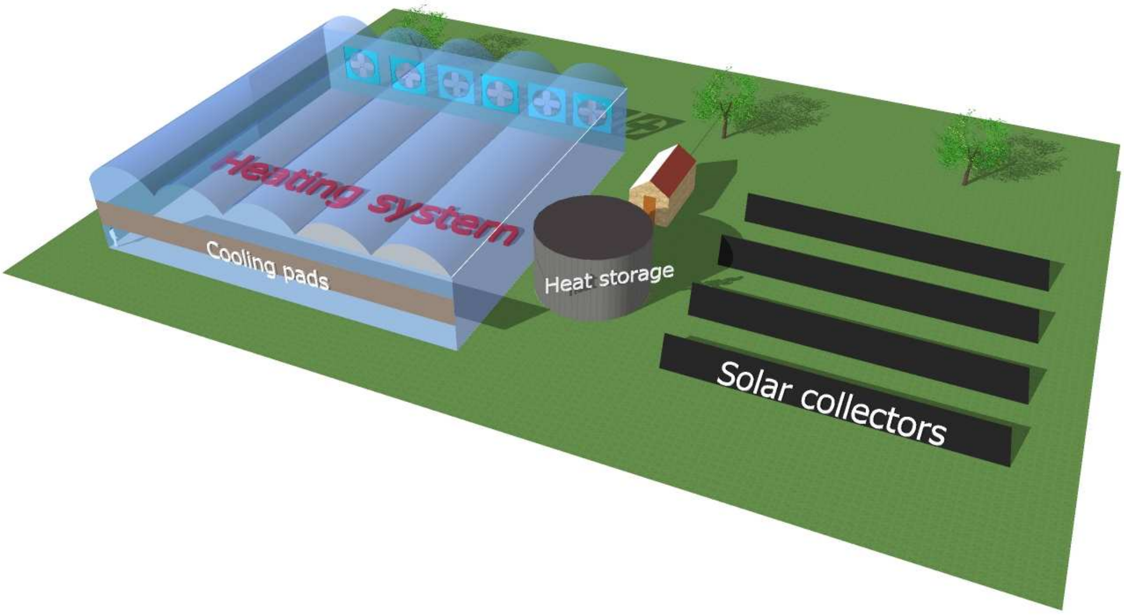
Sustainable horticulture and poultry farms in South Africa



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1 Summary

This report gives a trip report on the visit by Jouke Campen and André Aarnink visited South Africa from 24th of February till 1st of March 2009 as well as the preliminary calculations for the application of solar radiation as a heating source for greenhouses and poultry farms.
This project is financed by the Dutch Ministry of Agriculture, Nature and Food quality (BO-10-006-118 Sustainable temperature control system in confined agricultural production)

The goal of the mission was

1. Discuss with stakeholders in the public and private sector in SA on a their view of a more sustainable confined agricultural production.
2. Identify the current status of protected horticulture and poultry farms in SA in terms of fossil fuel use and production levels.

The major outcomes of the mission are:

- Farmers are eager to learn about ways to heat the facilties with other means then coal.
- The climate is ideal for solar energy application

The preliminary calculations using the weather data provided show that the application of solar energy as a heating source in South Africa is economically feasible.
The next step should be to demonstrate the feasibility and to monitor the energy saving potential.

2 Introduction

2.1 South African agriculture

South Africa has a dual agricultural economy, with both well-developed commercial farming and more subsistence-based production in the deep rural areas. Covering 1.2-million square kilometres of land, South Africa is approximately 30 times the size of The Netherlands. The number of inhabitants is approximately 3 times the number of The Netherlands (43 versus 16 million). South Africa has seven climatic regions, from Mediterranean to subtropical to semi-desert. This variety in climatic regions, together with a coastline of 3000 kilometres long and served by seven commercial ports, favours the cultivation of a highly diverse range of marine and agricultural products, from deciduous, citrus and subtropical fruit to grain, wool, cut flowers, livestock and game. Agricultural activities range from intensive crop production and mixed farming in winter rainfall and high summer rainfall areas to cattle ranching in the bushveld and sheep farming in the arid regions. Maize is most widely grown, followed by wheat, oats, sugar cane and sunflowers. While 13% of South Africa's land can be used for crop production, only 22% of this area is high-potential arable land. The most important limiting factor is the availability of water. Rainfall is distributed unevenly across the country, with some areas prone to drought. Almost 50% of South Africa's water is used for agriculture, with about 1.3-million hectares under irrigation. Today, South Africa is not only self-sufficient in virtually all major agricultural products, but is also a net food exporter. Farming remains vitally important to the economy and development of the southern African region. Since the country's first democratic elections in 1994, the government has been working to develop small-scale farming.
(http://www.southafrica.info/business/economy/sectors/agricultural-sector.htm)
The gross income of farmers amounted R 89 billion (1 Rand = 0.08 Euro) in June 2007. The gross income of the agricultural sector, which is derived from field crops, animal production and horticulture activities, has increased since 2006, mainly because of the strong performance of the livestock sector and is projected to grow further. Animal production accounts for more than 40% of the gross income of the agricultural sector.

2.1.1 Exports

South Africa is among the world's top five exporters of avocados, grapefruit, tangerines, plums, pears, table grapes and ostrich products. Farming contributes some 8% to the country's total exports. The largest export groups are wine, citrus, sugar, grapes, maize, fruit juice, wool, and deciduous fruit such as apples, pears, peaches and apricots. Other important export products are avocados, dairy products, flowers, food preparations, hides and skins, meat, non-alcoholic beverages, pineapples, preserved fruit and nuts, sugar, and wines. A number of high-growth niche markets are emerging, such as herbal beverages and luxury seafoods.

During 2006/07, the United Kingdom, The Netherlands, United States, Germany and Mozambique were the five largest trading partners of South Africa in terms of export destinations for agricultural products, with export values of R3 874 million; R3 287 million; R1 431 million; R1 428 million and R1 312 million, respectively.

2.1.2 Competitive advantages

South African agriculture and agribusiness have a number of competitive advantages, making the country both an important trading partner and a viable investment destination.
World-class infrastructure
South Africa has three deep-water ports, three international airports, a network of roads and railways, well-developed cold chain facilities, and a sophisticated financial sector.
Counter-seasonality to Europe
South Africa's counter-seasonality to Europe, the country's primary export market for horticultural and floricultural products, is a major competitive advantage. South Africa is the closest major southern hemisphere producer of horticultural and floricultural products to Europe, and has significantly shorter shipping times than its rivals.

Biodiversity
South Africa's diversity of climates - tropical, subtropical and desert - allows for a vast and varied array of agricultural products.
Marine resources
South Africa has almost 3 000 kilometres of coastline which is commercially used both for conventional harvesting and for mariculture and aquaculture.
Competitive input costs
While South Africa boasts infrastructure comparable to first-world countries, its cost structures remain highly favourable. Electricity is still relatively inexpensive, and labour rates are also competitive.
Trade agreements
South Africa's agriculture and agribusiness sector are benefiting from increased market access to its key trading partners, the EU and the US, as well as to sub-Saharan countries, through a number of trade agreements.

