfort, etc. What challenges and opportunities do the house and community provide? Does the dwelling have solar access or other renewable options? Are combustion products, radon, asbestos, vermiculite, or lead based paint risks that need to be considered? Are there opportunities to incorporate water reuse, rainwater capture, and to minimize the impact of basement flooding in the event of a deluge? Step 1 provides an opportunity to clarify energy benefits beyond site boundaries. Air pollution, energy supply, utility rate structures, electrical capacity, supply and transmission constraints can influence decisions.

Step 2. Optimize Enclosure to Reduce Heating and Cooling Loads

The goal of Step 2 is to reduce the heating and cooling loads through a combination of air-sealing, insulation, shading, and window treatments. The higher the R-value of insulation, the more critical it is to address thermal bridging. Minimizing summertime solar heat gain can limit electrical peak loads driven by air conditioning. If windows are being replaced, there is an opportunity to change window areas to maximize passive heating, minimize summertime solar gain, and optimize natural ventilation. Keeping thermal distribution systems within the thermal boundaries is important to achieve house tightness, minimize air handler-induced house pressure differences, and optimize distribution efficiency.

Step 3. Minimize Internal Loads (Lighting, Appliances, Electronics)

Although these improvements usually have shorter life expectancies than the building enclosure or mechanical equipment, they have a significant effect on the peak electric demand and heating and cooling loads and can add up to a large annual energy component. Load reduction is achieved by new technology, careful operation, and occupant understanding and feedback. Shifts in patterns of consumption represent an unknown that is largely driven by occupant knowledge, preference, and behavior.

Step 4. Provide Fresh Air

Even in mild climates, an intentional, distributed, efficient supply of outdoor air for ventilation is essential because there will be times when occupants do not open windows or ventilation rates are poor even when windows are open. Ventilation strategies vary depending on the climate. Control of indoor moisture, IAQ pollutants, and the exclusion of soil gases or pollutants from an attached garage, basement, or crawlspace should be considered during the ventilation system design phase.

Step 5. Control Humidity

Summertime humidity is often a source of discomfort. High humidity also contributes to allergens, mold, poor indoor air quality, and structural deterioration. Tightening the home and using a mechanical ventilation system is one way to minimize indoor humidity during the summer. Eliminating cold surfaces by raising their R-value can minimize condensation. It is also important to control indoor sources of moisture. Development of more efficient and effective dehumidification strategies is a priority.

Step 6. Determine Cooling Needs

Greatly reduced cooling loads provide the opportunity for nonconventional cooling strategies, and in many climates mechanical cooling can be eliminated. Humidity control can eliminate or minimize the need for cooling. Providing cooling with minimal impact on peak loads increases a home’s adaptability over time. Ironically, with a very efficient building enclosure, the effect of internal gains from lighting, appliances, and plug loads is sometimes significantly greater than gains from outdoor sources. Even in hot climates, annual energy use for cooling can be lower than for water or space heating. However, decisions regarding achieving summertime comfort influence the remaining mechanical systems.

Step 7. Integrate Hot Water with Other Loads

In many cases, the same equipment can provide both space heating and water heating. By combining two small loads, it is possible to justify a higher investment and obtain higher efficiency. Consider heat pump technology, combined hydronic, solar, and heat recovery from other processes. Hot water loads can be minimized by addressing distribution losses and more efficient end uses. Significant energy use is embodied in the entire water supply and treatment cycle, so reducing water use also reduces energy used to treat and pump water. In a deep reduction project, many households will use more energy for water heating than space heating.

Step 8. Determine Heating Needs

With greatly reduced heating loads and distributed ventilation air, it is possible to eliminate a central heating system in many climates. Substantial portions of the heating loads may be met with internal loads, a point source of heat such as a ductless heat pump, and / or a solar thermal system. Though electric resistance heat is the most flexible, it has low source efficiency (33%), unless it is from an on-site source.

Step 9. Integrate Renewable Resources to Address Remaining Loads

On-site renewable resources, whether active systems or integral to the building's design, can have a larger impact on the remaining energy uses once the household's energy loads have been minimized.

Step 10. Incorporate Verification, Feedback, and Evaluation

Careful design, best intentions, and good modeling results do not alleviate global climate change; real-world reductions in use do so. Deep home energy reductions must be verified through monitoring and utility bill analysis in order to ensure that expected savings result. Monitoring systems can provide feedback to all involved regarding temperature, humidity, and indoor air quality as well as energy use so that the building systems and their operation can be optimized. Measurement and verification are also a crucial aspect of learning from experiences, modifying our assumptions, and improving systems for achieving deep reductions.