# Improving Indoor Air Quality, Saving Energy & Reducing Your Carbon Footprint

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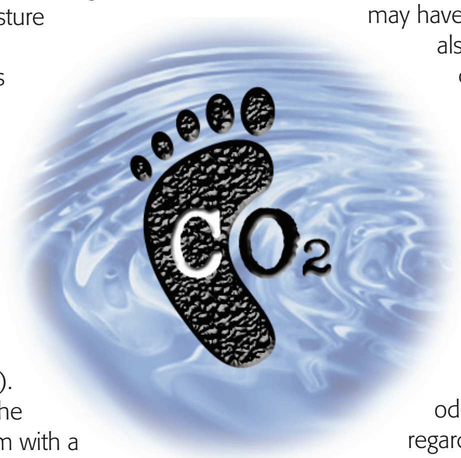
## 1.0 OVERVIEW

As you read this, it has been cold and windy in many areas of the USA. Given the current escalation in fossil fuel costs, and the drive to reduce greenhouse gases, most facility managers are looking for ways to save energy. Given the increased concerns for global warming, in this article we'll focus on reducing heating costs while still maintaining good IAQ/moisture control, and mention some of the impacts heating changes may have on carbon dioxide emissions, one of the greenhouse gases that appears to be a concern.




To provide an environment to enhance productivity or improve learning, a building must be reasonably warm when it is cold outside in the morning, must provide adequate ventilation, and must not blow cold air onto the occupants (create cold drafts). This may sound easy, but when it is 11 a.m., the sun is shining in on a southeast exposure room with a window wall, and a room with the northwest exposure is on the same ventilation and heating system, this can be a real challenge.

The ultimate goals are energy efficiency, good indoor air quality and good occupant comfort/productivity. Additionally, minimizing our carbon dioxide footprint or being carbon neutral is a sound environmental goal.

## 2.0 IMPORTANT QUESTIONS TO ASK WHEN TRYING TO IMPROVE HEATING ENERGY EFFICIENCY

### *1. Are heating and cooling/ventilation systems fighting each other?*

Are some areas overheating? Attempting to heat and cool the same air can be very expensive. Occasionally this is done to dry air, but there are better ways to do that with a commercial dehumidifier or by balancing makeup with exhaust. From a practical perspective, in the swing seasons or in winter, it is important to make sure the heating systems (modulating gas furnaces, modulating heating coils, radiant floors & boilers) are only providing heat when and where it is needed. An inexpensive infrared thermometer can help you figure this out quickly. Leaving a data logger in questionable areas to monitor temperature and relative humidity can quickly answer questions.

In older buildings where the windows and roofs have been upgraded, overheating rooms can be a big challenge for the facility and maintenance folks. Often adding insulation to pipes that don't have it is all that is needed. So long as there are years of future operation left in the piping system, adding heating coils (glycol should be considered) to ventilation systems on northern exposure room wings can also help, or adding additional heating control valves may be a good answer. In general any un-insulated heating pipes in an insulated building leads to lots of overheating problems.

One location where you need to be a bit careful about insulating heating pipes is crawlspaces. In some cases the heat loss may have been keeping the crawlspace dry for years, also keeping mold from growing or wood from decaying. There are likely better means of keeping the crawlspace dry, so certainly consider insulating any heating pipes, but also figure out how to keep the crawlspace from becoming a mold factory if you remove the historic drying mechanism (heat).

We have found that using sub-membrane exhaust systems in crawlspaces (radon removal technology) is very effective in assisting to keep them dry and stopping soil gas odors. There is lots of information now available regarding keeping crawlspaces sealed up, warm and dry year-round, vs. vented, damp and cold.

Air sealing the building envelope is a really important step, and adding insulation to buildings or pipes is also a great way to reduce emissions and your carbon footprint.

When buildings rely on economizer cooling, it is important to have a light colored roof to assist with effective economizer cooling and reducing microclimate effects on the roof.

### *2. Are the rooms with vending machines on the north side of the building?*

Vending machines, even with vend misers installed, give off lots of heat. Placement in a normally cool area is better than one where there is too much heat already.

### *3. Do the roof/wall joints, windows or air intakes leak lots of air at night?*

As noted above, and this is very important, likely more important than the amount of insulation in many facilities. Uncontrolled air leakage during unoccupied hours is a major source of wasted heat energy in any building, old or new. The National Institute of Science and Technology has released a report (rpt. #7238, 2005) showing that tight buildings would save, on average, 60 percent on heating and 25 percent on electricity. Snug fitting windows, doors, and dampers are always an important part of the equation, especially when it is below freezing. One roof penetration the size of your wrist can hinder attic insulation efforts.