2.1.3 Deregulation and market freedom

Since the end of apartheid in 1994, South African agriculture has evolved from a highly regulated and protected industry to one free from all constraints, unsubsidised by government and capable of competing with the best in the world. The Marketing of Agricultural Products Act of 1996 dramatically changed agricultural marketing in the country by closing agricultural marketing boards, phasing out certain import and export controls, eliminating subsidies, and introducing import tariffs to protect South African farming from unfair international competition. While a fairly radical process to some old-style producers in South Africa, deregulation has ensured a leaner and stronger agricultural industry, with farmers and agribusiness able to position themselves as players in a globally competitive environment. Phasing out controls and closing marketing boards led to a short-term shortage of essential services formerly provided by the boards and cooperatives, such as storage, grading, deliveries, value adding, information dissemination and research. As a result, specialised marketing support institutions, such as the South African Futures Exchange (Safex) and the Agricultural Futures Market of the JSE, were established to provide much-needed price risk management mechanisms.

2.1.4 Agricultural production areas

About 40% of South Africa's potato crop is grown in the high-lying areas of the Free State and Mpumalanga. Limpopo, the Eastern, Western and Northern Cape, and the high-lying areas of KwaZulu-Natal are also important production areas. Of the total crop, about 50% is delivered to fresh produce markets and a further 18% processed, with the South African potato processing industry having grown tremendously over the past decade. Potatoes make up about 40% of vegetable farmers' gross income, with tomatoes, onions, green mealies and sweetcorn contributing about 38%.
Tomatoes are mainly produced in Limpopo, the Mpumalanga Lowveld and Middleveld, the Pongola area of KwaZulu-Natal, the southern parts of the Eastern Cape, and the Western Cape. Onions are grown in Mpumalanga, the Western Cape and the southern Free State. Cabbage production is concentrated in Mpumalanga and the Camperdown and Greytown districts of KwaZulu-Natal.

South Africa's poultry and pig farms are mainly found near the metropolitan areas of Gauteng, Durban, Pietermaritzburg, Cape Town and Port Elizabeth.

3 Visits, workshops, meetings

3.1 25 February 2009

Semperflora

Willem Slootweg
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GPS: S 25.7159 E 27.7407

Dutch farmer who grows all kind of flowers. The greenhouses are not heated. The minimum temperature is this region is just above zero degrees. Sometimes temperatures drop below zero harming the crop. The hill located to the North causes the temperature to stay above freezing. The site is in production around 8 months a year. By the application of heating whole year production can be made possible. The profit coming from this additional production is estimated by the grower to be around 80 RAND per square meter. The temperature in the greenhouse should stay above 5 degrees Celcius for this.
The site is located jus below a small hill. The hill is located to the south making is an ideal location for collection solar energy.

Safropa
GPS: S 25.748 E 27,686
Frank Enthoven

safropa

Part of Fides

This farm is heated. They produce Kalanchoe. The heat is produced by coal installations. The control is done by Priva. A pad and fan system is used for cooling. The same amount of water is needed for the cooling as for the plants.The specifications of coal are the price are given by this company and attached to this report. This company can provide us with weather data.

Casper Burger, burbdy@mweb.co.za; Tel. 0827718498
Broiler farm
GPS: S 25.542 E 27.794

This farm has different broiler houses varying in size from 23 000 to 40 000 bird places. The houses are mechanically ventilated with side wall fans. Minimum ventilation is drawn through heat exchange tubes (see picture). This air can be pre-heated by a coal heater. On average for heating 12 to 30 tons of coal are necessary for 130,000 delivered birds per year. Birds are raised for 40 days to a weight of approximately 1.9 kg. The temperature inside the house is gradually lowered from 32 ^{o}C at day 0 to 22.6 ^{o}C at day 40. According to the farmer the heat distribution inside the house was ok. This is questionable, while the heat exchange tubes have a fast heat transfer. Energy use by coal could be reduced by: 1) better insulation, especially of the inlet valves and ventilator shafts or of the metal roofs (double metal sheets with a layer of air in between); 2) replacing the coal heater by a heat exchanger. In this way the incoming air is heated by the outgoing air; 3) using solar energy collectors.

Cucumber grower
GPS: S 25.498 E 27.710

This grower used gas to heat his greenhouse. He used this option since it is less time consuming to install and the greenhouse had to be finished. The amount of crop per square meter was limited to our idea but the grower set it was optimal since straying was more effective this way. The heaters produces a lot of water vapour which is a problem. The substraat used are wood chips.

Previous farm of Hans van der Arend
GPS: 25.485 27.727
Some small tunnel greenhouses are located at this area. They are used to make seeds.

3.2 26 February 2009

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Sipho Masinga
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GPS: 25.737 S 28.206 E

We had a very good discussion with the people of the Ministry of Agriculture. They were very interested in our project and ideas. With respect to animal production they would like to focus not only on energy use, but on emission of other greenhouse gases, mainly methane, as well. Climate change is a big issue for the Ministry, because livestock is a large contributor to greenhouse gas emissions. Worldwide this contribution is estimated to be approximately 20%.

University North West
Prof Mbewe
Email: Moses.Mbewe@nwu.ac.za
The university consists of faculties of Animal, Plant and Veterinary Sciences. In this area also a lot of coal is used to heat broiler houses. The size of broiler farms in this area is approximately 10 000 birds. Broiler houses are partly mechanically ventilated and partly naturally ventilated. Layer houses are mainly naturally ventilated.

ARC meeting
Dr. T L Nedambale
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GPS: 25.900 S 28.214 E
We were shown a breeding program on chickens. An important objective of this program is to store a wide variety of chicken genes by breeding different lines of pure bred birds. The houses at the experimental site were all naturally ventilated. Dr. Nedambale could help us contacting researchers in the area of poultry production and horticulture within ARC.

Hytech Agriculture
Jaco Boer
Greenhouse builder
Phone: +27 829535689
Email: hytech@lantic.net
S 26.114 E 27.815

Dutchman who recently started his own company. He first worked at a greenhouse builder. He can supply everything related to the installation of a greenhouse.

3.3 27 February 2009

Ministery of Environment and Tourism
Ms Tshilidzi Dlamini
Deputy director: climate change respons
Email: tdlamini@deat.gov.za
GPS: 25.748 28.193

We met with the whole group dealing with climate change. At first they reverted to the ministery of agriculture for our project. During the conversion they were more interested. Specially on the release of greenhouse gases like methane for farms. In a month a report will be published on the greenhouse gasses released from various sectors.

