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As sustainable practices gain steam in the green industry, greenhouse manufacturers are also contributing to the green design movement by making their structures more energy- and cost-efficient for growers.

Putting the 'GREEN' in Greenhouse

by Jason Bramwell

One of the hottest buzz words circulating throughout the green industry is "sustainability," defined by the EPA as "meeting the needs of the present without compromising the ability of future generations to meet their own needs." Sustainable — or "green" — practices are being implemented more by the industry, such as using integrated pest management programs instead of conventional insecticides, building more efficient engines for heavy equipment to reduce emissions and designing landscapes that protect and preserve natural resources.

Greenhouse manufacturers are taking notice of the green movement by designing structures that are more productive and energy-conscious for the nursery professional.

"There certainly are more questions being asked by the customer, particularly around the subject of energy conservation," says Craig Humphrey, vice president of engineering for Nexus Corp., Northglenn, CO. "We are selling a higher percentage of naturally ventilated houses with the Nexus Atrium roof vents. This is due to the energy savings in conjunction with the improved plant growing associated with these houses. There are less materials used, such as electrical wiring, conduit and other installation materials, to go along with the obvious advantage of using less electricity with atrium vents versus fans. When pad systems are used in conjunction with fans, you also have the additional waste of water that isn't required with natural ventilation."

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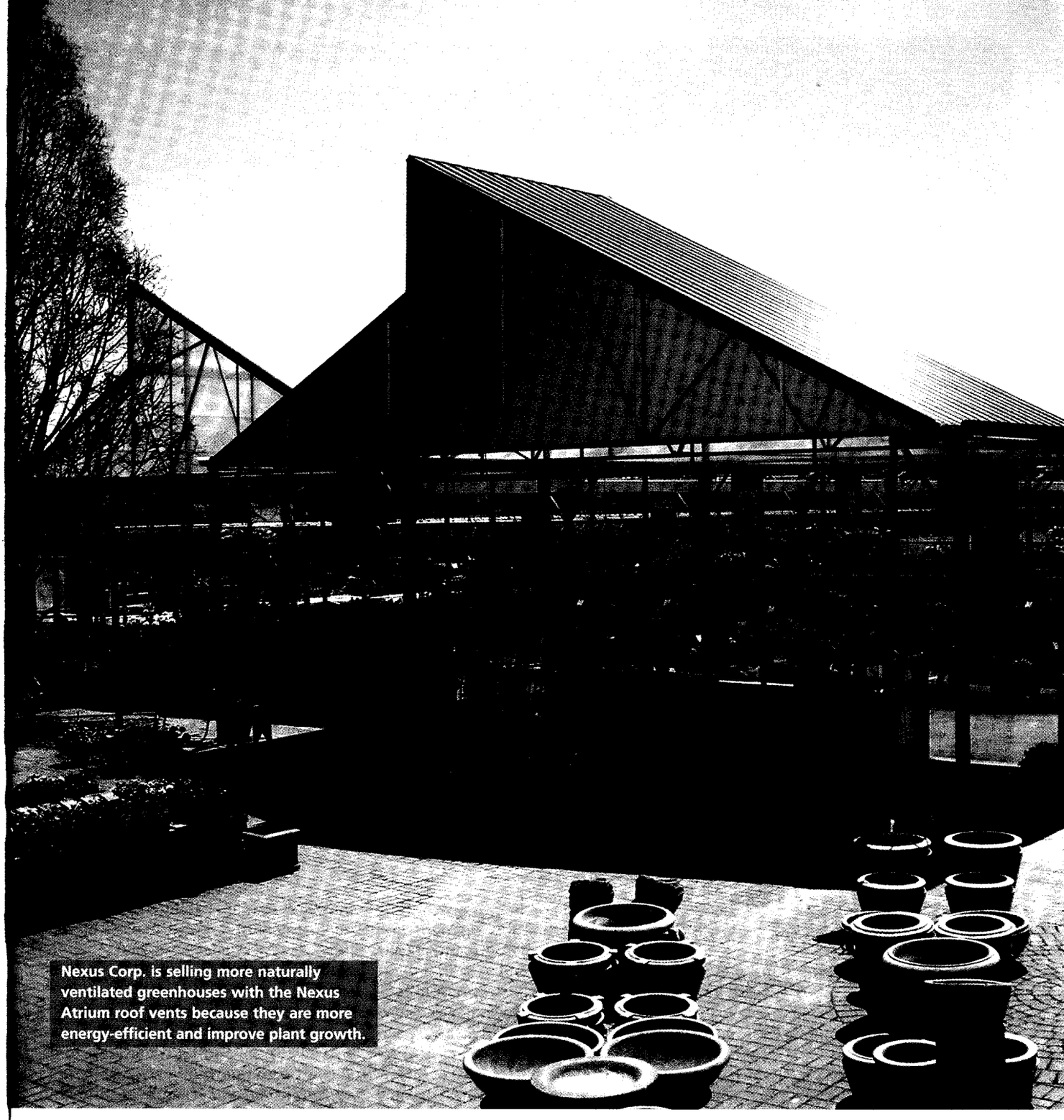

