Homework No. 4
Due February 21, 2024

A single-family residence located in Lakewood, Colorado, was audited with the basic information of the house is provided in pages 2 through 4 of this assignment.

Part 1:
Model this residence using eQUEST (you can also use BEOpt). Follow these tasks to perform the simulation analysis of the house:

1. Using the utility data for natural gas provided in Table 1, determine the balance temperature, the BLC, and the baseload. Assess the efficiency level of this house.
2. Attempt the same utility data analysis using the electrical energy use data provided in Table 1. Estimate the baseload as well as the balance temperature and the BLC of the house during the cooling season. Discuss the accuracy of this utility data analysis using electrical energy use data. Note that Colorado has limited cooling degree days.
3. Model the house based on the information provided in pages 2 through 4. Plot the monthly energy use (natural gas and electricity) and compare against the utility data.
4. Calibrate the building model using the monthly utility data (refer to Table 1). Clearly state all the changes in your initial model and the steps you had to make (mostly adjust DHW usage and occupancy schedules) to calibrate the building model. You may use the basic approach discussed in class.
5. Compare the results from the simulation tool with the variable base degree-days method for predicting the heating and cooling energy uses.

Part 2:
Determine the energy savings (using the simulation tool) and the cost-effectiveness (use both simple payback period and LCC analyses) of each of the following energy conservation measures:

(i)   the infiltration rate is cut by 50% with a total cost of $200.
(ii)   Air layer is replaced by R-19 in the walls with a cost of 0.30/ft^2.
(iii) the temperature is set back to 55ºF (winter) and floating (summer) during unoccupied period (8 am to 5 pm) using a programmable thermostat at a cost of $100.
(iv)   Use a central air-conditioning system with EER=13 at an increment cost of $2,500.
(v)   all the measures listed above are implemented simultaneously.

For the economic analysis, assume 25-years and 5% discount rate. Assume the electricity cost is $0.090/kWh and $1.95/therm.

Briefly discuss if the results make sense to you (explain why?).

Description of the house

Building Information:
- Located in Lakewood, CO
- Built in 1962
- 1 story with a basement (almost all exposed) and a garage (unconditioned)
- 1800 square feet (36'x24' for both basement and ground level, 20'x24' for the garage)
- Front faces East
- All attic roof area

Construction Information:
- Exterior walls full brick wall with insulated air layer (no insulation) with total R-value=8
- Roof asphalt shingle with R30 insulation in attic
- No insulation between interior floors
- 0.20 ACH for air infiltration
- Majority are single pane storm windows with metal frames.

- WWR of 5.1% (refer to the 3-D renderings provided in Figures 1 and 2 for the window repartition)

Load Information:

- 3 occupants in the home
- Equivalent LPD of 1.072 W/square foot
- Equivalent EPD of 0.158 W/ square foot
- 40 gallon gas water heater

System Information:

- Forced air gas furnace 92% efficient
- Central air conditioning SEER 11
- Heating design temperature of 65°F
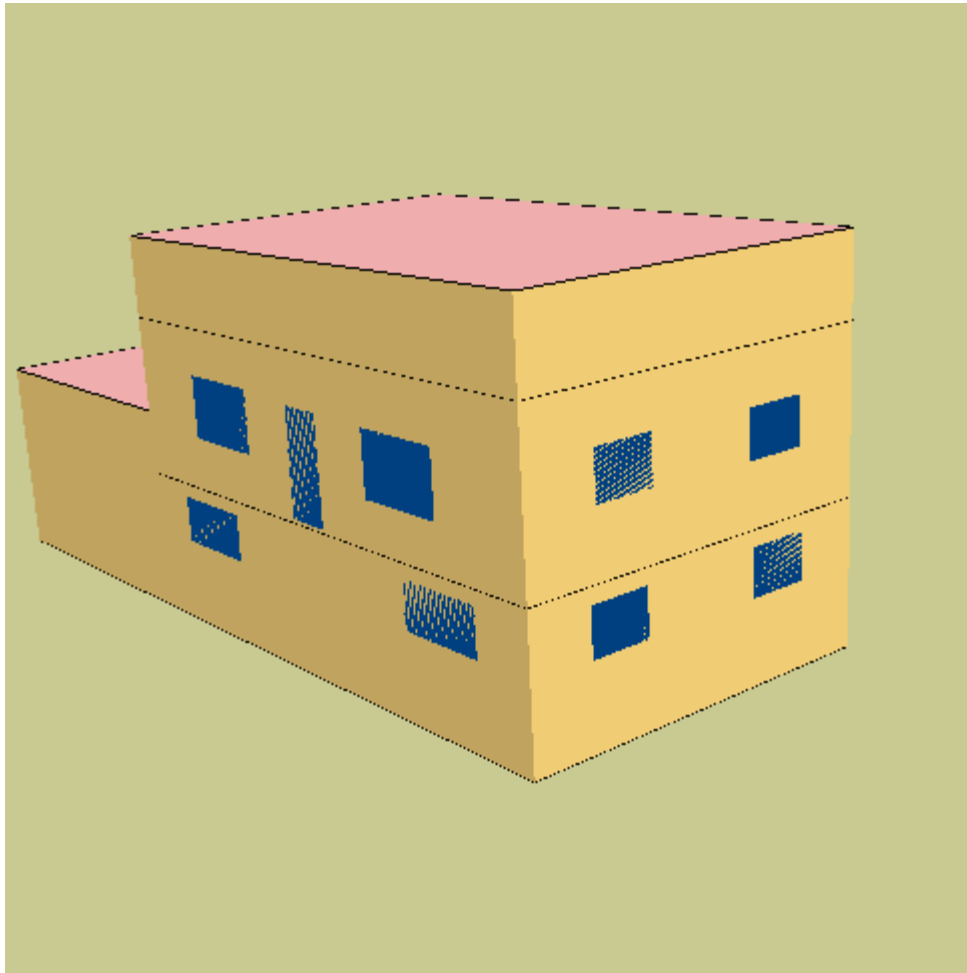- Cooling design temperature of 74°F

