The Argus Advisor

March 2001

Environmental Control Systems

An environmental control system can provide substantial paybacks in both energy conservation and improved crop quality and yield. In almost any greenhouse, best performance will be achieved by looking at all aspects of your operation and selecting the best combination of improvements or managment changes that can be achieved within your capital budgets and expected payback time.

Energy Conservation Tips

*(start preparing **now** for the next heating season)*

A great deal of research and development into energy conservation techniques for greenhouses took place in the late 1970's and early 1980's. This was in response to rising energy prices at the time. Most of this information is still relevant today, and many of the concepts such as thermal curtains and double glazed sidewalls have been adopted as standard practice. Some of the publications of that era can still be obtained, but many are out of print. See the end of this document for more information.

Unfortunately, there are no magic answers. Greenhouses need lots of light transmission, and they accomplish this at the cost of thermal efficiency.

Ways to Conserve Energy in Winter

For greenhouses, energy conservation in winter can be achieved in three ways:

1. **Reduce heat loss.**

   This usually involves design modifications to the building envelope and the use of retractable thermal/shade curtain systems. Various steps can be taken to reduce the amount of heat loss due to radiation, conduction, and convection.

2. **Improve the efficiency of heat conversion from energy sources and improve management of heat distribution.**

   This usually involves using improved heating equipment and heat distribution systems coupled with environmental control systems that measure the controlled climate and external conditions with great accuracy, and then deliver a precise amount of heat to meet the current demand.

3. **Increase yields and quality with better climate control, improved varieties, better space utilization, irrigation, and crop management.**

Growers must address all of these issues when developing an energy conservation plan. Often there are tradeoffs. For example, if you were to focus solely on reducing energy costs you could drastically lower your setpoints and keep the thermal curtains pulled most of the time. Unfortunately, you probably would not produce a saleable crop for your efforts. The secret to successful crop production is discovering the fine balance between minimizing inputs, and maximizing output in a manner that is economically workable. This is seldom easy.

Energy Conservation Tips

Before attempting any major climate changes you should first check with your local horticulturists or crop advisory services to determine whether a new strategy is practical for your particular crops.

1 **Don't just turn down the heat.**

Most crops will survive cooler average temperatures, but they may not thrive. Recommended growing temperatures have been established for most horticultural crops after many years of trials and experimentation. They are often the minimum recommended temperatures, so lowering the average daily temperatures or average weekly temperatures may have drastic effects upon crop timing and quality. Check with your local extension agencies, your seed and cuttings sources, and your horticultural advisors before attempting to grow at lower temperatures than are recommended.

2 **Make sure that all controlled equipment is operating normally and has been properly interfaced to the control system.**

3 **Ensure that all sensors are working properly, and that they are properly positioned.**

Aspirated temperature and humidity sensors should be placed in or just above the cropping canopy.

4 **Provide good internal air circulation (use HAF fans).**

5 **Confirm that the climate setpoints match the true requirements of the crop.**

6 **Make sure you provide an adequate deadband between heating and cooling setpoints (usually at least 2°C).**

While the control system may be capable of maintaining a very precise climate temperature, it may do so at the expense of energy conservation, by using both the heating and ventilation equipment to achieve these tight tolerances. Furthermore, most crops are not as particular about the instantaneous climate temperatures provided they are within a wider band of crop tolerance and are not changing too rapidly. Generally, the average light levels and temperatures determine the growth rate and crop quality provided damaging temperature extremes are avoided.

7 **Make full and regular use of the data recording, monitoring, and alarm functions of your control system.**

Review the recorded climate and equipment operation data regularly to spot performance problems.

8 **Use split day/night temperatures (cooler nights) if your crop will tolerate it.**

Use your control system to provide smooth ramping between temperature setpoints. This reduces plant stress and humidity problems.

Your Greenhouse is a Heat Sink

Remember that your greenhouse is a heat sink with some thermal lag. Whether or not you use the soil for cropping, the large thermal mass under the greenhouse acts as a moderator whenever you try to create short-term air temperature changes. For example, if you set a very low air temperature at night, heat will be extracted from the (warmer) ground. This cooled soil will then absorb a considerable amount of your daytime heating energy when you attempt to run higher air temperatures.

This is not to say that reducing the air temperature whenever possible is pointless, but you may not save as much on heating costs as it would first appear. Likewise, if you shut a greenhouse down during an idle period allowing it to cool or even freeze, expect to pay a lot to restore the soil temperature when you start to heat again.

There are two management considersations:

1. Take advantage of the heat storage capacity of the soil to help smooth out temperature fluctuations and to store as much solar energy during the day for use at night.
2. Thermally isolate the soil from your greenhouse environment by using insulation, plastic sheeting, benching systems, etc.

