SLU
ALNARP

Unofficial translation

LTJ-faculty Fact Sheet

Unofficial translation of Fact Sheet 2014:17

Facts from Partnership Horticulture

Cover Material That Makes It Possible To Save Money When Constructing A New Greenhouse

BY: JONAS MÖLLER NIELSEN, STEFAN KARLSSON, KLARA LÖFKVIST, CHRISTINA STÅLHANDSKE, SVEN NIMMERMARK

There are many modern types of glass that have been developed for the building sector. The glasses have been developed with focus on energy saving, sun protection and optimal sight experience. Several of these glasses have characteristics that are of interest for greenhouses. With the right combination of new glasses in the greenhouse, energy savings of up to 30 % can be achieved. In a new construction, it is possible for a tomato production to improve the economic result with 400 SEK/m2 during a period of 10 years, if you chose modern glass instead of just continuing with standard float glass.

Here in the north, it is important to use as much as possible of the natural light, and at the same time keep the energy losses low. A cover material that transmits optimal amount of light of the right quality, with as low energy losses as possible, would therefore be ideal. Newer cover materials can be worth considering both when retrofitting existing greenhouse structures as well as for new construction. The new glass materials have good energy savings but the light transmission is reduced slightly, and thus also the photosynthesis which influences the growth. When building a new greenhouse, it is today possible to improve the economical result with 400 SEK/m2 during a period of 10 years, if a new glass material is chosen instead of a conventional float glass. To chose an energy efficient glass does not necessarily mean a more costly investment, on the contrary it can be cheaper to build a greenhouse with a modern glass material.

Partnership Horticulture has during the autumn 2013 and the spring 2014 financed a project where Glafo, JTI, SLU and Cascada has done economical calculations with different cover materials from a greenhouse perspective.

New exists

A lot have happened in the window glass industry, especially when it comes to energy saving coatings and production costs, and when the energy prices have increased it has been more interesting to investigate the new glass materials for greenhouses. Both in Germany and The Netherlands, they have investigated different kinds of glass and glass coatings, for some years now. So far they have now certain recommendations, but glass that scatters the light is being used widely in the greenhouse sector in The Netherlands. Increased production with as much as 5 % and 10 % in cucumber production have been mentioned.

Glass with coatings

By treating the glass with a coating it is possible to get unique properties. Coatings that can be of interest för production of plants in greenhouses are low emission (energy saving glass), anti reflective and self cleaning coatings. But also the iron content is important, since iron absorbs the light, and by producing a glass with a lower iron content a higher light transmission is achieved. Anti reflective coatings reflect less light than normal untreated glass and increases the transmission with a couple of percentages. But it is difficult to theoretically judge the effect a higher light transmission in the greenhouse will have on the production, since this can vary a lot depending on what is being produced. Scattering glass is also of interest for

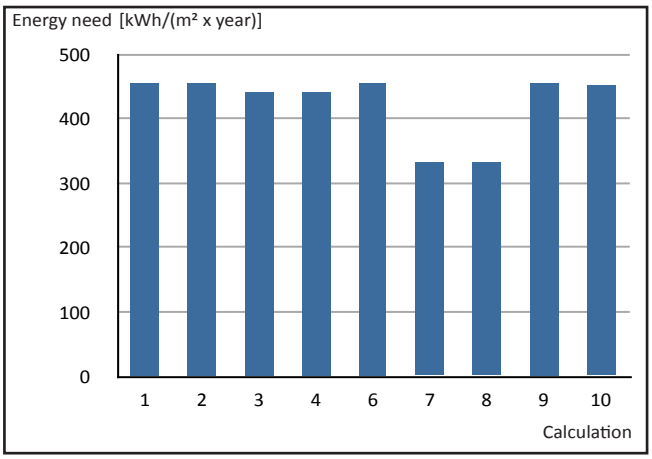

Diagram 1: The energi need for different glass treatments. Case 1 is the standard house which works as a reference. For the different treatments see table 1.

