



# CALIFORNIA STATE SCIENCE FAIR 2010 PROJECT SUMMARY

<b>Name(s)</b> Nathan G. Behrens	<b>Project Number</b> <b>J1001</b>
<b>Project Title</b> Using the Thermal Mass of a Building to Lighten the Load of an Air Conditioner	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> To determine if the efficiency of the air conditioner (AC) varies over a one-day cycle and if the thermal mass of a house in Bakersfield is sufficient to avoid running the air conditioner at peak daily electrical demand and non-efficient run times.</p> <p><b>Methods/Materials</b> Two experiments were run. First, a three-week heat capacity test was run where data loggers recorded the internal, attic, garage and external temperature while the house was vacant. The vacant house transient data were then used to best fit the heat capacity by matching the calculated and observed internal daily temperature swings. The second experiment was to test if there is a more efficient run time for an air conditioner by recording data from loggers outside, in the attic, at the evaporator inlet and outlet, and at the inlet and outlet vents within the house. Humidity was also recorded at the inlet and outlet vents. The numerous data points recorded were culled down to 400,000 data points covering 22 days and 345 AC cycles. Data taken from the inlet and outlet vents within the house provided the delta H, or difference in enthalpy between the air before and after running through the air conditioner vents and evaporator. By comparing the delta H of air conditioner cycles at different attic temperatures, the most efficient run time can be determined.</p> <p><b>Results</b> It was determined that the heat capacity of a house is large enough to avoid running the AC during the heat of the day in Bakersfield (which allows the AC to run at the coolest part of the day when it is most efficient as determined in the second experiment). With a livable interior temperature of 29°C (84°F), a well insulated house can use the AC only at night even with 35-40°C outside high temperatures. For outside temperatures greater than 27°C, the usable delta H of the AC drops from 4kJ/kg to 0kJ/kg when the attic temperature rises from 35°C to 50°C.</p> <p><b>Conclusions/Discussion</b> It was discovered that a building's thermal mass was great enough to avoid running the air conditioner if the house is cooled to 22°C by 6:00 A.M. and the maximum outdoor temperature never exceeds 35-40°C, the interior temperature would be 29°C. The air conditioner is most effective when run during the night which also avoids electrical demand peaks and associated high rates.</p>	
<b>Summary Statement</b> The heat capacity of a house was measured and determined to be sufficient to carry the house through the daytime heat allowing the air-conditioning to be only run at night, which was determined to be more efficient.	
<b>Help Received</b> Dad wrote some VBA to pull out data as needed from the data logger output text files and dump it into Excel where I worked it.	