

Ten Ways to Reduce the Greenhouse Energy Bill

A.J. Both
Assistant Extension Specialist
Rutgers University
Bioresource Engineering
Dept. of Plant Biology and Pathology
20 Ag Extension Way
New Brunswick, NJ 08901
both@aesop.rutgers.edu
<http://aesop.rutgers.edu/~horteng>

Introduction

Unfortunately, as we near the end of 2006, the greenhouse industry is faced with high fuel prices and the general consensus is that prices will remain high for the foreseeable future. In addition, the situation may get worse depending on weather conditions during the upcoming heating season. Thus, growers should not only focus on quick fixes, but also on long-term improvements. Shortly after the last energy crisis in the early seventies, many research projects were undertaken to study energy saving technologies for commercial greenhouse production. Many different ideas were investigated and described in various publications. However, due to the relatively cheap energy prices during the eighties and nineties, many energy saving technologies were eventually abandoned. Nevertheless, the ideas that were developed in the seventies combined with recent technology developments can be used to help reduce our energy consumption in the early 21st century. The following list of ten different approaches, in no particular order, may give some ideas for where to start.

1. Install Energy Curtains

Energy curtains are relatively easy to install, especially in newer gutter-

connected greenhouses that have sufficient space for curtains between the trusses and the gutters. A properly installed curtain system can save a significant amount of energy. With the current fuel prices, these systems will pay for themselves in a short time period (generally 2-3 years). An added advantage is that curtain systems can also be used as shade devices during periods of the day with high solar radiation. For even greater energy saving, two curtains can be installed: one for maximum energy saving and another for shading. One potential problem with trying to close the greenhouse for maximum energy saving is that the relative humidity can increase because the air exchange rate (leakage) is usually significantly reduced. Thus, growers should pay attention to their humidity control strategy and make changes where appropriate. In addition, growers should be careful when opening an energy curtain early in the morning. At that time, the air volume above the curtain is still cold and could cause problems when it falls down onto the crop underneath (cold air is heavier, or more dense, than warm air). Therefore, growers usually open curtains in small increments in the morning to allow the colder air mass above the curtain to heat up. Growers are advised to consult with curtain manufacturers/installers to investigate alternative installations in older greenhouses. For example, in some of these greenhouses the curtains could be installed parallel and closer to the glazing. In that case, special supports have to be used to support overhead heating pipes and supplemental light fixtures, etc. Or external curtains can be installed. Depending on the type of curtain material, these external curtains can also help reduce radiation losses from the greenhouse to a cold night sky.

2. Reduce Air Leakage from the Greenhouse

Depending on temperature differences between inside and outside air, and wind speed and direction, air will move through cracks or other openings either into or out of the greenhouse. Therefore, it is important to close these openings to prevent this unwanted movement of air (and thus potential energy loss). Such unintentional openings are often found around doors and windows, and where the glazing attaches to the greenhouse frame. In addition, it helps to insulate openings that are temporary out of use (e.g., ventilation fans that are turned off or ventilation windows that remain closed during the winter season). Over time it is not uncommon for louvers on ventilation openings or for ventilation windows to only partially close (e.g., when parts are bent or warped). Therefore, it is important to make sure that these systems close properly and tightly in order to minimize unwanted air movement between the inside and outside of the greenhouse.

3. Provide Heat Only Where it is Needed

Bench and floor heating systems provide heat close to where the crop is grown. The clear advantage is that less energy is needed to heat the rest of the greenhouse air volume. Many growers that use bench or floor heating systems report that they are able to successfully grow a crop while maintaining a lower air temperature (resulting in energy savings). However, this practice should be carefully evaluated since lower temperatures generally reduce plant growth and development rates. The installation of circulation fans (HAF: horizontal airflow fans) inside the greenhouse will help provide uniform temperatures throughout the growing areas.

4. Install an Energy Efficient Heating System

It is recommended to install the highest efficiency units one can afford (these are generally more expensive to buy, but save in operating cost by reducing fuel consumption). In addition, try to use so-called separated combustion units that use outdoor air for the combustion process and return this air to the outside without it making contact with any indoor greenhouse air. Using separated combustion units ensures that combustion gasses will not contaminate the greenhouse air (some by-products, e.g., ethylene, are known to cause plant stress). Some growers have opted to install dual fuel systems (that can burn two different fuels), which allow switching between fuel sources when one of the fuels becomes more expensive or is not easily available.

5. Regularly Calibrate Temperature Sensors

It is important to regularly calibrate temperature sensors. Every environment control system responds based on temperature readings and if the sensor provides incorrect measurements, the control system will not be able to provide the intended temperature set points. In addition to potentially increasing energy consumption, plant growth can be negatively affected. Some growers have decided to lower their temperature set points in order to save energy. However, one should be cautious because lower temperatures reduce plant growth rates, and can increase insect and disease problems when plants are grown under sub-optimum conditions.

6. (Perimeter) Insulation

The installation of perimeter insulation (e.g., 2 inch polystyrene board installed

vertically around the entire perimeter to a depth of two feet) will reduce the heat loss through the greenhouse floor to the ground directly surrounding the greenhouse. Usually, the heat loss to the ground underneath the greenhouse floor is relatively small, but if the water table underneath the greenhouse is high (less than 6 feet below the floor), it may be worthwhile to install insulation (e.g., 2-inch polystyrene board) underneath the entire floor. And for opaque sidewalls and doors, use insulation material with the highest possible R-value.

7. Use a Double Layer Glazing System

Over a typical heating season, double poly or even double glass will reduce the heat loss by approximately 50% compared to a single layer of glazing material. However, most glass-clad greenhouses are constructed with a single layer of glass. In those cases, installing an energy curtain can significantly reduce heating costs. Sometimes, especially in the colder regions of the country, growers install a temporary layer of (inflated) plastic film over the single layer of glass during the heating season to reduce the heat loss through the roof.

8. Install Windbreaks

In areas with high wind speeds, especially during the heating season, it is recommended to install windbreaks (shrubs and trees) around the entire greenhouse or at least in the upwind direction from the prevailing wind. However, these windbreaks should not reduce the amount of light entering the greenhouse (especially during the

wintertime) and should be designed so that snowdrifts do not accumulate against the greenhouse.

9. Use the Cheapest Fuel

It is not always easy to determine which is the cheapest fuel (prices fluctuate depending on many different factors), but one should be able to get a good idea by talking to other growers and local fuel suppliers. As discussed earlier, dual fuel or even triple fuel systems allow one to switch fuels depending on availability and price. This flexibility has the potential of realizing significant cost savings. Initial installation, however, will be somewhat more expensive. Growers using natural gas can in many cases negotiate usage charges when contracting with their supplier of choice. Some growers using fuel oil have installed storage capacity allowing them to buy in bulk when prices are low (e.g., outside the heating season).

10. Alternative Energy Sources

It is a good idea to investigate alternative energy sources (biomass, wind, water, solar, etc.). Financial incentive programs may be available to help with the installation costs. In some cases, recent technological developments have resulted in significant improvements in conversion efficiencies. Co-generation units (producing both electricity and heat) can be an attractive alternative making growers less dependent on local power companies, and boosting the overall conversion efficiency of the fuel source used. In some areas it is possible to sell any excess electricity back to the local utility, generating additional revenue.