University of Pretoria

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Prof John G Annandale
John.annandale@up.ac.za
Cell: +27 82 374 3706
GPS: 25.756 28.235
GPS: 25.751 28.259 E (Experimental site)
Dr. Esté van Marle-Köster
Senior researcher Poultry Genetics
She can bring us in contact with other researchers in the field of poultry production at the University of Pretoria.

This university would be a good partner in a project since they have the facilities and connections needed for the project.

Flamingo Flowers (Pty) Ltd
Sven de Groot
Cell: +27 82 909 6060
Email: sven@flamingoflowers.co.za
GPS: 26.074 S 27.598 E

This company has 22 ha of greenhouses. They produces chrysantium. The annual coal use of the company is 500 ton per hectare. This includes streaming. During winter time 24 man are needed to operate the boiler 24 hours a day. The minimum temperature is set at 16 degrees. The darking screen is used as an energy screen as well. It is a Ludvig Svensson screen. The cover is cleaned in wintertime every week. During summer the rain cleans the cover. The lower heating system is located between the flowers. The maximum temperature of this system is 38 degrees. The upper system is used when more heat is needed.
The company is very well managed. Their IPM is very advanced. They did a lot of study on biological control. The about of spin is determined every day by counting based on these results the biological control is applied. The biological control preditors are also being counted and monitored.

3.4 Overall summery of the meetings

- We have visited intensive horticulture and poultry farms in SA. These intensive farms will be the focus of our project, while they use considerably more fossil energy per unit product then small scale low-input low-output farms.
- Water seems to be no problem for the farmers since they all have a well or a river in the vicinity of their farm. People from ministery and university stress that it is a problem now and even more in the future. Water is not being charged so for the farmers it is not an issue.
- The burning of coal is the common way to heat greenhouses and poultry farms. Some growers use liquid gas. The burning of coal is becoming more costly and the supply of coal can be insecure. Morefore the process is labor intensive.
- All of the growers we visited are very interested in alternatives for their heating. The idea of using solar energy has been though of by them as well but not been put into practice at the moment.
- Governmental agencies have sustainability and food safety high on their agenda. Through the available programs they are willing to invest in new developments. Capacity building should be an important issue in this process.
- Research institutes and universities are doing proper research. They are willing to participate in a new project.
- Climate conditions vary depending on location. Some locations do not have any frost and some have temperatures of minus 8 degrees.

4 Sustainable production in South Africa

A sustainable alternative for coal can be solar energy. South African climate is ideal for the application of solar energy. First of all there is a sufficient of amount of solar energy also in wintertime (3.5 GJ in the second and third quarter of the year according to measurements by Fides). In wintertime the clear sky increases the efficiency of a solar collector. Secondly the climate is not very harsh. So by application of insulation the heat needs during cold nights can be kept minimal.

The application of sustainable energy as to be economically feasible for growers. The solar energy concept compeeds with the tradional way of heating by coal or is a way to extend the crop production to wintertime.

The coal installation costs come from the coal itself, the maintaince of the system and the labor needed to operate the system. The coal is prized currenty at around 800 RAND per ton.

4.1 Opportunities for solar driven heating and optionally cooling for sustainable horticulture and poultry farming in South Africa

Solar heat can be used for heating and optionally cooling of e.g. greenhouses and poultry farms.
Solar collectors convert solar energy into heat (hot water). Solar collectors are used for various purposes:

- generation of hot water,
- collection of heat for heating purposes,
- generating heat for driving thermal-driven cooling units,
- etc.

Heat collection efficiency mainly depends on the actual solar radiation, solar collector type and hot-water temperature setpoint. Generally speaking, the simplest (and cheapest) collectors have lower efficiency than the high-tech collectors (Table 1).
Thermal-driven cooling is far more expensive than heating because:

- high temperature water (preferably over 80°C) is needed; this demands for advanced collector types.
- absorption cooling systems are needed, with are quite capital-intensive.

Because of the relatively high solar radiation in the South African area considered, solar collectors seem very appropriate. Because of the cold nights, the heating function is most interesting.
Because of moderate relative humidity and cool nights, cooling demand is lower, and can be met with less expensive technology (such as pad and fan systems).

Solar collectors

Efficiency and net solar conversion (W/m^2) for photovoltaic modules and thermal collectors: flat panel, evacuated flat panel (EFP), and compound parabolic concentrator (CPC)

Type of solar collector	Efficiency expression	Efficiency η at specified conditions[a]	Net conversion (W/m^2) at specified conditions[a]	Cost per m^2[c]	Installed cost per Net kW elec. or thermal
Photovoltaic (PV), single crystal or poly-crystalline, not thin film	0.15	0.15	123	\$616–\$740	\$5500–\$6500[b]
[7]Flat Panel: single-glazed ($\tau_S = 0.86$), black paint ($\alpha_S/\varepsilon_{IR} = 0.96/0.96$)	$0.83–8.6(T_{coll} - \overline{T}_a)/q_S$	0 @ max. $T_{coll} = 111$ °C	0	\$175	Cannot reach T_{coll}
[7]Flat Panel: double-glazed ($\tau_S = 0.79$), black paint ($\alpha_S/\varepsilon_{IR} = 0.96/0.96$)	$0.76–4.9(T_{coll} - \overline{T}_a)/q_S$	0 @ max. $T_{coll} = 160$ °C	0	\$200	Cannot reach T_{coll}
[7]Flat Panel: single-glazed ($\tau_S = 0.89$), solar-selective ($\alpha_S/\varepsilon_{IR} = 0.90/0.20$)	$0.80–3.8(T_{coll} - \overline{T}_a)/q_S$	0.162	133	\$200	\$1500
[6]Flat Panel: double-glazed ($\tau_S = 0.79$), solar-selective ($\alpha_S/\varepsilon_{IR} = 0.95/0.15$)	$0.75–3.4(T_{coll} - \overline{T}_a)/q_S$	0.179	147	\$225	\$1530
Evacuated Flat Panel (EFP): etched single-glazed ($\tau_S = 0.95$), solar-selective ($\alpha_S/\varepsilon_{IR} = 0.92/0.10$)	$0.874–1.754(T_{coll} - \overline{T}_a)/q_S$	0.580	477	\$250	\$524
Compound Parabolic Concentrator (CPC): CR = 10, etched single-glazed ($\tau_S = 0.95$), solar-selective ($\alpha_S/\varepsilon_{IR} = 0.92/0.10$)	$0.613–0.381(T_{coll} - \overline{T}_a)/q_S$	0.549	451	\$375	\$831

[a] $T_{coll} = 170$ °C, $\overline{T}_a = 32$ °C, $\overline{K}_T = 0.60$, $\theta \approx 0°$, $\beta = 20°$, $\rho_{surr} = 0.2$, $q_S = 822\ W/m^2$.
[b] Cost of additional PV needed for HVAC added onto 3 kW array for non-HVAC usage.
[c] Equals retail price plus estimated installation cost of \$50/m^2.