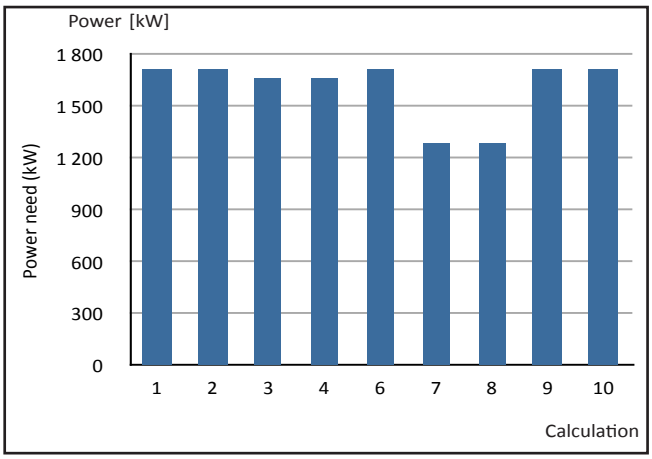

Diagram 2: The power need for different glass treatments. Case 1 is the standard house which works as a reference. For the different treatments see table 1.

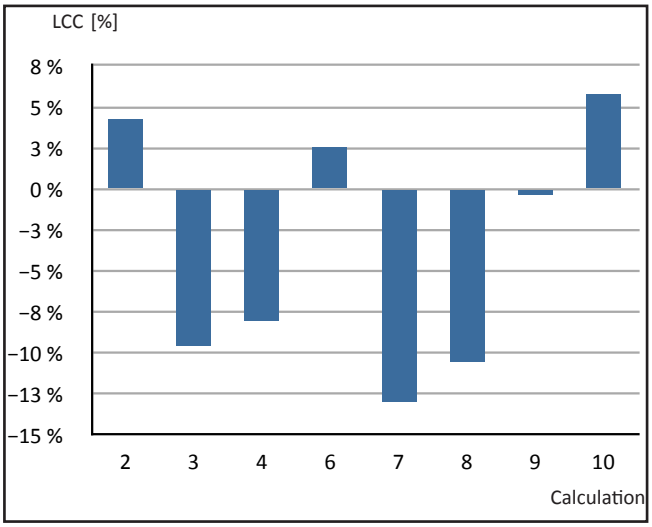

Diagram 3: The change in life cycle cost over ten years in Swedish Crowns, compared with the reference house, that is put to 0 %. Calculated interest rate 6 %. For the different treatments see table 1.

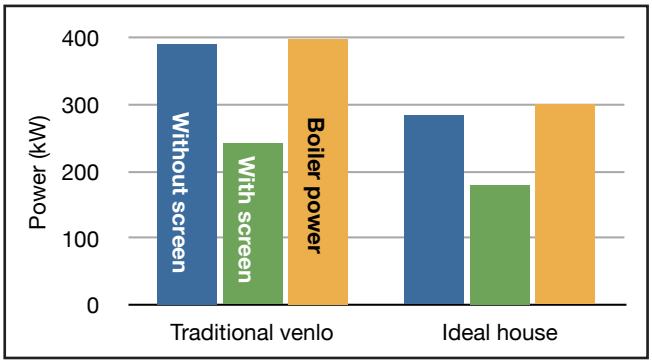

Diagram 4: The power need can be reduced significantly with newer glass materials, and for the smaller venlo greenhouse the boiler size was reduced by 25 %, from 400 to 300 kW.

Table 1: The different glass alternatives that was investigated. Alternativ 1 is a standard venlo house and serves as reference. Alternatives 2, 3 and 4 are alternative wall materials, and alternatives 6 to and including 10 are alternative roof materials.

#	Roof material			Wall material		
	Glass	Treatment	U-value W/(m² x K)	Glass	Treatment	U-value W/(m² x K)
1	4 mm	-	7.0	2 x 4 mm	-	4.3
2	4 mm	-	7.0	2 x 4 mm cassette	OptiWhite	4.3
3	4 mm	-	7.0	2 x 4 mm cassette	OptiTherm (S2)	3.2
4	4 mm	-	7.0	2 x 4 mm cassette	OptiTherm (S2) + OptiWhite	3.2
6	4 mm	OptiWhite	7.0	2 x 4 mm	-	4.3
7	4 mm	Antireflex + K-glass (S2)	4.8	2 x 4 mm	-	4.3
8	4 mm	Anti reflex + K-glass (S2) + OptiWhite	4.8	2 x 4 mm	-	4.3
9	4 mm	Anti reflex + OptiWhite	7.0	2 x 4 mm	-	4.3
10	4 mm	Active	7.0	2 x 4 mm	-	4.3