Energy Conservation Tips *(continued)*

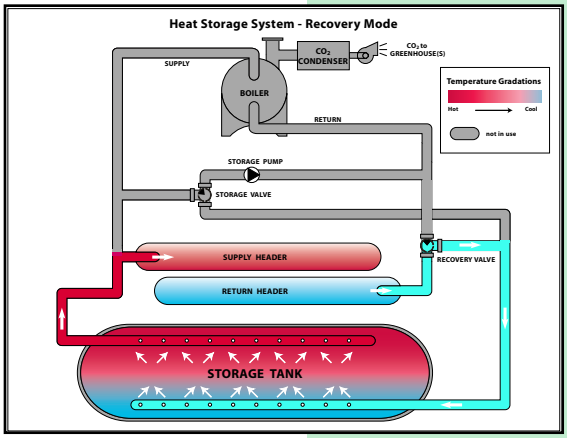
9 Monitor and manage the amount of energy used for humidification.

While heating and venting for humidity control are key requirements for maintaining crop quality and controlling disease in many locations, excessive ventilation can be very costly. With precision measurement and good internal air circulation, you may be able to manage slightly higher humidity levels without problems. Be very careful when using minimum crack settings for vents. This is a control override. It's usually better to allow the control system to manage the ventilation requirements in a responsive manner rather than jamming a vent open!

10 For crops where there is a proven benefit, use CO_2 to improve your yields without added heating.

11 Store heat produced during daytime CO_2 enrichment, and use it to heat the greenhouse during the night.

For more information on the construction and control of heat storage and recovery systems, contact Argus.



12 In the winter, allow the cooling ventilation setpoint to rise a few degrees with increased light levels.

On sunny, cold days, the plants may well assimilate more light at these warmer temperatures, and the heat at this time is free if it can be provided by the sun. In addition, some heat will be stored in the soil.

13 Monitor and record the average daily temperature.

On dull days, there is not much light energy for plants to assimilate, so you may be able to adjust your heating setpoints downward without affecting crop quality or timing. Similarly, by allowing slightly higher average daily temperatures on sunny days, you can achieve higher assimilation rates while letting the sun provide some or all of the additional heat. This can be accomplished automatically through the careful use of light-moderated heating and cooling setpoints.

14 Use the sun.

If you run cooler night than day temperatures and its going to be a sunny day, you might want to let the sun contribute to your daytime heating lift. Try delaying the switch to use the daytime setpoint, or use a light-based setpoint modifier.

15 Heat for the available light.

For some crops there may be no point in running high day temperatures when there is only marginal potential for photosynthesis. On particularly dull, cold days, some growers will even leave their curtains pulled and just run their supplemental lights underneath at a lower heating setpoint.

What is Heat Storage?

"If you supplement the greenhouse environment with carbon dioxide obtained from condensed boiler flue gases, consider a heat storage and recovery system. Usually carbon dioxide is required in the daytime when combustion heat may not be needed. Heat storage systems store this heat in a hot water reservoir for later use during the evening. The result is either free heat or free carbon dioxide, depending how you look at it.

An integrated control system can manage the somewhat complex operation of the heat storage and recovery system as well as carbon dioxide extraction and dosing."

From the article "Beyond Temperature Control" by Argus Control Systems that appeared in the March 2001 issue of GM PRO magazine.

Further Reading

An excellent summary of energy conservation options entitled Energy Conservation for Commercial Greenhouses is available from the NRAES (Northeast Regional Agricultural Engineering Service). Ordering information is available on the Internet at **http://www.NRAES.irg/publications/NRAES3.html**, or you contact the NRAES as follows:

mail: NRAES
152 Riley-Robb Hall
Ithaca, NY 14853-5701

sales: +1 (607) 255-7654

e-mail: NRAES@cornell.edu

Planning to Retrofit or Expand?

We invite you to contact us before you make any significant investments in modifications to your facility or equipment. Argus has many years of experience in all aspects of greenhouse construction and associated equipment systems, and we'd be happy to discuss your plans and provide advice on any control issues that may arise. Argus' team of greenhouse managers, horticulturists, applications engineers, software programmers, and hardware systems specialists are here to provide you with the knowledge you need to succeed. You can find more information on this topic and related control issues at our web site, **http://www.arguscontrols.com**.

Argus Contact Information:

mail: Argus Control Systems Ltd.
1281 Johnston Rd.
White Rock, BC V4B 3Y9

sales: +1 (800)667-2090 (toll-free in North America) or + 1 (604) 538-3531

service: +1 (888) 667-2091 (toll-free in North America) or +1 (604) 536-9100

fax: +1 (604) 538-4728

e-mail: argus@arguscontrols.com

ARGUS CONTROLS

The Argus Advisor

Advisor is printed in Canada by
Argus Control Systems Ltd.

Comments are welcome.