



Reducing energy costs up to 40%

Cost-effective use of solar energy in East African horticulture

Green Farming
Demonstration Project



Green Dutch
Energy Solutions;
solar-powered
greenhouse



The link between Dutch and East African horticulture



Green Farming is a Dutch programme that unites horticultural networks in the Netherlands, Kenya and Ethiopia. This is achieved by setting up joint activities, projects and co-operations in the areas of research, development and production.

All Green Farming activities are related to one or more of the five main themes of the programme:



Water management



Crop management



Climate and energy



Post-harvest and logistics



Research and knowledge exchange

Who is involved?

The Green Farming consortium consists of over 25 leading Dutch companies in horticulture technology. Wageningen University and Research Centre supports the programme and is actively involved at the level of research and knowledge exchange.

Green Farming is coordinated by AVAG, the representative of joint Dutch horticultural suppliers, and by DLV Plant, active as an advisory company in the international agribusiness. The Dutch Ministry for International Trade and Development Cooperation supports the programme in close cooperation with the Dutch Embassies in Nairobi and Addis Ababa.

What are the activities?

Green Farming organizes a broad spectrum of activities, both at business-to-business and government-to-government levels.

The business-to-business activities include:

- Market studies and sector reviews
- Exhibition visits and participation
- Trade missions
- Matchmaking
- Seminars
- Demonstration projects

Green Farming sets up various demonstration projects together with local businesses and knowledge institutions to show which technologies, products, knowledge and services are available and how these can be applied to the local situation. The results in terms of production levels, efficiency of input use, production costs and revenues are shared with the sector via open days, professional journals and seminars.



Need for an affordable and reliable energy supply



Energy prices in East Africa are expected to keep rising over the next few years. Investing in an own energy supply is already an attractive prospect. It provides horticultural businesses with considerable cost savings and enables them to be less dependent on the uncertain electricity supply. The sun is a constant source of energy which could be much better utilized.

The expectation is that the acreage with greenhouses in Kenya and Ethiopia will increase over the coming years. The high increase in production costs is inducing entrepreneurs to apply more efficient and more advanced technology in their businesses. Increasing demands from the international market in regards to continuity, uniformity, quality, volume and sustainability is also generating developments in the areas of technology, service and knowledge-exchange.

Energy problems

Energy prices have soared over the last few years, and the electricity is sometimes of very poor quality. The uneven current causes damage to equipment in many places and there are regular power cuts. Furthermore, weather conditions are resulting in a growing interest in being better able to control the greenhouse climate. At the moment, most greenhouses are still unheated. Heating can reduce a number of cultivation problems, such as fungal infection. It can also increase the quality of the product and production levels.

Utilizing the sun

Kenyan businesses are increasingly focusing on reducing energy costs. They are familiarizing themselves with energy-efficient systems and applying sustainable energy, including solar power. Solar energy is readily available in Kenya and in Ethiopia.

“Solar energy is cheaper in the long run. It is sustainable, of good quality and is constantly available.”



Solar energy used in practice

In autumn 2013 the demonstration project 'Green Dutch Energy Solutions; solar-powered greenhouse' was put into practice at the farm of rose breeder and propagator Olij in Naivasha.

Over a period of two years this project will provide the East African sector and Dutch partners with information about the opportunities of solar energy in horticulture. The expectation is that Green Farming will demonstrate that horticultural production in East Africa could go a long way towards being self-supporting in electricity and greenhouse heating.

Goals of the project

With the implementation of proper technology and management it is possible to run greenhouses independent of the national grid, at lower energy costs than traditional systems. That is the main output that Green Farming wishes to show with the solar project.

Payback time

The financial advantages will result in an attractive payback time on the solar system. If the system is used only for generating power the estimated payback time of the installed technology is at most four years. If it is also used for heating, the payback time will be shorter.

If electricity prices increase, the return on investment period will decrease simultaneously.



Implementation

The farm of Olij consists of 3 hectares of greenhouses used for rose propagation and breeding. It is located in Navaisha, at an altitude of about 2000 meters above sea level. The temperature here is normally between 20 and 26 degrees Celsius in the daytime and between 10 and 15 degrees Celsius in the night. Although there is 12 hours of daylight per day throughout the year, the intensity of the light varies; as a result, maximum solar radiation is achieved for around 5.5 hours per day.