Nexus Corp. is selling more naturally ventilated greenhouses with the Nexus Atrium roof vents because they are more energy-efficient and improve plant growth.

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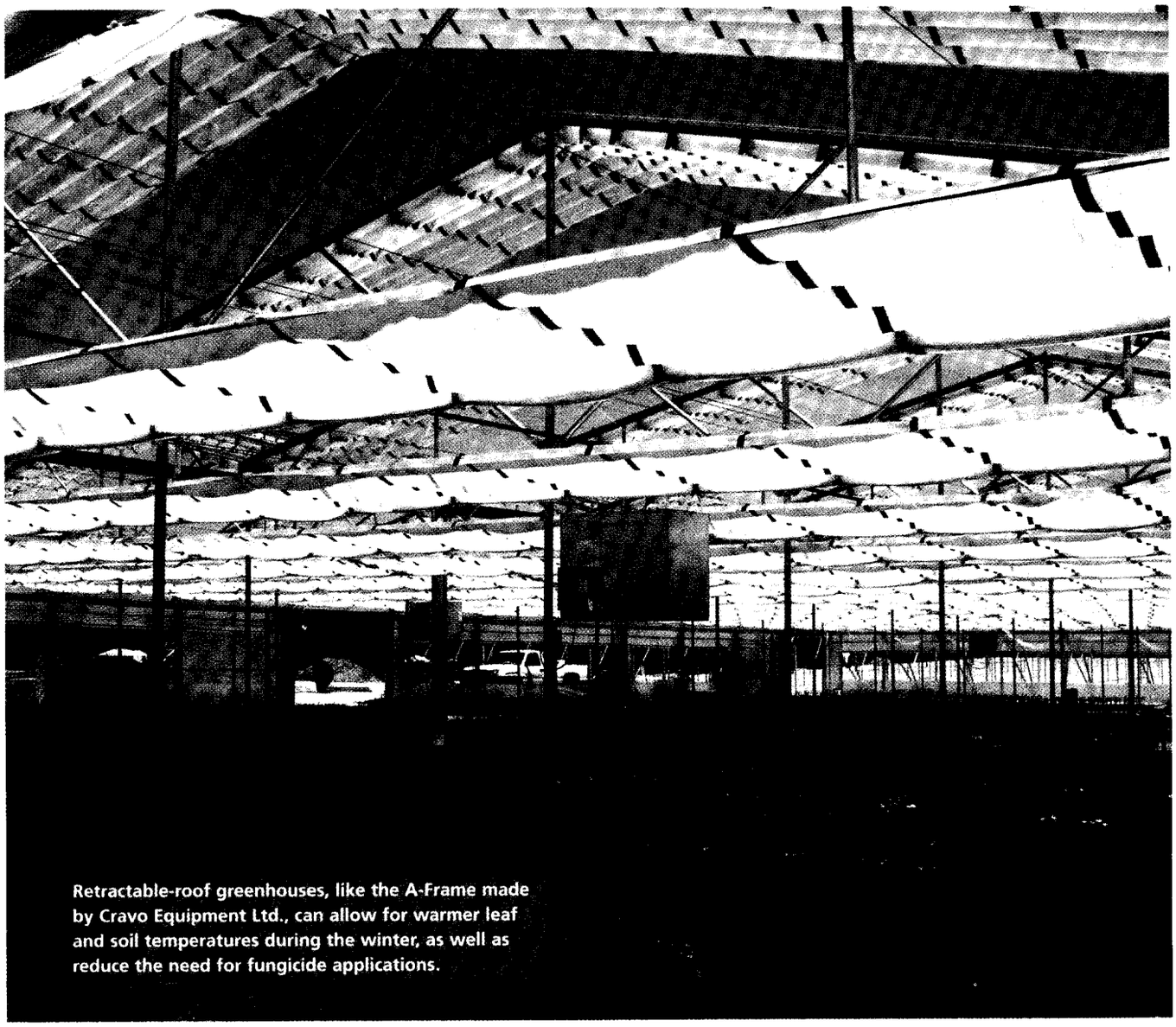
The type of greenhouse covering has a large impact on heat loss. According to research conducted by the Mississippi State University (MSU) Extension Service, Starkville, single-layered glass loses almost twice the heat because of conduction and radiation as a double layer of polyethylene film. A single layer of polyethylene film over glass reduces heat loss by almost 25 percent compared to single-layered glass alone.

