Cost & benefit of an energy screen in a glasshouse in New Zealand

Elly Nederhoff & Bert Houter
CropHouse Ltd, New Zealand
Elly@CropHouse.co.nz
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Energy screen or thermal screen

Using an energy screen, also known as a thermal screen, is one of the methods for increasing energy efficiency in a glasshouse. A retractable or moveable screen is an insulating curtain made of special materials that can be drawn over the plants. It is typically closed at night, and open at day time. The advantage is improved energy efficiency, but there are some disadvantages too. First there is the risk of too high humidity and hence fungal diseases when the screen. Then there some loss of production due to loss of light. The initial hurdle is the high cost. This article looks at the effectiveness and especially at the cost-benefit ratio of an energy screen.

Screens in New Zealand

Energy screens are used a lot in colder climates overseas. Only a few growers in NZ have a screen, for instance some of the large operations have a screen installed in one compartment of a glasshouse complex. Due to the rising energy prises, more growers now want to know if a screen is cost-effective. Note that screens are only a realistic option in modern glasshouses, in particular when they are installed at the time the glasshouse is built. It is more expensive to retro-fit it in an existing glasshouse. In old-style glasshouses and in most plastic greenhouses, installing a moveable (=retractable) energy screen is either impossible or not feasible.

Shading in summer

The light intensity in summer is higher in NZ than in most other countries. Therefore growers in NZ would want to use a shade screen. Shading can avoid sunburn and stress on the plants and improve the growing conditions in summer. A shade screen must be semi-transparent for light (to keep the photosynthesis going) and semi-permeable for air and moisture (the screen must 'breath' to prevent high humidity). However, a screen with such qualities does not provide the maximum level of energy saving. Overseas, some growers install two screens, one for shading and one for energy saving. The costs are probably about double the costs of a single screen, which is far too expensive for most NZ growers. So growers in NZ would choose a screen that is a compromise between shading and energy-saving. There are screens suitable for both purposes combined (see http://www.svensson.nl/). Their energy saving factor of a dual-purpose screen is for instance 30% or 47%. In contrast, a screen designed solely for energy saving can save 74% when closed (according to the manufacturer), but this screen blocks light and moisture.

Study

Recently we conducted a study as part of the Project '*Improving Energy Efficiency in Greenhouse Vegetable Production*' funded by the Sustainable Farming Fund of MAF. This study aimed to answer the question whether a (retractable or moveable) energy screen is cost-effective for glasshouses in NZ (Auckland & Christchurch). It did not consider using the screen as a shade screen for improving growing conditions in summer. Calculations were made with a simulation model to analyse data recorded over the year 2004 by two greenhouse control computers (one in Auckland and one in Christchurch).

The model assumes the instantaneous energy saving factor of a screen is either 30 or 50 %. It accounted for 'gapping': this is leaving small gaps (1-5%) in order to let moisture escape. It assumed wider gaps are applied when the outside temperature is higher (then the humidity problems get worse, and plants are more easily infected by fungi!). Hence the model assumes that the energy saving factor declines progressively at higher outside temperature, to as low as 10%. The energy saving per year is calculated in MJ/m^2/y. This is compared to a 'standard annual energy use' (estimated at 1300 MJ/m^2/y in Auckland and 2000 MJ/m^2/y in Christchurch) to determine the energy saving percentages.

Results

The results show that an energy screen with energy saving factor 50% enables a grower to save up to 200 MJ/m^2/year or 15% of energy consumption per year in Auckland, and up to 400 MJ/m^2/y or 20% per year in Christchurch. These figures are found for a certain regime, namely closing the screen at outside temperature below 12 °C and opening the screen in the morning at light level 100 W/m^2. Technically, the energy saving in MJ/m^2/y is about twice as much in Christchurch as in Auckland, due to colder climate on the South Island (S.I.). Also the monetary savings are higher in the S.I. than in the N.I. currently. Nearly all S.I. growers use coal (which is cheaper than natural gas), whereas many N.I. growers use natural gas. So usually the monetary saving is not twice as much on the S.I. compared to the N.I.

Our calculations show that a screen with energy saving factor 70% could save up to 537 MJ/m^2/y or 5370 GJ/ha/y or up to 27% per year in Christchurch. However, this type of screen blocks out light and moisture, making it unsuitable as a shade screen in summer. So growers in NZ would probably not choose this type of screen.