Table 1. Solar collectors indicative costs and efficiency (Lambert and Beyene, 2007)

Table 1 gives an overview of efficiency and costs of modern solar collectors (for "house-owner scales"; for large-scale applications some discount is expected).
Heat production by solar panels will depend on:

- solar panel type
- collector or setpoint temperature (closely related with the chosen thermal chiller system)
- actual solar radiation (influenced by solar angle and weather conditions).
- hot-water buffer size and isolation.

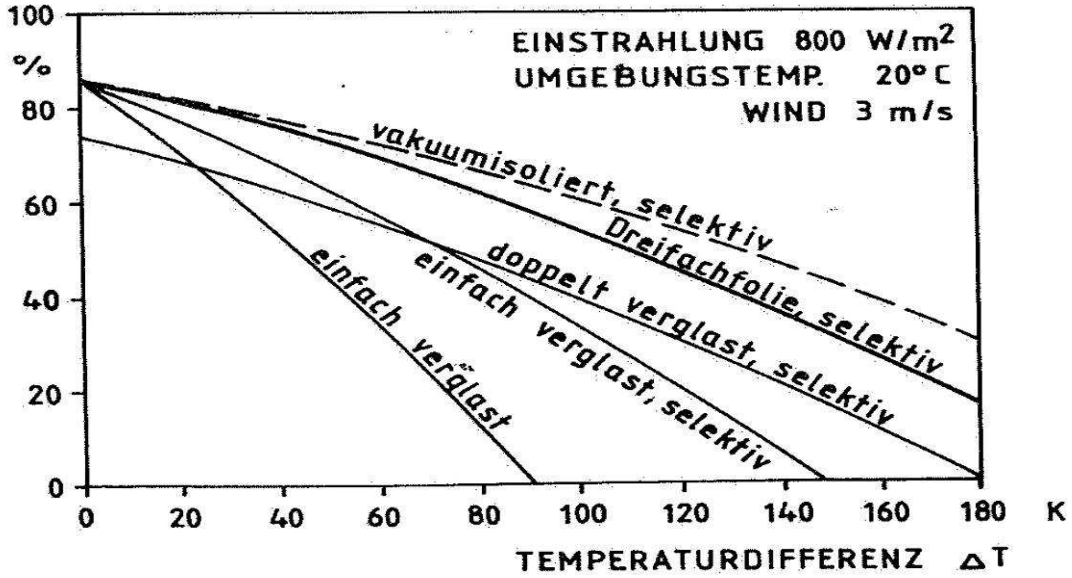

Figure 1. Efficiency of various solar collector types with solar radiation of 800 W/m2. Source: Alois Stork, Munchen

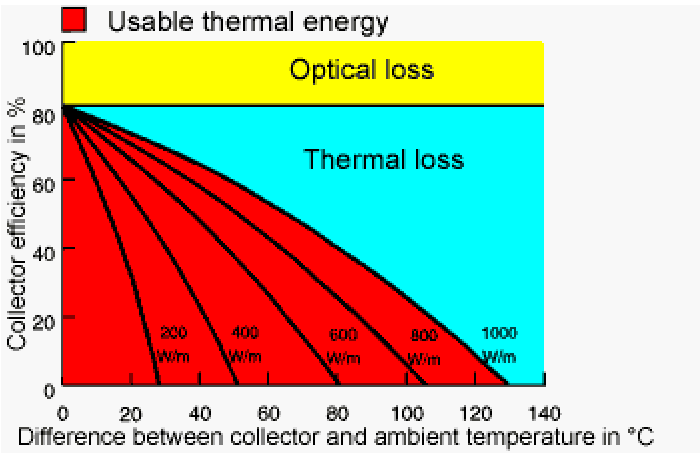

Figure 2. Figure 1. Dependency of solar collector efficiency for solar radiation intensity (flat plate collector). Source: www.apricus.com

Literature and further info

Lambert, M.A. and A. Beyene: Thermo-economic analysis of solar powered adsorption heat pump. *Appl. Thermal Engineering* 27, pp. 1593-1611 (2007).

4.2 The application of solar energy on greenhouses

The annual radiation is around 7.5GJ which is twice the amount of solar radiation in The Netherlands. Due to the clear skies in winter the amount of solar radiation is still 90% of that in the summer.
Solar radation can be collected relatively easy and stored into the form of heat using water. The most simple way is by placing a black plastic pipe in the sun and letting water run through it. The system can be made

more effective by placing a transparent cover over these pipes insulating the system. The efficiency of the system is expressed by the amount of solar radiation collected. Well insulated solar collectors can have an efficiency upto 80% (figure 1). The efficiency depends on one side on the insulation and transmissity of the system and on the other hand on the temperature level of the outgoing water. If the temperature level is to be around 80 degrees more losses can be expected than at 40 degrees. The wanted temperature depends on the application of the warm water. The size of the heat storage tank decreases with increasing water temperature.

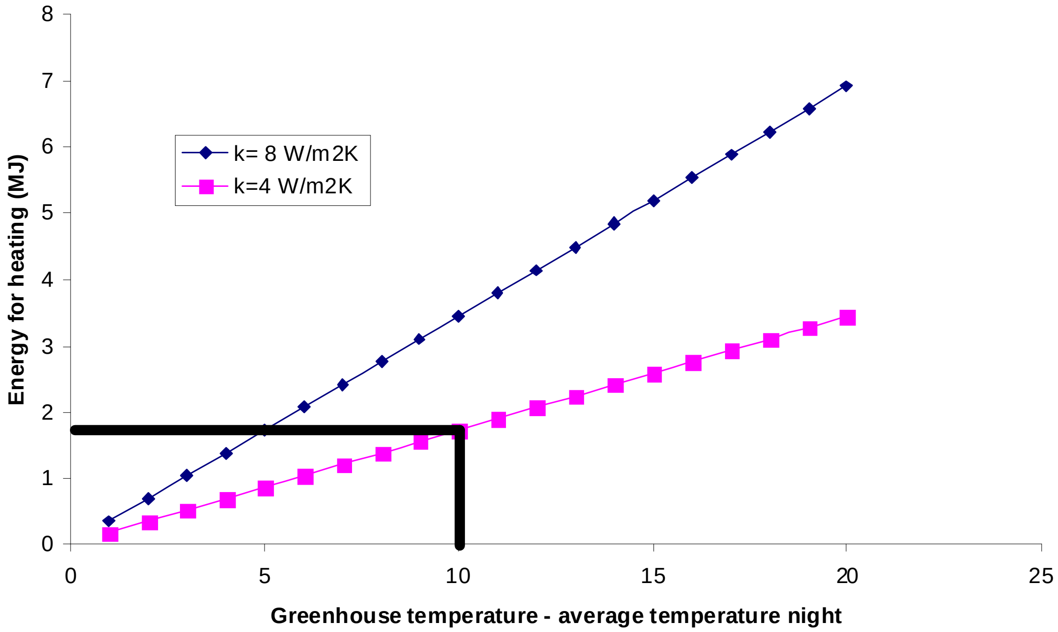

Figure 3. Energy needed for heating as a function of the temperature difference between the greenhouse air and the average night time temperature for a greenhouse with and without a screen

Figure 2 shows the energy use for heating for a greenhouse with and without an energy screen. (K value of 8 W/m2K or 4 W/m2K) for as a function of the temperature difference between the greenhouse air and the average night time temperature. For example is the greenhouse temperature is set to be 20 degrees and the average outside temperature is 10 degrees the energy use by the heating system is 1.8 MJ for that day if a thermal screen is applied. Based on a yearround simulation the size of the heat storage tank can determined. Losses on transporation of heat should be minimized by good insulation of the transport pipes and by storing the heat close to the greenhouse.