Humphrey says coverings are a big factor when purchasing a greenhouse.

"The design of a good greenhouse should incorporate an ability to be able to change coverings in the future to a more energy-efficient covering — one that may not even exist today," he adds. "Energy efficiency can be measured in heat savings with some of the more insulative, multi-walled sheets, but also in the reduction of heat gained by reflecting it back out of the greenhouse, therefore reducing the amount of cooling that is required. Retrofitting existing structures is another sales opportunity as more owners are looking at upgrading their structures to reduce their energy costs."

Barry Goldsher, president of Engineering Services & Products Co., South Windsor, CT, believes the introduction of the energy screen, an insulating curtain that can be drawn over plants, is the No. 1 improvement for energy conservation in greenhouses. But, he adds, not enough strides have been made by the greenhouse industry as a whole to conserve energy.

"As a country, we haven't done enough.



Retractable-roof greenhouses, like the A-Frame made by Cravo Equipment Ltd., can allow for warmer leaf and soil temperatures during the winter, as well as reduce the need for fungicide applications.

There is not enough solar energy. Payback has been too slow," Goldsher says.

What options are available? According to a September 2003 report conducted by the Minnesota Department of Commerce Energy Office titled, "Energy Conservation Opportunities for Greenhouse Structures," the top low-cost, high-impact strategies for reducing heating energy and costs include:

- energy-efficient heating systems — unit heating systems with power-vented exhaust as opposed to atmospherically vented systems, which stop airflow through the flue when the unit is not operating;
- insulation on walls — insulation added to the north and east walls during the winter months reduces heat loss and has a minimal impact on solar heat gain and transmission;
- infrared anti-condensate (IRAC) covering — a layer of IRAC film installed on the inside layer of the two-ply covering reduces radiation during nighttime hours and heat loss from warm objects in the greenhouse; and
- night setback temperature controls — if plants can accommodate reduced temperatures during nighttime periods, significant energy and cost savings can be achieved.

Sylvia Courtney, south central regional sales manager for Ludy Greenhouse Manufacturing Corp., New Madison, OH, believes the cost of a greenhouse with a forced-air ventilation system and the cost of a naturally ventilated greenhouse with an energy curtain are about the same, but the operating costs are much lower for a naturally ventilated greenhouse. Courtney says growers in the South have been more concerned about cooling the greenhouse than heating the structure.

"With the increase in fuel costs, more growers are receptive to using one layer of infrared radiation film when using double poly, and they are willing to consider 8-millimeter polycarbonate in place of corrugated polycarbonate," she says.

Humphrey says shade/heat-retention systems are being installed more to gain increased insulative value in reducing the heat requirements.

"One system may have a clearer cloth and be pulled during the growing hours to conserve heat and still provide enough light to grow the plants," he states. "[Nexus] structures have to have enough room designed into them for our dual-curtain systems, either at initial installation or for the future."

Richard Vollebregt, president of Cravo Equipment Ltd., Brantford, Ontario, says retractable-roof structures have become more valuable as fuel prices increase.

"Because growers can retract the roof, they can let the sun shine directly on the soil, which warms up the soil as opposed to the air. The problem with conventional greenhouses that are always closed is

PHOTOS COURTESY OF CRAVO EQUIPMENT LTD.; COURTESY OF ENGINEERING SERVICES & PRODUCTS CO.

'The ability to open and close the roof to take advantage of the natural outdoor environment and the natural greenhouse environment is the best way to prevent plants from becoming exposed to fungi and plant stretch.'

when the sun is shining, the roof covering will stop a lot of the infrared radiation and convert it into convective heat or hot air," he says. "So what ends up happening is when it's sunny out, you end up with warmer air temperatures and cooler leaves and soil temperatures. In the winter, you want warmer leaf and soil temperatures. You have to take the roof away to let the sun shine on the plants and the soil."

Vollebregt adds that retractable-roof greenhouses can help reduce the use of fungicides.

