

Energy & thermal analysis for LANDHOUSE

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This report summarizes the findings of our energy evaluation for the proposed “Landhouse” development to be located in southern England. A Landhouse will be about 1400 square feet in heated floor area on two levels. Windows will be located on the north and south orientations. The plans include green roofs and some bermed walls.

The homes are designed for energy optimization, taking into consideration envelope improvements, orientation, the amount and type of glazing, and various heating and ventilation systems. Our analysis includes an examination of the annual energy consumption, peak heating loads and peak summer temperatures of the proposed designs with various energy efficiency measures.

ASSUMPTIONS & METHODS

The Landhouse design was modelled in SUNCODE, an hourly simulation program using TMY2 weather files. The weather data used for this project was taken from London, England. Our model is of a duplex configuration for each type, where the output is for two homes that share one common wall and the garden patio side facing south.

The baseline buildings assume high-performance envelope components, including R-10 insulation below the slab, SIPs (structural insulated panels) in the walls and roof, and good windows with a 0.40 Btuh/hr.sf.F U-value.

Baseline ventilation rates assume 0.35 air changes per hour, an infiltration number common to new construction. The baseline also includes night venting in the summer at a rate of 3 air changes per hour.

Also factored into the baseline was the mass associated with a 4” concrete slab on the ground level and the interior walls finishes with gypsum wall board.

From the baseline, we modelled a number of efficiency measures to compare their effect on energy, heating loads and internal temperatures. To begin, we modelled the entire building rotated 90° clockwise, so that the front entrance faced east and the garden entrance faced west. Our second run looked at the effect of adding 2” of Gypcrete to the upper floor of the building. The next run used a heat recovery ventilator to reduce the ventilation to the equivalent of 0.25 air changes per hour, followed by the same measure plus reducing the window U-value from 0.40 to 0.33, and then the additional mass associated with the Gypcrete on the upper floor. Finally we modelled a run with a combination of the above measures plus the effect of internal shades drawn in the summer.

RESULTS

Description	Modelled Annual Heating GJ	Peak Heating Load KW	Indoor Temp deg C	Annual Savings Over Base
Baseline	70.5	9.5	32.2	0.0%
Rotate 90 degrees clockwise	75.4	9.5	33.9	-7.0%
Added mass 2" Gypcrete	67.9	9.8	30.0	3.7%
Use Heat Recovery Ventilator (HRV)	62.3	8.7	32.3	11.6%
HRV and windows upgraded to 0.33 u-value	55.6	8.0	32.3	21.1%
HRV 0.33 windows, added mass	52.9	7.9	30.0	24.9%
HRV 0.33 windows, added mass, internal shades	54.6	9.2	27.1	22.5%

The rotation of the buildings demonstrates the importance of orientation in good, passive solar design. This measure produced both a significant increase in heating energy in peak indoor temperatures in the summer. In the winter, windows facing only east and west cannot take advantage of the solar heating provided by a low winter sun. In the summer, there is no way to effectively shade windows to the east and west. This run only confirms that the current orientation planned is ideal.

Additional mass slightly increases overall energy consumption, but significantly cuts back on the peak temperatures generated inside a building. It requires a little more energy to heat up additional mass in the winter. In the summer, however, that mass stores more energy that would otherwise go toward heating up the air and thus reduces the maximum indoor temperatures generated in the summer.

Typically, ventilation comprises a larger fraction of the overall heating load and energy consumption. Therefore, any measures to reduce this effect have a large effect on the overall energy consumption. This one measure provided the single largest heating energy savings. Windows have the second largest effect on heating energy consumption in a residence, and any optimization there can also produce significant savings.

Finally, adding internal shades provides a way to mitigate overheating in the summer, but still allows for the benefit of passive solar heating available in the winter. Our results show that internal shades greatly reduced the peak internal temperatures in each building.

RECOMMENDATIONS

An efficient envelope is the first step in a high-performance green building. Structural insulated panels are one of the best options for thermal performance in walls and roofs, and also prevent air leakage. We would also highly recommend insulating the main floor slab with R-10 both underneath the slab and along the edges to prevent thermal losses at the perimeter of the building.

In terms of windows, we recommend minimizing the U-value while maximizing the shade coefficient (or solar heat gain coefficient). The U-value is a measure of how easily heat conducts through a window (the inverse of R-value), and therefore the lower it is, the less heat

loss you get. The shading coefficient is a measure of how much light (and solar energy) is allowed through the window, and the higher it is, the more heat can be gained from the sun. Lower U-values are achieved with low-e (low-emittance) coatings that come on the internal surfaces of windows. Double paned low-E windows can achieve U-values as low as 0.3 with shading coefficients ranging from 0.4 to 0.8. You will want to target a window with a U-value of 0.33 maximum and a shading coefficient of 0.6 minimum. Examples of glass products that can achieve this effect include PPG's Sungate100 or LOF's EnergyAdvantage.

While maximizing the shading coefficient saves heating energy in the winter, it also allows more heat to enter in the summer, promoting overheating. One way to remedy this is to provide good overhangs that shade out the high summer sun. Increasing the overhangs on these large south windows would reduce the potential for overheating. Internal shading is another approach to cut back on solar gains and glare. Our final run demonstrated that internal shades were able to cut down the peak internal temperature from 30°C to a more comfortable 27°C. Internal shades can then be left open in the winter to maximize the heating potential of your south-facing windows. We recommend Nysan or Mecho indoor roll-down shades designed specifically for sun control, with a visible transmittance of no more than 20% and a reflective surface facing outside.

Finally, overheating can be alleviated with natural ventilation methods with operable windows. By opening high and low windows, a "stack effect" is produced, forcing cool air in low into the building as hot air escapes out high. Natural ventilation flows are proportional to the height difference and size of the high and low openings. We recommend evaluating the window configuration to have at least 12 square feet of operable window area on each floor, facing both north and south, that are easily accessible and can be secured when unattended (such as at night).

A de-stratification fan (ceiling fan) can provide a cooling effect with higher air velocity in the summer and prevents warm air from stratifying high in the winter. We also highly recommend a heat recovery ventilator to provide high indoor air quality much more efficiently than traditional ventilation methods.

While space heating uses the greatest amount of energy in residential buildings, domestic hot water also constitutes a large portion of the overall energy consumption and holds potential for savings. Low-flow fixtures, particularly shower heads, are a simple, cost-effective measure that will drastically cut down in hot water consumption. Installing 1.8 gpm shower heads, will reduce your domestic hot water consumption by as much as 30%. Furthermore, drain waste heat recovery is another opportunity to recoup up to 50% of hot water waste heat and transfer it into the incoming cold water.

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