DOCTORAL DISSERTATION ABSTRACT

Dissertation Title: Effects of Vegetation, Structural and Human Factors on the Thermal Performance of Residences in a Semi-Arid Environment

Director: Andrew C. Comrie, Ph.D.

The objectives of the study were to examine and quantify the relationship between vegetation and the thermal performance of residences in a hot arid environment. Also explored were structural and human influences on residential energy consumption. A primary goal was to determine how much energy savings could be realized through strategic planting of vegetation. This study sought to validate previous simulation and modeling studies that documented annual savings of 2-11% on residential cooling loads. Also examined was whether shrubs and grass could provide a benefit similar to that of trees, assessing the importance of evapotranspiration versus shading. An empirical study was conducted using 105 existing homes in the metropolitan area of Tucson, Arizona. Data included construction type, amenities, living habits of occupants, and energy consumption for heating and cooling over a two-year period. These data were analyzed with a combination of bivariate and multivariate analyses to examine direct correlations between specific variables and energy consumption and the relative importance of each variable. These analyses were unable to document any measurable savings in summer cooling loads as a result of vegetation adjacent to the house, and the presence of trees actually increased the winter heating load by 2%. While trees provide important shading benefits, and can reduce the direct solar gain through the windows of a house, analysis demonstrated that structural and human factors were the most important aspects in residential energy consumption. The size of the house is of primary importance. Houses with evaporative cooling consumed significantly less energy than those with air conditioning. Thermostat settings and habits regarding thermostat operation were the most critical human factors. Occupants who adjusted their thermostats a few degrees cooler in winter and warmer in summer realized measurable savings. Occupants who turned their heating and cooling equipment off when they were not home used significantly less energy for heating and cooling. These factors far outweighed any impact from vegetation on annual energy consumption. While trees should not be considered as a primary means of reducing annual energy consumption, properly placed vegetation can provide aesthetic benefits and increase the thermal comfort of the occupants.

MASTER'S THESIS ABSTRACT

Thesis Title: The Effects Of Orientation And Regional Climatic Variations On The Thermal Performance Of a House

Director: Richard Larry Medlin

Building orientations in a hot-arid climate were studied using Calpas3. The results are analyzed in terms of annual energy consumption. An existing residence and several variations were simulated using weather files for both Tucson and Phoenix, Arizona. The selected variations comprise a representative sample which demonstrates that orientation may not be as significant a factor in a building's thermal performance as the literature suggests. There is a general range between 25-35° of either side of due south in which the thermal performance of a building is satisfactory; however, the effect of orientation is related to all of the building's characteristics. Of these characteristics, glazing area and location play the greatest role when analyzed by a simulation program which measures heat gain and loss across the building envelope. Variations in local climatic conditions can also have a significant effect on the thermal performance of a building.