"The best preventive to using fungicides is letting the sun shine on the leaves to dry them off," he says. "So for professionals who are trying to reduce the use of plant growth regulators and fungicides, the ability to open and close the roof to take advantage of the natural outdoor environment and the natural greenhouse environment is the best way to prevent plants from becoming exposed to fungi and plant stretch."

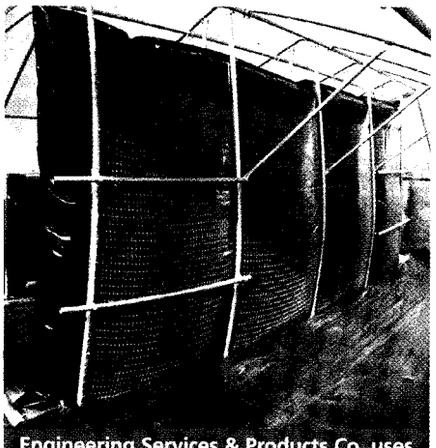
Engineering Services & Products is developing a low-cost roof vent specifically for the agriculture sector of the industry, according to Goldsher. The goal of the roof vent is to conserve energy by ventilating the greenhouse in the summer without using fans.

"What some of our clients have struggled with is ventilation in the summer, and they have tried mechanical vents, but they are not strong enough to be able to withstand the wind," Goldsher says. "The new roof vent will give them a more effective growing environment in the summer.

"The other thing that we've felt in the past few years hasn't really taken off is using thermal mass in the greenhouse to store heat," he adds. "There haven't been a lot of growers who have taken hold of that technology, but more and more will. We've developed a black water bag that attracts and absorbs the heat so the water inside gets warm during the day, stays warm and radiates the heat during the night. Except for the investment in the water bag, it's free heat."

Humphrey says an important issue not often addressed by some greenhouse manufacturers is how the structure's load rating was obtained. He states there are code reductions for certain greenhouse coverings that will allow a lesser snowload design based on the covering being used.

"If the owner doesn't realize this, they could be buying a structure that doesn't allow them the chance to go to a more energy-efficient covering in the future. The structure may not be able to support the added snow load created by the increased R-value in the new covering," he adds.



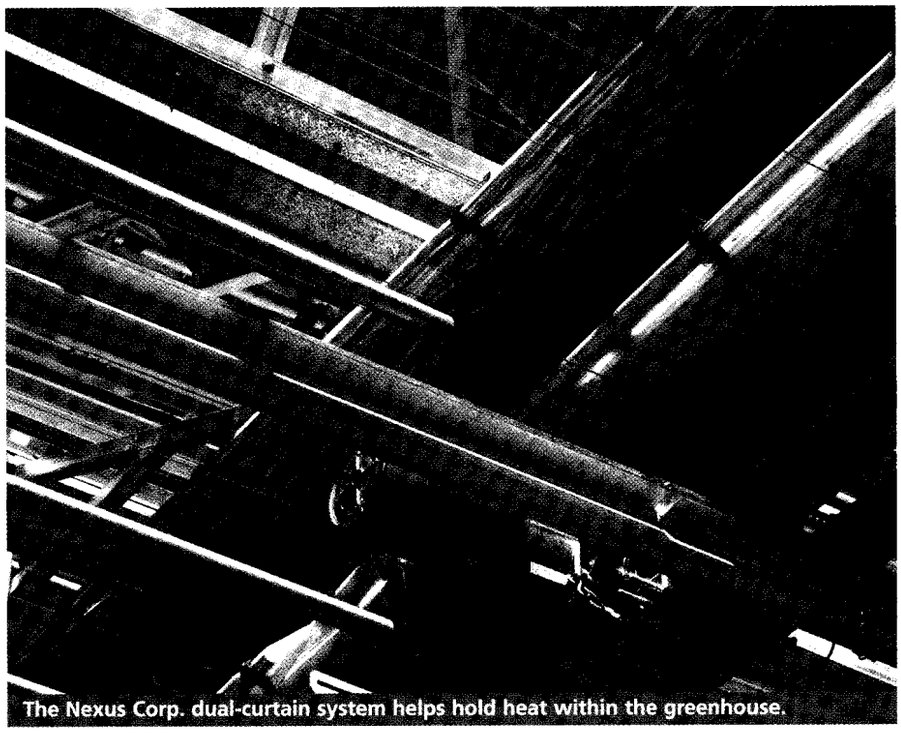
Engineering Services & Products Co. uses thermal mass in its greenhouses to store heat. The company developed black water bags to absorb heat and keep the greenhouse warm during the evening.