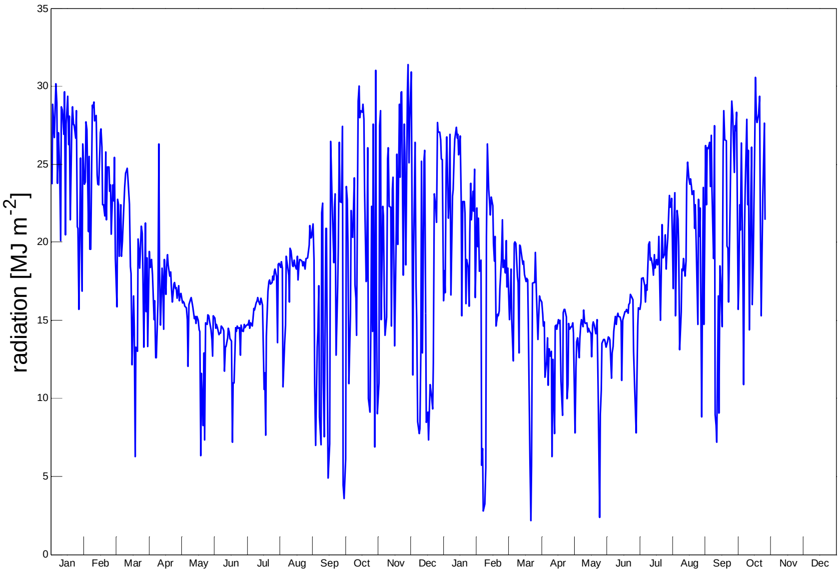

Figure 4. The radiation over the year 2007 and 2008.

The figure above shows the radiation near Krugersdorp over a two year period. The annual radiation is this area is 6.9 GJ/m2.

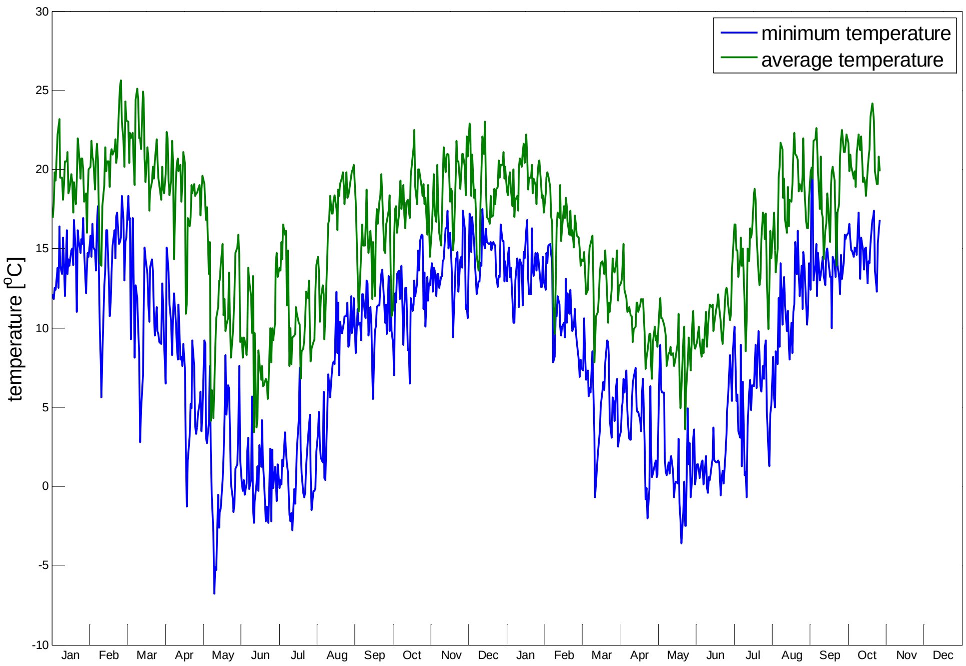

Figure 5. Average and minimum temperature over a two year period

Based on the radiation information and the temperature the size of the solar collector and the heat storage can be determined in more detail. The amount of heat collected over the year is based on the daily radiation, the size of the collector and the efficiency of the collector. The amount of heat which can be stored depends on the size of the daily heat storage and the maximum temperature at which it is stored. For the calculation this maximum temperature is set to be 70°C. The size of the heat storage is set to be 100 m^3 per hectare of greenhouse which is common in the Netherlands. The efficiency of the solar collector is set to be 60% for this temperature which is normal for a low tech solar collector as shown in the previous paragraph. The heat losses from the greenhouse depend on the minimum temperature maintained in the greenhouse and the heat transfer coefficient. The minimum temperature in the greenhouse is set to be 16°C.

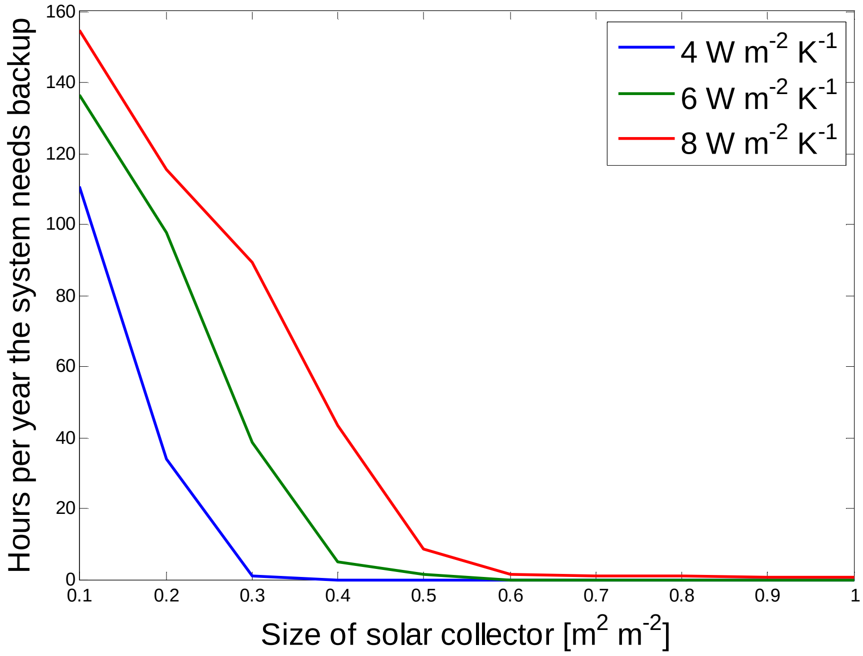

Figure 6. Hours per year the solar collector system does not supply a sufficient amount of heat as a function of the size of the solar collector for different heat transfer values of the greenhouse.

