**Some Thoughts on Energy Efficiency for Historic Buildings**
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The fact that historic buildings are old and we wish to preserve their historic nature presents challenges when we seek to improve their energy efficiency. We should follow the steps of repairing, refurbishing and lastly replacing when it comes to maintaining and improving historic buildings. Some of the most important characteristics of the building that we wish to preserve can present some of the greatest challenges. When make energy efficient improvements to a building, not all may be cost effective based solely on the energy saved. When we can couple energy improvements with repairing, refurbishing and replacing building components, devices or equipment due to maintenance, renovations or an addition then these measures often become cost effective. Other benefits associated with these improvements are better thermal comfort, indoor air quality and lighting levels, and the reduced impact on our environment.
Most building systems such as lighting, heating, air conditioning and ventilation are based on what we call design conditions. These are the more extreme conditions a building will be subjected to, such as the darkest night, coldest or hottest day of the year, or when a room is filled with people. On average these conditions occur 10% to 20% of the time and in some cases as little as 5% of the time. Consequently, systems are often oversized, cannot vary to meet the conditions and operate inefficiently. When replacing devices, equipment and systems, it is best to select those that can dim, be switched, modulate, setback or turned off when the load or demand varies.

Some specific thoughts, observations and challenges for historic buildings to think about:

1. Moisture Intrusion-In general any portion of a building that is being considered for weatherization should be checked for moisture intrusion before the work takes place.
    a. Many historic buildings have foundations that were built with materials that allow moisture to enter through the walls and floors. Seldom were walls waterproofed or moisture barriers installed at the floors. Weatherization measures should not be installed until this problem is corrected. Trapping moisture can cause mold and possibly over time, structural issues.
    b. Before insulating the inner portion of masonry walls, particularly brick, an analysis should be done to make sure the dynamics of the wall are not adversely affected by moisture that will allow freezing in the wall.
    c. Wood framed structures should be checked for moisture intrusion before blowing cellulose or fiber glass into wall cavities.

2. General Air Sealing
    a. This is filling multiple holes, gaps, voids, etc. found throughout the building. Foam, caulking or otherwise filling them is low hanging fruit and can reduce the air infiltration by 10% to 20%.

3. Windows are typically single glazed and often double hung.
    a. Refurbishing windows so they fit tightly (including weather stripping) and adding interior or exterior storms can significantly improve their energy efficiency.
    b. The cavities around double hung windows can filled with foam insulation reducing air infiltration and improving the R-value significantly.

4. Doors are typically worn and fit poorly. Refurbishing doors so they fit properly and adding weather-stripping can efficiency significantly improve their. It is often not possible to improve the door's R-value without affecting their appearance.

5. Lighting can be low hanging fruit due to significant advances and cost reductions in LED lighting. Retrofitting historically significant fixtures with LED's has become more feasible. Lighting controls offer a number of opportunities to reduce electrical consumption and improve lighting quality.

6. Heating, Ventilating and Air Conditioning (HVAC)
    a. HVAC systems in buildings encompass a wide range of systems from simple to sophisticated. Most systems are older, not fixable with poor to moderate efficiency. Recommendations for improvements vary based upon the existing systems. Many options are available such as natural gas and propane fired boilers that can modulate and are high efficiency. Wood pellet boilers with a higher first cost are similar. Heat pumps and the more sophisticated Variable Refrigerant Flow (VRF) systems are another approach, especially if air conditioning is desired. However, a backup system may be needed for very cold days. Furnaces and air handlers have also improved and the more efficient ones can modulate, have better controls and often can serve multiple zones. When considering to air conditioning, heat pumps are highly recommended. However, split units have also improved considerably. Efficiency improvements of 20% to 50% are common.
    Ventilation in many existing buildings relies on operable windows. However, as a building is tightened up it may not be sufficient and even existing buildings may not provide adequate outside air for occupants. Heat recovery ventilators are recommended and they can usually recover about 70% of the heat in the air and have similar results on the cooling side.
    Keeping HVAC systems simple should be a guiding principle. However, they should have adequate zones and controls for efficiency and thermal comfort.

7. Plug Loads
    a. Plug loads have become an increasing user of electricity as more and more electronic equipment is used in our daily lives. Selecting energy efficient devices and equipment such as energy star is the first step. Again shutting devices off or turning them down when not needed is the next step. There are strategies and controls that can help with this. The DOE has websites that offer helpful information.