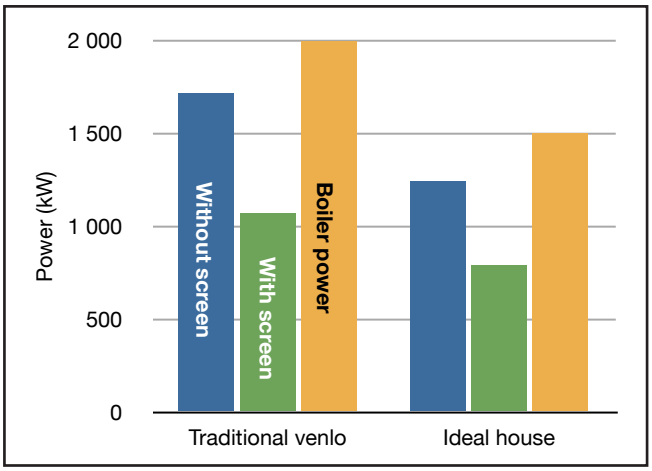

Diagram 5: The power need can be reduced significantly with newer glass materials och for the larger venlo greenhouse the boiler size was reduced by 20 %, from 2 to 1,5 MW.

Swedish conditions since it increases the growth of the plants and their tolerans towards high light intensities (less likely to get burn damages).

Different glass qualities influences the spectral composition of the incoming light from UV, visible and long wave heat radiation. In cases the UV-radiation will increase and in other cases the long wave heat radiation will be influenced. There has not been resources to investigate these aspects in this pre study.

Small changes give big gains

Table 1 shows which treatments that have been tested theoretically, and which U-values that they have including mullions. All calculations 2 up to and including 10 have been compared with calculation 1 that is the larger reference house of 5 000 m2, se the separate box with facts. In the calculations 2, 3 and 4 only alternative wall materials have been tested, and in the calculations 6 up to and including 10, have only alternative roof material been tested.

In cases 2 and 6 a glass with low iron content have been tested in wall and roof respectively, but since it has not been possible to estimate how much the increased light transmission influences the energy balance, it has not been possible to get any changes in the need for power nor energy, compared with the reference house, which is shown in diagram 1. On the contrary, the calculations 3 and 4 has shown positive effects on the need for power and energy compared with the reference house, which is also shown in diagrams 1 and 2. Even if the difference in percentage is small, it can have a significant influence on which boiler size to chose at the moment of investment. This is clearly shown in diagram 3, where the life cycle cost calculations for the calculations 3 and 4 are 8 to 9 % better compared with the reference house. The influence of changes in the walls is greater in small greenhouses than in larger greenhouses since the walls represents a larger part of the surrounding area, which is now shown here.

Alternativ 7 and 8 with low emission coating in the roof shows great reductions in the need for power and energy, 25 and 27 % respectively. This means that during a ten year period the results have improved nearly 1,9 million Swedish Crowns for alternativ 7, which corresponds to a little more than 13 % compared with the reference house.

The conclusion is that a rather small extra investment in the cover material during the initial investment can have considerable consequences in the longer term. The lower need for power results both in a lower investment cost in the boiler system and a yearly lower energy cost. Thus it is important in the moment of investment, to look at the total investment as a whole and see how different measures influences each others instead of looking each part separately.

Reduced need for power & energy

Regardless the size of the greenhouse the energy use was reduced by 30 % when the newer glass materials were used, that is from 512 to 359 kWh/m2 for the lower house (1 000 m2) and from 455 to 318 kWh/m2 for the larger greenhouse (5 000 m2). The saving in percent depends on what reference house that is used to compare with, and this is important to keep in mind when calculating on the energy saving. The reduced energy use has as consequences that the power need is reduced (diagrams 4 and 5). This can be an advantage when building a new greenhouse where the size of the boiler can be adapted for the need.

Though it is not always that it is real advantage at the moment of investment, since the boilers are manufactured in fixed sizes. Because of this it might be needed to invest in a boiler that is unnecessarily big, even though the greenhouse's power need is much lower. This becomes clear in the calculations for a new construction of a reference greenhouse of 5 000 m2, where the necessary power needed without screen is 1,7 MW, but where the suitable boiler size on the market is 2 MW. The small reference house (1 000 m2) has a power need without screen of 391 kW, and suitable boiler size on the market is then 400 kW, which is very close to the need.