The figure above shows the amount of hours annually the system can not provide enough heat to keep the temperature in the greenhouse above 16°C as a function of the size of the solar collector. The size of the solar collector is related to the size of area of greenhouse. So when the size of the solar collector is only 10% of the area of the greenhouse 110 hours of the year the system can not provide enough heat when the heat transfer coefficient of the greenhouse is 4 W m^{-2} K^{-1}. The heat transfer coefficient of a greenhouse depends of the covering material and the application of a thermal screen. A glass greenhouse of a plastic greenhouse with IR treatment has a heat transfer of around 8 W m^{-2} K^{-1}. If a thermal screen is applied the heat transfer is reduced to around 4 W $m^{-2}K^{-1}$.
So a well insulated greenhouse can depend completely on solar energy by installing solar collectors covering 40% of the greenhouse area.

An economic evaluation of the application of solar panels in greenhouse horticulture is made.

Table 2. Estimates of the solar panel costs per MJ for different panel types

Collector type	*net conversion*	*heat collected per m2 per day*	*panel cost per m2*	*area needed per MJ/day*	*system cost per MJ/day*	*annual capital costs per MJ/day*	*per MJ (used 100 days/y)*
Flat panel, single-glazed	68 W/m2	1.7 MJ/m2	$175	0.58 m2	$102	$11.93	$0.12
Flat panel, double-glazed	211 W/m2	5.3 MJ/m2	$200	0.19 m2	$38	$4.39	$0.04
Flat panel, single-gl, solar-selec	290 W/m2	7.3 MJ/m2	$200	0.14 m2	$27	$3.20	$0.03
Flat panel, double-gl, solar-sele	280 W/m2	7.1 MJ/m2	$225	0.14 m2	$32	$3.73	$0.04
Evacuated flat plate, single glaz	437 W/m2	11.0 MJ/m2	$250	0.09 m2	$23	$2.65	$0.03
Compound parabolic concentra	349 W/m2	8.8 MJ/m2	$375	0.11 m2	$43	$4.99	$0.05

These calculations are based on write-off period of 15 years and interest rate of 8%.
Note that additional costs for ground, buffers and installation are not included.

Coal costs 0.03 Rand per MJ (annex 1), which is far below the listed costs of solar heat, but the operational and investment costs are not considered in this case. Including these costs and the fact that the price of coal is going to be higher in the near future, we are convinced that with smart solutions, solar heat can be a sustainable and feasible alternative. In Kenya a project using solar energy for heating greenhouses has been applied successfully as can be written in annex 2.

4.3 Solar heat in broiler production

Starting points for calculations:

- Growing period broilers: 6 weeks
- Temperature requirement (with linear interpolation between set points):
    - Day 1: 32°C;
    - Day 7: 26°C;
    - Day 14: 25°C;
    - Day 21: 22.6°C;
    - Day 21 – day 42: 22.6°C;
- Present heat use poultry farm: 400 MJ/m^2 per year
- 20 broilers per m^2
- Broiler house of 1000 m^2
- Efficiency solar collector: 50%
- Storage period solar energy: 1 day

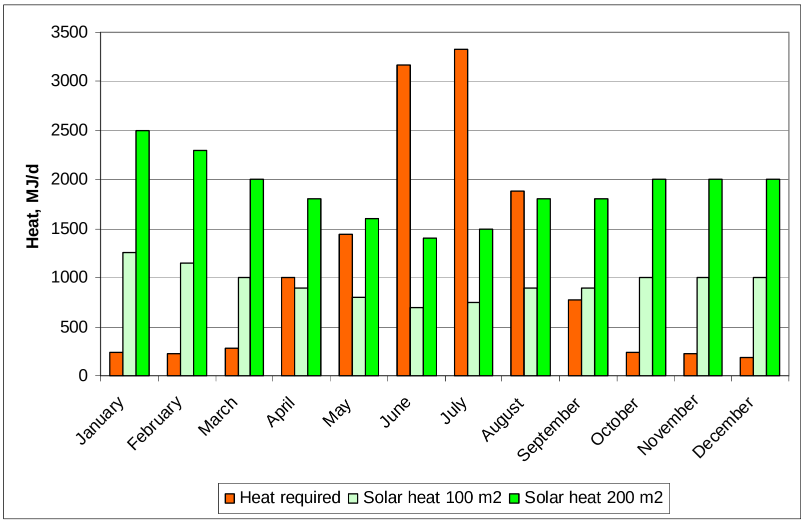

Figure 7. Average heat requirement per day for each month of the year for a house with 20,000 broilers and the average heat production from solar panels of 100 and 200 m2.

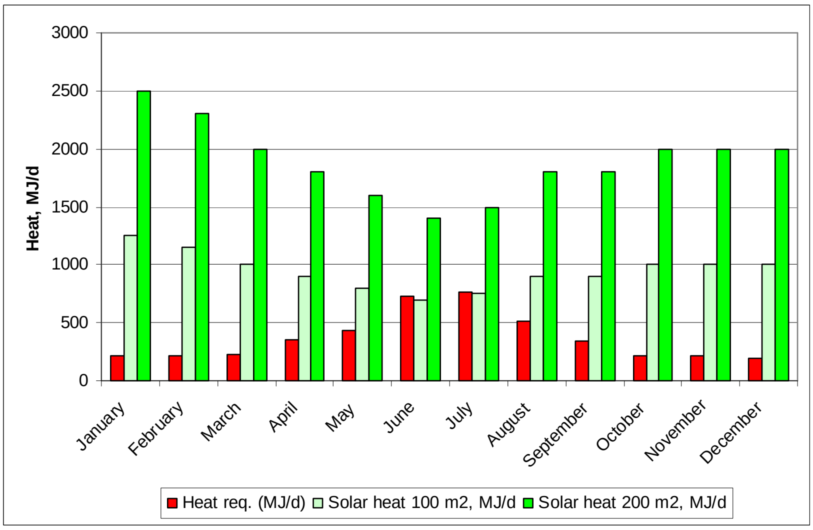

Figure 8. Average heat requirement per day for each month of the year for an optimal insulated and climate controlled house for 20,000 broilers and the average heat production from solar panels of 100 and 200 m^2.