Anecdotal examples of use of a screen

We looked at some examples of screening by two growers, one in Auckland and one in Christchurch. Both growers saved about 1.5 MJ/ha/day (15 GJ/ha/day) on random days in August. However, the screens were not controlled optimally. Both screens were opened some hours before dawn, missing the coldest hours of the night. If they had been opened shortly after dawn, the savings would have been 16 GJ/ha/d in Auckland, and 20 GJ/ha/d in Christchurch. This equals $92 or $144 per ha per day for Auckland, and $115 or $180 per ha per day for Christchurch (at current prices for coal and gas of $5.75 and $9 per GJ, respectively).

It was also noticed that on many other nights, the grower in Auckland opened the screen during the night or set at 25% gap due to imminent humidity problems. Unfortunately a gap of 25% nullifies the energy saving by the screen.

High humidity problems under screens are well recognised. Dutch researchers and growers developed a screen control regime to overcome such problems. The guidelines for control are summarised in the report (see below), and they will be reported in an article in May.

Cost-benefit analysis

We did a cost-benefit analysis, as accurate and realistic as possible, using price quotes from the suppliers (NGC, SE, Faber). Our calculations reveal that at the current fuel price levels, using an energy screen, even with energy saving factor 50%(!), does not save enough energy in winter to compensate for the costs (investments, capital and maintenance costs). This was even without accounting for production loss due to light loss (estimated 3 - 4.5% income loss per year). On the other hand, the positive effect of using a screen for improving growing conditions in summer has not been accounted for either, as this must be studied separately.

The earn-back time was found to be between 5 and 29 years (depending on fuel, location, screening regime, etc), and would be even longer if production loss was accounted for. The break-even point can only be reached if the fuel prices rise further, or if a screen with higher energy saving factor was used, or if the cost of a screen was lower. The break-even point is even harder to achieve if production loss is included. With such a very poor return on investment, it is understandable that growers in NZ are not keen to purchase a screen.

Financial and economic considerations

Energy screens are developed and manufactured by a Swedish company, and implemented a lot in Scandinavia, the Netherlands, Canada and other countries. They are most effective in countries with long cold (winter) nights, where the investments costs are earned back by energy savings. Since the NZ winters are much milder, it is harder to recover the costs. Also note that moveable (=retractable) screens are not a realistic option for older structures and plastic houses, which make up a large part of greenhouses in NZ.

Most importantly, the economic and financial climate in NZ is very different from elsewhere. In contrast to European growers, NZ growers operate in a small domestic market and are further away from export markets. Returns may be lower, while the costs of (imported) materials are far higher than in Europe. Most growers do not have the means for investment, especially not for projects with a low return on investment. Many European growers receive investment subsidies, tax incentives and other financial support from their governments, whereas NZ growers receive no support at all.

Summary

A computer study was conducted on the effectiveness and economics of energy screens in glasshouses in NZ. This study found that, technically, screens are very effective when used in the correct way. They can save up to 15% energy in Auckland and up to 20% in Christchurch. This is for a screen with energy saving factor 50% (when closed), used with a certain strict control regime. Looser control will lead to less savings.

However, this study found there are not enough cold-enough hours in a year to make a screen cost-effective, especially in the Auckland area. Technically, the energy saving is higher (about double) around Christchurch than around Auckland. But since the fuel on the South Island is relatively cheaper (coal), the monetary savings don't compensate for the investments costs either. The return on investment is negative in most cases.

Energy screens may become cost-effective when energy prices increase even further, or when screens with a very high insulation factor could be used, or when the costs of screens came down. At the moment, NZ greenhouse operators need investment subsidies or tax incentives on energy-saving measures (as exist in many other countries), to enable them to install energy screens.

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Full report

The full report can be requested from Horticulture NZ at info@hortnz.co.nz. The full title is *'Energy screens in glasshouses in NZ: effectiveness, economics and optimal use'. Report 15 of Project 03/158 for MAF Sustainable Farming Fund & Industry Stakeholders. By Elly Nederhoff and Bert Houter, Technolutionz Ltd. 25 pages. January 2006.*

Further information

Screen manufacturer Ludvig Svensson in Europe (http://www.svensson.nl/), and Living Shade in Australia (info@livingshade.com.au).