The new economical greenhouse

Several different glass coatings that traditionally have been used in the normal building sector where investigated theoretically, and the best alternatives from the perspectives of energy and plant, where chosen for an "ideal greenhouse", that then was investigated considering needed heat power, energy use and total economy. The materials where chosen based on their energy efficiency and light transmission, and if the material had a reasonable price level. The chosen material for the roof of the ideal greenhouse was Pilkington K-glass, a float glass with a low emission coating (energy saving glass), that reflects back the heat radiation into the greenhouse. In the walls of the ideal greenhouse, glass cassettes where chosen where one side was coated with the low emission coating Pilkington OptiTherm.

Money to save already day one

The total economy for the different cover materials were calculated and the difference in life cycle cost (LCC) between the ideal house and the standard houser (reference) was calculated. In the LCC consideration were taken to the investment cost for standard glass and the chosen glass types in the ideal house, and the boiler system, including maintenance cost, and the difference in production between the two house types. The investment cost for both house sizes were in some calculations lower for a house with an energy efficient cover material. The life cycle was put to 10 years and the interest rate for calculations was set to 6 %. The energy saving material has theoretically 5 % lower light transmission than standard float glass. The tomato production was assumed to change with 1 % for each percent that the light transmission was changed.

The life cycle cost calculations for a new construction of a greenhouse showed that the ideal greenhouse, no matter size, was more economical already day one, thanks to a lower investment cost for the boiler system, since the power need was smaller. What was saved in a smaller boiler system covered the extra investment costs for the more expensive glass material. This is illustrated with the larger house where the investment cost for glass was

140 000 SEK and for the boiler system was 1,4 million SEK, but for the ideal house the corresponding costs were 250 000 and 1 million SEK respectively. During a 10 year period the result for the smaller house (1 000 m2) was improved with 440 000 SEK and for the larger house (5 000 m2) a little bit more than 2 million SEK.

Several solutions for the future

Special studies need to be done in order to investigate which materials that are suitable during renovation of old greenhouses with old cover materials, especially houses with polycarbonate or acrylic sheets, since there is a need to change these materials. In a greenhouse with an older cover material like polycarbonate or acrylic, the reduction in light transmission can be as high as 40% without taking into account the shading caused by the mullions or dirt. This should be compared with a K-glass that has a light transmission of 17 %.

Continued calculations and investigations needs to be done in order to chose the best cover material for the future in greenhouse produktion in Northern Europe.

FACT - Calculations

In the project theoretical calculations were done for a venlo greenhouse in the south western part of Scania, for two different greenhouse sizes, 1 000 m2 and 5 000 m2, with a transparent energy screen and tomato as crop. The tomato crop were assumed to be 54 kg/m2 with a average price of 9 SEK/kg. The heating temperature were 16 °C all year round. Calculations were done for different kinds of new glass materials and the results were compared with a reference hous with the same size with the standard materials 4 mm float glass in the roof and double glass in the walls.

The life cycle cost was calculated over 10 years and the interest rate was set to 6 %. The tomato crop was assumed to change with 1 % for each percent that the light transmission changed.

When determining the size of the boiler system considerations have been taken to ISO SS-EN 13031-1, that states that the heating must have necessary capacity to melt snow by keeping an indoor temperature of 18 °C at the dimensioning outdoor temperatur, in Scania -18 °C.

Fact

- Authors: Jonas Möller Nielsen, Klara Löfkvist, Christina Stålhandske, Stefan Karlsson & Svennimmermark
- Project Manager: Jonas Möller Nielsen
- Informationsbladet är utarbetat inom LTJ-fakultetens Område Agrosystem, SLU Alnarp
- The Fact Sheet is finansed by Partnership Horticulture
- On the webbaddress http://epsilon.slu.se the original fact sheet can be downloaded in Swedish

Partnership Horticulture

Är ett projekt som syftar till att ge förutsättningar för ökad konkurrenskraft och tillväxt inom trädgårdsnäringen genom nytänkande och samarbete. Projektet finansieras av Europeiska jordbruksfonden för landsbygdsutveckling: Europa investerar i landsbygdsområden, SLU, LTJ-fakulteten Alnarp, LRF/GRO, Hushållningssällskapen i Malmöhus, Halland och Kristianstad, Lovang Lantbrukskonsult AB, Mäster Grön samt Prysek.

Tillväxt Trädgård

SLU

Europeiska jordbruksfonden för landsbygdsutveckling: Europa investerar i landsbygdsområden