In figure 8 the average daily heat requirement is given for each month of the year. In this figure the heat produced by solar panels of 100 and 200 m^2, respectively 10 and 20% of the floor area of the broiler house, is given, as well. This figure shows that there is a big variation in the heat required during the year. In 10 of the 12 month a solar panel area of 200 m^2 seems to be sufficient to deliver the required heat. Only in the winter months June and July a lot more heat is required. In this broiler house the heat required per year is approximately 400 MJ/m^2. This was the situation for the visited broiler farm in the area of Rustenburg. When the broiler house would have been optimally insulated and optimal climate controlled, then the heat requirement would reduce to approximately 135 MJ/m^2 (figure 9). Important points for improvement to reduce the energy requirement are a well insulated roof and a well controlled minimum ventilation. Furthermore, for broilers older than 3 weeks the set point temperature could be lowered.

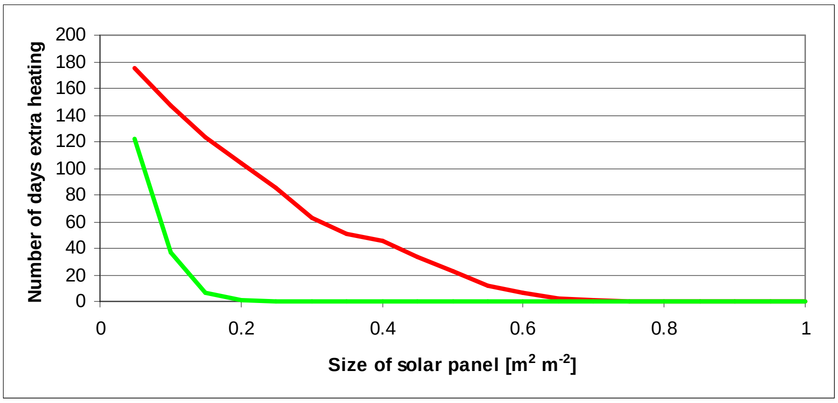

Figure 9. Number of days extra heating is required. Red line: situation broiler house Rustenburg area; Green line: for an optimal insulated and climate controlled broiler house.

Figure 10 shows the number of days extra heating is required during the year. The number of days extra heating is required can be reduced by storing the solar energy for a number of days and/or by increasing the size of the solar panels. For the optimal situation a solar panel area of 200 m^2 would be sufficient to heat the animal house during the whole year. For the present situation in the broiler house in Rustenburg area a solar panel area of approximately 700 m^2 would be necessary to heat the broiler house with 20,000 broilers during the whole year. It should be calculated, however, what the optimal size is of the solar panel, in relation to the extra costs of an extended solar panel and the energy saved by this extended area.

The solar panels could be installed on top of the roof of the broiler house. For new buildings the solar panels could also be integrated in the roof itself.

4.4 Water usage

The pad and fan system uses water for cooling. By evaporative cooling the greenhouse air is cooled. This method uses a substantial amount of water. Growers estimate that the water use by the pad and fan system is equal to the water use of the plants. Moreover the fans are operated by electrical power and are in operation almost yearround. There is no sustainable method available to replace this pad and fan system. Only by air conditioning the cooling can be done but this costs a tremendous amount of electrical energy. The only way to reduce the application of the pad and fan system is by reducing the amount of solar radiation entering the greenhouse. New techniques in this area are being developed where part of the solar radiation not contributing to the plant production is being reflected. The application of the new technique will not be successful if growers do not have to pay for their water.

5 Conclusions and the way forward

Main conclusions

- Growers are willing to use an alternative for the coal burning for heating.
- Governmental organizations are willing to participate in a project with the goal to make horticulture and poultry farming more sustainable.
- Simple calculations show that the potential of solar energy as an alternative for heating is realistic.

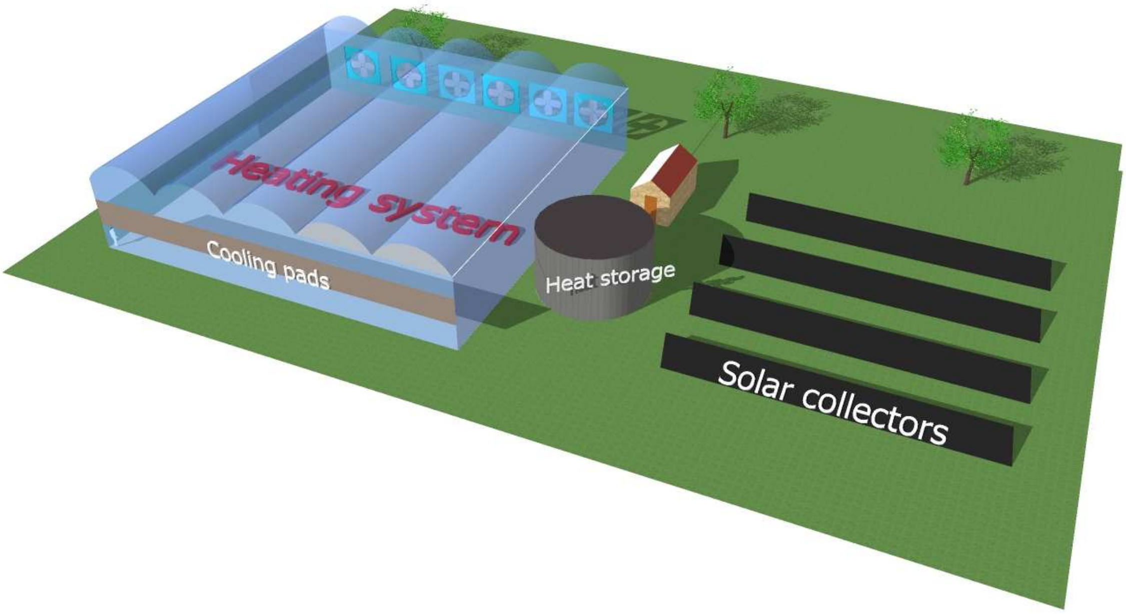

Figure 10. Artist impression of the research and demonstration center

Way forward

The concept of using solar energy has to be proven in practice. The saying "Seeing is believing" applies when new technologies are introduced. Though this is not a new technology as soon in the previous section, users what to see this technology working in their vicinity. Farmers want to be convinced the alternative heat source can be applied. For this reason a demonstration project has to be set up where the principle of using solar energy as a source for heating is demonstrated. The ultimate goal of the project is to make South African agriculture more sustainable

Subjects presented at the centre are:

- Using solar energy for heating
- Water use efficiency "More crop per drop"
- Application of covering materials

Concrete results from the project:

- Demonstration of sustainable heating system
- Training trainers to disseminate the knowledge to other farm managers and workers.
- To exchange best practices at farm level.
- To enhance the collaboration between government, universities and research institutes aiming at a shared focus and a higher performance of the sector.