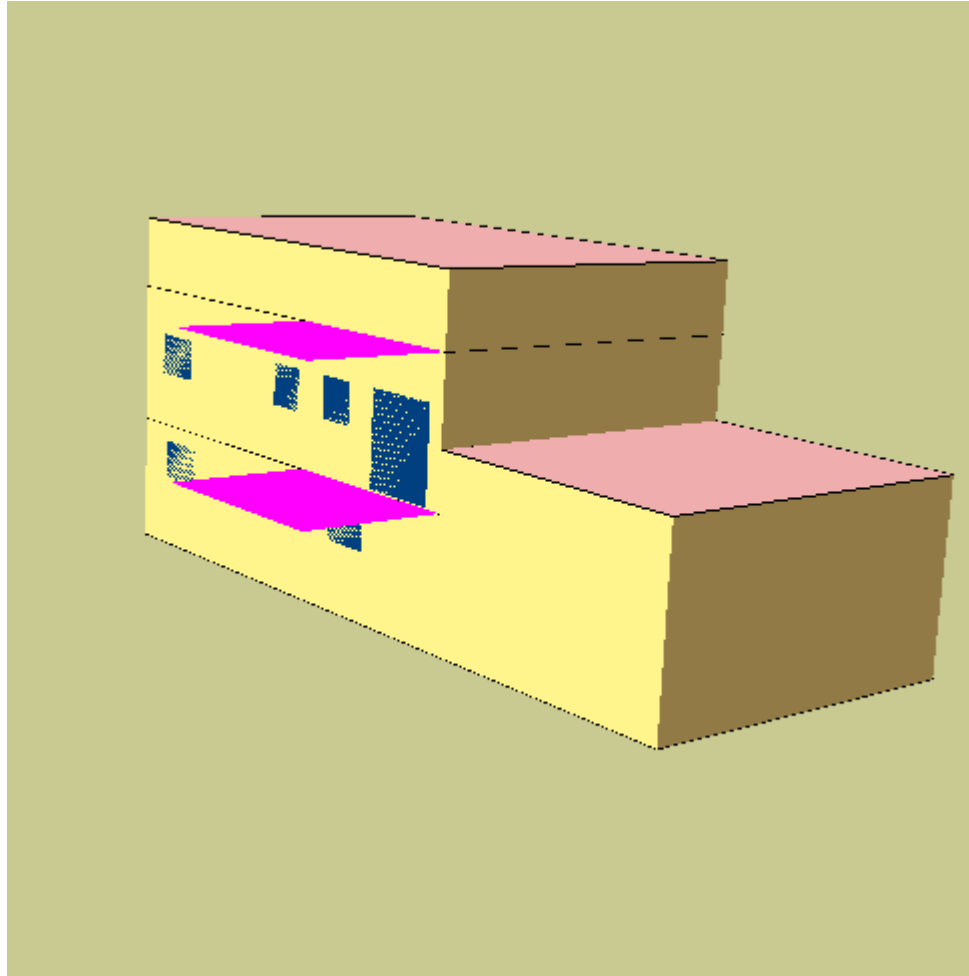**Figure 1**: 3-D rendering of the house to provide the window layout in two directions

Figure 2: 3-D rendering of the house to provide the window layout in two directions

Table 1: Monthly Electricity and Natural Gas Usage

Month	1	2	3	4	5	6	7	8	9	10	11	12
Electricity (kWh)	515	453	454	440	615	870	1068	1348	992	567	499	640
Gas (Therms)	67	59	50	32	29	20	16	16	19	28	49	63