Almost all flat roofs leak air where they join the top of the wall unless they have been sealed up with expanding foam. As a retrofit, one can often push the insulation in the joint inward, and

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***CARBON FOOTPRINT*** *(Continued from page 1.)*

use expanding fireblock foam to seal up the gap. The good re-usable foam gun should cost $30-50 and the foam is about $20 for a large screw on canister. This type of system is much more controllable than hardware store aerosol can squirt foam. There's not a lot of benefit to anyone to heat and cool the outdoors.

### 4. Are exhaust fans or ventilation systems running when not needed?

Most ventilation systems that move air out of or into a building need only run when the building is occupied. Further, they likely do not need to run at full speed unless the full occupancy is present. This can be a tricky topic, but more and more, folks are using demand-controlled ventilation to reduce over-ventilation and excess dryness in the winter or excess humidity in the summer. These control strategies can either reduce outdoor air damper openings on constant volume systems, or control variable speed drives on VAV systems. If carbon dioxide levels are only in the range of 600 PPM in an occupied building by 11 a.m. during very cold weather, the building is likely getting way too much outdoor air, and/or is likely to have severe air leakage problems that can be found with a few hours of infrared thermography. Areas with high quantities of make-up air should be evaluated for any recent change of use that would lower ventilation needs, and long-term energy recovery opportunities. Moving outdoor air through a building is likely worth about $6 to $7 a year per CFM depending on your location and hours of operation. Reducing over-ventilation is a great way to reduce one's carbon footprint.

### 5. Can you eliminate odors?

Odors need to be found and eliminated. Diluting them is a poor way of controlling sources and wastes energy. Wet moldy areas should be removed under containment in accordance with US EPA Guidelines, and rebuilt to keep them clean and dry. Spot odor-makers, such as high use copiers or laminators, should be isolated and locally exhausted; distributing their fumes to the occupants makes no sense.

### 6. Are control systems working as intended?

Are air filters and belts being maintained? Nighttime operation usually has a very different objective than the occupied mode. Running systems in the occupied mode for 24 hours because the controls are not operating correctly, or because the building shell is leaky and perimeter areas get cold, usually wastes lots of heating and electrical energy. Motors running with loose belts provide poor heating air distribution, and poor or missing air filters (less than MERV 7) mean that the owner will unnecessarily be paying for expensive coil and duct cleaning.

### 7. What does the thermal envelope look like with an infrared scan?

This is a critical step when it comes to finding heat loss. In any size building, the most effective means of quickly finding the building envelope air leakage holes (that cost lots of completely wasted energy use at night during cold weather when the wind is blowing) is with an infrared camera and operator. For likely $2,500 or less on a heating season night, the owner can very quickly locate (and record digitally) the air/heat leakage holes, and any poorly insulated walls to prioritize "draft stopping". Uncontrolled air leakage often accounts for huge extra costs in heating energy in the winter, causes freeze ups, contributes to dryness problems, and wastes significant electrical energy running pumps that move hot water, all likely contributing to a larger carbon footprint.
(See #3 for more info on sealing air leakage sites.)

### 8. How inefficient is the combustion in the furnace or boiler for heating?

Inefficient combustion equipment needs to be scheduled for eventual replacement. If the building has been insulated since it was built, or windows improved, a qualified professional should be engaged to look at electric savings from installing variable frequency drives on heating pumps and/or on fans. Reducing most pump and fan flows by only 20 percent often reduces the electric consumption by 50 percent. Many utilities will help to cover VFD costs. A large building might easily save $10,000 per year in electrical costs.

With the current costs of liquid and gaseous fuels, many heating system improvements may take only three to five years to begin to result in long-term annual savings.

### 9. Should you be exploring alternative systems and fuels?

Is it time to think about geothermal heat pump heating and cooling? Yes, if investing in future insulation from fossil fuel costs is considered worthwhile. In some limited areas of the USA, high efficiency wood fired heating or other biomass fuels may make sense. Many consider wood carbon neutral since it carbon was derived from recent photosynthesis. However, wood combustion produces about twice the amount of carbon dioxide per BTU as most liquid or gaseous fuels. In most facilities, use of geothermal heat pumps may make sense alone or combining them with thermal solar. We have developed a hybrid system we call E-MAX GEOTHERMAL that uses solar and geothermal integrated for maximum heating efficiency with often a 10-year simple payback in new construction. This system drastically reduces carbon dioxide emissions.

### 10. Conclusion:

In many cases it also makes sense to look at the building shell and ventilation systems in considering fuel switching or geothermal retrofits. Reducing the capital costs of new equipment by reducing the load of the building almost always makes long-term economic sense.

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