PHOTOS COURTESY OF CRAVO EQUIPMENT LTD.; COURTESY OF ENGINEERING SERVICES & PRODUCTS CO.

Payback. In its "Greenhouse Energy Conservation Checklist," researchers from the University of Connecticut, Storrs, state "with typical annual energy usage being 75 percent for heating, 15 percent for electricity and 10 percent for vehicles, efforts and resources should be put where the greatest [energy] savings can be realized."

The research states that using poly with an infrared inhibitor on the inner layer of the greenhouse will result in a 15 percent energy savings, and payback is between two and three years. Adding a single or double layer of plastic over older greenhouses can reduce infiltration and heat loss by 50 percent, according to the report. Installing a thermal blanket can result in a 20 percent to 50 percent energy savings, and payback is between one and two years.

Students at Appalachian State University, Boone, NC, also conducted research in 2007 to determine if greenhouse technologies have the potential to reduce the



The Nexus Corp. dual-curtain system helps hold heat within the greenhouse.

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construction cost of energy-saving solar greenhouses, also called bioshelters, and how long it would take to recoup those costs. They built two 24- by 14-foot bioshelters on a test site located on Watauga River Farms, Valle Crucis, NC, and tested the use of soap foam insulation and the use of subsoil storage to moderate heating and cooling cycles within the bioshelters.

In one bioshelter, liquid soap foam was used at night to reduce heat loss and then transferred to storage tanks during the day. The liquid soap often failed to fill the cavities between the double polyurethane walls. In the second bioshelter, the students captured heat stored in the earth's subsoil and piped the heat into the greenhouse, according to the students' report. The result was increased air and soil temperatures, which more than doubled plant growth. It was estimated the subsoil heat system would pay for itself in two to four years based on the value of the energy it stores and releases.

But when it comes to making business decisions, Humphrey believes paybacks are overused and misapplied.

"You have to play the 'future cost game,' and at some point, you are just guessing with inaccurate numbers, and you have to know your business well enough to have the intuition as to what makes the most sense," he says. "So what is more important to me is looking at a more efficient heating system, heat-retention curtains and more insulative coverings. A single wall covering on the sides or ends is not a very good purchase when you consider the heat loss for a typical greenhouse is 10 percent to 15 percent through your walls. You could get a multiwall covering and an insulated metal covering as a knee wall and pay for the difference in a year or two. The additional light through these areas is rarely worth the fuel costs year after year."

Maintenance issues. According to the MSU Extension Service report, air leaks can be a major cause of heat loss. Caulking and weather-stripping around glass laps and other locations can reduce the amount of outside air entering the building. The report states that older green-

PHOTO COURTESY OF NEXUS CORP.

houses usually benefit the most in savings. Caulking and weather-stripping can reduce heat loss up to 37 percent in some buildings. Researchers recommend using a water-resistant silicone sealant and to check the siding on houses to make sure it is completely closed.

Goldsher agrees with the report and adds that good maintenance pays dividends.

"If you've been in greenhouses year after year in cold weather, a lot of them aren't tight, and maintenance needs to be performed," he says. "The covering needs to be replaced and patched, and inefficient heaters need to be repaired and replaced. It's all about good housekeeping, which will tell you how efficient the greenhouses are. You have to stay on top of maintenance, both for winter heating and summer cooling."

A poor venting system may cause improper fuel combustion, reduced efficiency and potentially harmful fumes, the MSU Extension Service report states.

"There are free dollars lying around if you find the holes that your heat is escaping through, just like in your own home," Humphrey adds. "It's the same for someone who hasn't put in a curtain baffle underneath the gutter. You can go into a greenhouse and see the tail edge of the curtain hanging down, and the heat is going right up to the gutter and conducting to the outside."

Innovations on the horizon. Humphrey says the biggest future innovation in energy savings will likely come from the covering manufacturers.

"This may be from the exterior coverings having better R-values that still let in enough light to grow the plants. There are coverings on the market that will reflect the heat spectrum of light and still allow the proper light spectrums for growing plants," he states. "We may eventually have greenhouses that are solidly covered and are great insulators, and the plants will be grown with advanced lights that will reflect at all angles and in the correct wavelengths needed by individual plants."

Goldsher says Engineering Services & Products is investigating an underground method of storing heat and cold for greenhouses using aggregate.

"This could be really big for our customers who are struggling so much because of the rising costs of energy and raw material market inputs," he adds. "I think our whole country needs relief. I think farmers and growers are so important, and they should benefit first."

Jason Bramwell is senior associate editor of AMERICAN NURSERYMAN.

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