Heat Loss Sources

There are primarily two methods of heat loss in a building. One is convective heat loss and the other is conductive heat loss.

Convective Heat Loss

Convective heat loss is caused by air exiting the building through an opening in the thermal barrier. Convective heat loss areas can be a poorly insulated chimney bypass, electrical wiring thermal boundary gap, a plumbing vent, poorly air sealed windows and doors, or an inadequately air sealed attic which allows warm air to leak out of the perimeter of the attic. This leakage can result in ice dams. The air leakage can account for half of your heat loss in a building. Merely insulating without properly air sealing severely impacts the possible efficiency gains of the insulation. Convective heat loss accounts for at least 50% of home's heat loss.

Convective heat loss can be measured by the air changes per hour of the building while the blower door fan is operating at -50 pascals (ACH50). The target for a home in your climate zone is 3 ACH50. This home's leakage is 3.4 times higher than the targeted goal. Properly air sealing the attic and basement walls should decrease the leakage by at least 35%.

You should not limit the air sealing of a home to avoid making the house too air tight because there are many solutions for getting additional air into a home. These include the installation of a direct vent supplemental air supply pipes, an outdoor air kit on the boiler or furnace, air intakes that are tied to the thermostatic control of the combustion devices, and an air intake system that is triggered by the activation of the exhaust hood range of the stove.

The current recommended mechanical ventilation rate is 0.0 cfm for this home during closed building conditions. This is based on the ASHRAE 62.2 standard. ASHRAE 62.2 is a minimum national standard that provides methods for achieving acceptable indoor air quality in typical residences. If you notice an increased moisture build up or a sense of stale air you can run a bathroom fan for a few hours per day.

Conductive Heat Loss

Conductive heat loss is the heat transfer through a solid barrier. These barriers include but are not limited to foundation walls, living space walls, roofs, and windows. If insulation is poorly air sealed the conductive heat retention of insulation is severely impaired. High conductive heat loss contributes to ice dams as well. R-value is used to measure the capacity of a material, such as insulation, to impede heat flow, with increasing values indicating a greater capacity. R-value = resistance value. A 4% gap in your insulation decrease the R-value by 9 points.

Attic

The greatest conductive heat loss is in the attic. Since heat rises the attic is the most important thermal boundary for a home. The target is an R-49 of properly air sealed insulation for flat ceiling attics, R-38 for vaulted ceilings, and R-30 for sloped side walls ending in flat ceilings. Not only will properly insulating your attic keep your home warmer in the winter it will keep the home much cooler in the summer.

This home has an estimated R-value of 9 in the attic and 6 in the sloped ceiling cavities excluding the kitchen room. That room has an estimated R-value of 13 in the slopes. Removing the fiberglass in the sloped rafter bays and installing dense pack cellulose along with installing another 13" of cellulose in the attic flat areas should increase the efficiency of the home by at least 20%. The resulting R-values will be 53 in the attic flat and 20 in the upgraded slope ceiling areas.

Walls

Walls can be responsible for high conductive heat loss. The infrared imaging of the walls shows that there is below average insulation in the walls. Removing the insulation and dense packing the walls with cellulose will improve the efficiency by an estimated 9%. The R-value will increase from 6 to 20.

Windows

Your windows do not need to be upgraded but the skylights could use inside storms and/or insulated blinds. The current R-value of the skylights is an estimated 2.5. An inside storm positioned 3" away from the glass of the skylight will increase the R-value of the window by 400%. Adding an insulated blind on a track will add another R-8 to the skylight efficiency. If combined, both upgrades will increase the skylight R-value to an estimated 18. This calculation can be used for windows as well.

Basement

The basement walls and rim joist pockets account for at least 5% of your efficiency loss. There is quite a bit of heat generated by the heating system and without proper air sealing and insulation that heat is going outside rather than up into your home. Also, as the heated air in homes rises and leaks out of the home it pulls cold air in to replace it. Properly improving the thermal efficiency of the basement walls will decrease the infiltration of cold air into your home. I recommend adding 3" closed cell foam to the rim joist pockets and walls to a depth of 2' feet below grade. The resulting R-value will be 21 for the rim joist pockets and walls.

Reduction of Thermostat Temperatures and Savings

Lowering the temperature of the heated space of a home by 1 degree can save roughly 1.5% of your heating costs. Using programmable thermostats with setbacks can increase the efficiency by at least another 4%.

Heating System

The current boiler has an efficiency rating of 84.8%. By installing an outdoor reset or an optimizer the efficiency of the system should be improved by at least 10%. I have attached heat pump information for your future planning.

Outdoor Reset:

The outdoor reset is a control on the boiler that will sense outside air temperature and readjust the heating system water to a minimum water temperature to satisfy the heat loss of the home. As the outside temperature gets colder the heating water gets hotter and as the outside temperature gets warmer the system water temperature gets cooler. This does two major things for us. One it will save fuel and second it creates more comfort. While running at lower water temperature than we were used to the radiation will feel cooler but the comfort level is increased. We are running cooler water around us for a longer period of time. It becomes almost a trickle of warmth all the time which tries to mimic constant heat.

Optimizer:

An optimizer saves energy by adjusting the burner run pattern to match the system's "heat load." Its action is similar to the industry-accepted method of "outdoor-air temperature reset control," but does not require an outdoor-air temperature sensor or the need to profile the building in order to adjust the "reset" controller properly. *IntelliCon-HW+* determines the "heat load" by using an easily installed strap-on temperature sensor that monitors the boiler's out-flow water temperature and the rate that this temperature is changing.

Domestic Hot Water System

You have a tankless coil domestic hot water system. With this kind of system the boiler has to fire up to heat the hot water that is used in the home. There is a small reserve of hot water in a tank but it is not enough to handle the demands of washing dishes, clothes, or bathing. This is the most inefficient method of heating hot water.

There are other domestic hot water heating solutions including the installation of a heat pump system. Alternative systems will keep your boiler from being the heat source for your hot water. Heat pumps remove the heat from the surrounding air by using an air pump that operates on a small amount of electricity. Not only are they a very efficient way to heat your hot water they also dehumidify the air that is around them. Switching from your current domestic hot water system to one of these systems should increase your efficiency by 10% or more.