Potential energy saving measures categorised

Elly Nederhoff & Bert Houter
CropHouse Ltd, New Zealand
Elly@CropHouse.co.nz
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Rising energy prices force greenhouse operators to reduce the energy consumption and improve the energy efficiency. Some things can be done to this end, ranging from low-cost repairs to high-cost investments. European growers have been struggling with the energy issue for some decades, and have developed energy-saving technologies and practices. However, not everything that is successful in Europe is cost-effective here in New Zealand, due to different conditions (climate, economy, regulations). This article categorises the possible energy saving measures.

Actions and priorities

Greenhouse operators can do something to reduce the energy consumption, and so improve the energy efficiency. Possible actions in no particular order:

1. Increase the production without increasing energy use
2. Repair broken gear
3. Keep up maintenance and servicing
4. Upgrade the technology
5. Insulate the greenhouse
6. Insulate the heating installation
7. Install energy saving technology
8. Apply energy-wise climate control through a good computer
9. Avoid temperature gradients
10. Change to alternative energy
11. Install co-generation (combined heat & power)
12. Improve your knowledge
13. Record and analyse climatic data
14. Replace very old greenhouses

It makes sense to start with actions that are easiest achievable, give best results, or are cheapest. This depends on the situation. Below follows a brief description of possible energy saving actions and technology.

(1) Energy efficiency

Energy efficiency can be improved by reducing energy input and/or by increasing the production (without increasing the energy use). This can be achieved by a wide range of measures, including choice of variety, good propagation, plant management, growing system, watering, fertilisation, climate control, CO_2 enrichment, etc. The previous issue of the Grower (May) contained an article about crop recording as a tool for improving production.

A major factor for production is light. The old-fashioned rule of thumb says '1% light = 1% production', although some scientists say the effect is a bit less. In winter the light level can be critically low, limiting the production. Therefore it is important to maximise the light level, especially in the winter. It pays minimising the shade from overhead pipelines, structural elements etc. Generally this must be done in the building stage, but sometimes can be done later. If there is a line of high trees casting a shadow on the greenhouse, it helps to lower their height. This improves the evenness of the crop, as well as the production and thus the energy efficiency.

(2) Repair
Most greenhouses have small things in need of repair, for instance broken windows, leaking pipes, rambling pumps, inaccurate sensors, faulty vent motors, vents always on a crack, draughts from doors, bust equipment in greenhouse and boiler house. Deferred maintenance can waste a lot of energy and fuel. Broken things can cause cold & wet spots. Places with 1 °C lower temperature have a 5% higher relative humidity. Plants in these spots stay behind and are prone to disease outbreaks. Hence it pays to repair or replace things when they break down.

(3a) Maintenance and servicing of equipment
Everything needs regular maintenance and servicing. A dirty boiler can have 5-10% lower efficiency, which means 5-10% unnecessary increase in fuel costs. The fan of the burner should draw enough air for proper combustion, but not too much, as that wastes energy. Buffers (hot water storage tanks) are notorious for flaws. If a buffer tank it present, the flows and temperatures should be critically reviewed by an expert.
The vents can suffer from deferred maintenance, so that they are not closing and opening accurately. Some vents will be constantly on a crack when they are supposed to be closed. This can waste an enormous amount of energy. The solution is to tune the vent motors and to calibrate and re-adjust the vents. This does cost time and money, but will be earned back by energy saving. The CO_2 lay-flat ducts should be checked: ducts straightened, condensation water removed, broken ducts replaced. If the pressure in the ducts is uneven, corrective measures can be taken.

(3b) Maintenance and servicing of sensors
Sensors need regular maintenance too. The wet bulb temperature sensor, that measures the air humidity, must be kept wet. If the wick is dry, the humidity reading will be too high, even 100%. The controller will then try to overcome the supposed high humidity by activating heating and/or venting, thus spending energy.
The CO_2 meter needs regular calibration, not just by sticking the tube out of the window. Without proper calibration it may deviate 50 ppm or more, and the controller will always aim for higher or lower than meant to be. This costs energy or production. Check that the air is sampled from the greenhouse and not by accident from the boiler house. The CO_2 meter should not hang in the boiler house anyway. Also, make sure that moisture is trapped and removed so that it does not block the CO_2 sampling.
If you use light-dependent adjustments in your climate control, make sure the computer gets the correct light measurements. A light meter (or radiation meter) should be placed outside on a shade-free location and should be clean. Light meters can give strange readings due to incorrect set-up. Also the sensors for wind speed, wind direction and rain must function well.