Annex 1 Coal information by Fides

CMS

CMS Coal Marketing
Services (Pty) Ltd

Registration Number: 1995/07860/07

DATE: 24 February 2009

TO: **Safropa**

ATT: **Henk**

RE: **COAL SUPPLY QUOTATION**

With reference to our recent discussions, CMS has pleasure in forwarding an offer for the supply of coal for delivery as detailed below.

INTRODUCTION

CMS Coal Marketing Services is a national distributor of coal, including neighbouring states. We have sound relationships with both large and small coal producers, plus exclusive marketing agreements with some producers which ensures quality conformity and consistency of supply. CMS has an alliance with some of the largest road transporters in the coal industry, which allows for excellent transport rates and timeous deliveries. Our years of experience in the coal industry coupled with our policy to supply selected reputable consumers only, ensures a high level focussed service.

PRICING AND SPECIFICATION

Element	Peas ex Twistdraai
Calorific Value	+26.56Mj/kg
Ash	12.5 %
Volatiles	29.7 %
Inherent H20	4.8 %
Fixed Carbon	By difference
Sulphur	0,72 %
AFT	+ 1400°C
Sizing	6 x 25 mm
Delivered Price	R765.00per ton

Unit 2, Midway Office Park, 181 Girdwood Avenue, Boskruin, 2154, South Africa
P O Box 689, Strubens Valley, 1735, South Africa
Tel +27 11 801-8060 **Fax** +27 11 792-6952 / url: www.cmscoal.co.za / e-mail: info@cms.co.za
Directors:, ADJ Rayment (Managing), SB Barnard, SX Mpingwana, PCJ van der Merwe

Annex 2 Project in Kenya

Greenhouse heating with free-of-charge energy

Two years ago the Kenyan rose nursery Bilashaka Flowers, part of Zuurbier & Co. and Van Kleef Kenya, received a lot of attention because of its revolutionary solar heating system. The system works well and improves both yield and quality of the roses. As a result of the success, the number of solar panels is going to be doubled. There is also interest from other growers, but none of them have yet taken the step of installing the system.

By Ulko Reinders

The solar catchment area is 3,200 m². This capacity is enough to heat all 18 ha of greenhouses for a few hours in the early morning.

Bilashaka Flower director Joost Zuurbier in front of the greenhouses and the solar heating on the right side of the green buffer.

The boiler is used occasionally during very dark days in the period July/August.

The outlet of the solar heating system from where the water is pumped to the buffer.

The solar heating system at Bilashaka Flowers, situated at the north side of Lake Naivasha in Kenya, was officially inaugurated by the Kenyan Minister of Agriculture in February 2007. Now, with two years of experience the system has proved its added value, as Joost Zuurbier, director of Bilashaka Flowers, commented: "We clearly see a difference between roses grown with and without heating. The most important advantage is the reduced pressure from downy mildew and *Botrytis*. This is due to the dryer climate in the greenhouse in the early morning."

Zuurbier explained that the heating is switched on between 4:30 and 5:00, when the temperature drops below the dew point and condensation starts. These humid conditions make it easy for the fungi to spread, which can cause major problems in roses. This is prevented by increasing the temperature by 5°C. "Because of the lower pressure from diseases and less spraying, the quality of the roses is better: the buds are larger, the stems are longer and the yield is higher," Zuurbier commented. The average yield at Bilashaka is 235 stems of medium-sized roses per square metre. At the moment, all greenhouses benefit from the heating system but to extend the period of heating every day the system will soon have double the capacity.

After Cor Zuurbier (who also owns a 13 ha rose nursery in the Netherlands) and his daughter Judith (owner of Van Kleef Kenya) bought Bilashaka Flowers in 2001, they installed a boiler fuelled by kerosene. After that year, however, the oil price started rising fast and running the boiler became too expensive. For the sake of the quality of the roses, the Zuurbiers wanted to continue heating so they started to look for alternatives, eventually opting for the solar system – not illogical in light of the high solar radiation in Kenya.

The Zuurbiers approached Frans van Zaal Totaal Techniek, who developed the system. Together they calculated a payback period 1.5 years for replacing the existing boiler with the solar energy system for heating.

The project was partly financed by the Programme for Cooperation with Emerging Markets (PSOM) of the Dutch government, which was possible because of the innovative character of the project and the location in a developing country, which are the conditions for receiving the finance.

How the solar heating system works

The working of the system is quit simple: by exposing water to solar radiation, it gets heated up. When a temperature of about 50°C is reached, a pump starts operating and the water is pumped to a buffer tank. From the buffer, with a size of 800 m³, the water is pumped through the greenhouses when heating is required.

For more exposure to the sun, Van Zaal developed right-angled metal water pipes that are set up outside under sheets of glass to intensify the heating effect. The size of this solar catchment area is 3,200 m². This capacity is enough to heat all 18 ha of greenhouses for a few hours in the early morning.

To heat for a longer period, Zuurbier is going to double the capacity of the solar heating system. As a back-up, Zuurbier occasionally uses the boiler, but only during very dark days in the period July/August, because of the high costs of kerosene.

Interest from all over the world

Until now Van Zaal had only installed the solar heating system at Bilashaka Flowers. According to Gerard Peek, sales manager at Van Zaal, there is quite some interest from all over the world. "But growers have problems with the investment needed to install both the heating and solar systems," he added.

At the moment, heating is not the top priority for growers in Kenya. Especially not at this time when rose prices are under pressure, making growers tend to reduce their costs rather than to invest in techniques to improve production.

Despite this objection, Peek still believes the system is a good choice for growers: "The maintenance and running costs are very low, so once the investment is recovered, the heating is practically for free." Other arguments that persuaded Peek of the favourable changes for the system are the increased demand for quality roses, the expected rise of oil and gas prices and the increased pressure from governments on CO_2 emission.

Most economical solution

Interest in the system mostly comes from rose growers, but growers with different flowers have also approached Peek for an offer. In most cases, the purpose of the installation is to keep the greenhouse dry in the morning. For countries with a lot of sunshine and with cold nights, Peek believes that the sun collectors are the most economical solution. "Cooling down below the ideal temperature may harm the crop and can also cause moisture in the early morning as the relative humidity can rise too much, so there must be a possibility for heating," Peek explained.

When drying is the main purpose, heating is particularly necessary in the rainy season. On these days, however, the weather is cloudy and as a result less solar energy can be collected. According to Peek, the reduction of energy collection during cloudy days is about 75% compared with a sunny day. However, it does not pay to increase the capacity. "Therefore, it is better to install a boiler as back-up for cloudy days," Peek advised. ■

Source: Flowertech 2009, vol 12, nr 5