(4) Upgrading
Many older greenhouses are set up with very basic equipment, for instance hot-air heating, small second-hand boiler, old fans for cooling, very basic controller, soil-based growing system, etc. It would be good to identify the weakest point for energy efficiency and to upgrade that. For instance, an old boiler can perhaps be replaced by a modern efficient boiler, and may earn itself back in a short time. Hot-air heating might be upgraded to hot-water pipe heating, which may immediately increase the production and reduce disease problems. Heating pipes that are now located up high in the greenhouse, may be brought down. It is much more efficient to deliver the heat where it is needed, close to the plants, rather than close to the roof. An old controller can be replaced by a decent computer, to save time and energy and increase the production. Growing in soil might be changed to growing in hydroponics, resulting in better production and better controllability. An energy consultant can help you to prioritise points for upgrading.

(5) Insulating the greenhouse

Greenhouses loose heat through the roof and walls. Energy loss is less for double plastic cladding than for single plastic or single glass, but also light transmission is lower. (On the other hand, light in a twin skin plastic house is more diffuse, which is good). Double glass in the roof is too expensive and costs too much light, thus reducing the yield. Energy loss via the roof can be reduced effectively by closing a thermal screen, but the costs are very high (see article 29 in this series).

The greenhouse walls are less important for capturing natural light, especially in large greenhouses, and especially on the south side. So it is useful to insulate the walls, especially the south wall. Double glass or synthetic insulating panes would be ideal, but they are expensive. It is also good to fit shiny insulation material that reflects light back into the greenhouse. A cheaper option is installing an extra layer of single plastic (inside) or double plastic foil or bubble film (inside or sometimes outside) to the walls. The air between the material and the greenhouse cladding acts as insulator. In large greenhouses the wall insulation saves 2-4% energy per year, and in small greenhouses it is more.

(6) Insulating the heating installation

Priority should be given to legging pipes that are outside. They are often large and hot, and most exposed to the weather. To insulate them, they can be wrapped in industrial insulation material and then covered by aluminium cladding. Hence they should be placed on brackets or hanging on chains to allow movement and avoid damage.

If there is an option to run the transport pipes inside the greenhouse, it is often wise to do so, so that any heat lost comes inside the greenhouse. Overseas, hot water transport pipes are often put underground, of course with excellent insulation and protection. The advantage of underground pipes is that they are out of the way and don't shade the plants. Note that hot pipes expand and shrink with changing temperature.

The second priority should be given to legging hot water transport pipes coming directly from the boiler, as they are large pipes and very hot. Equally important is the insulation of the boiler house. Some boilers are situated under a shelter only or in a leaking un-insulated glasshouse. Proper housing in an insulated enclosure (e.g. shed) as well as proper legging of the pipes saves a lot of energy, and increases the energy efficiency.

The third priority is to insulate hot water transport pipes that are inside the greenhouse. Loosing heat inside is not as bad as outside, but hot pipes create uneven temperatures causing uneven plant growth. Moreover, they dry the air and can burn the plants.

(7) Installing energy saving technology

Installing special energy saving technology can include a wide range of gear, some achievable and affordable, others very expensive. Some examples are: modulating gas valve, variable speed auger for coal supply, variable speed pumps in heating system, flue gas condenser (gas only), heat storage tank (/buffer), energy screen (/thermal screen).

(8) - (13) have been discussed or will be discussed in other articles in this series.

(14) Replacing very old greenhouses

This point is meant as a reality check. There are quite a few very old greenhouses being used in New Zealand, that can never be upgraded to 'modern' and 'efficient' greenhouses. Some have a very low light transmission. Due to low light level, the production will be very low. (Remember 1 % light is 1% production). Such greenhouses cost a lot to heat and to work in, and the production can be very disappointing.

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