In this project solar energy is used to accommodate the energy requirements of the farm. Solar panels are installed to produce electrical energy and solar heat collectors generate thermal energy. Some sections of the farm are also lit with artificial lighting. A generator can be used to power this off-grid.

Part of the energy that the solar panels produce is directly used by pumps and motors in the greenhouse. The excess energy is stored in a battery-pack from which energy can be tapped during the night. The solar collectors are installed to heat part of the farm: three greenhouses totalling 4000 m². These greenhouses are heated during the night by warm water flowing through pipes, which are installed below the cultivation table in the greenhouse. The heating prevents diseases and increases production.

Expected results

Green Farming aims to demonstrate with this project that:

- It is possible to run a greenhouse independent of local energy suppliers.
- Energy costs can be reduced by 40 percent.
- Production quantity and quality can be increased.
- The greenhouse climate can be more balanced.
- The use of pesticides can be reduced.
- A lower system maintenance is possible.
- The risks and costs resulting from power cuts and dirty power can be lowered.
- Horticulture production can be environmental friendly.

Expected output

All inputs and outputs are registered by the computer. This includes the electric energy consumption and the consumed amount of expensive emergency power. A year-round profile of input needs, production results and required running costs is made available every year. Ultimately, the project will result in a report on savings on energy costs linked to production results and a financial business plan.

The running costs remain low while the returns increase thanks to the use of solar energy and the improved production results (due to lighting and heating of the greenhouse). Calculating the eventual payback time for the installed technology forms an important outcome of the project.

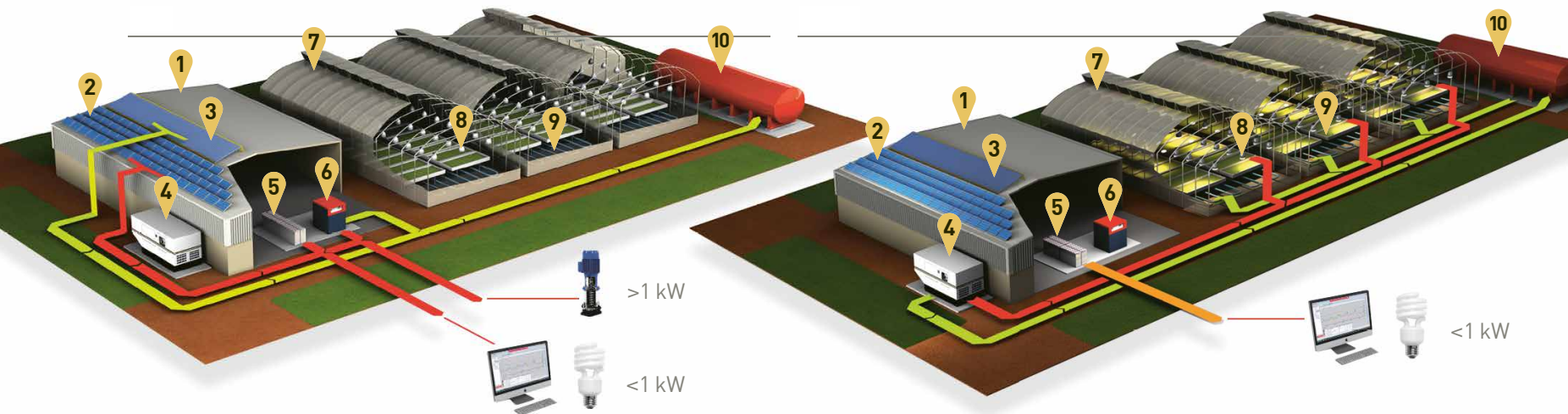
Project partners

The project is an initiative by Green Farming member Van Zaal, in cooperation with Green Farming members Bosman, DLV Plant and Hoogendoorn Growth Management.

The consortium is cooperating with Olij in data recording, processing and data analysis. Olij Kenya Investments is part of the Olij Group and is well-known for their good performances in providing the international rose business with high-quality starting materials and new rose varieties.

Green Farming Demonstration Project solar-powered greenhouse

Technical data demonstration project solar-powered greenhouse



- 1: Processing area 2: PV panels (electricity) 3: Solar heat collectors (water) 4: Cogeneration unit (CHP) 5: Battery pack 6: Electrical boiler 7: Horticultural greenhouse
8: Greenhouse lighting 9: Greenhouse heating 10: Heat storage tank

The drawings show what the Green Dutch Energy Solutions can look like. In the demonstration project at Olij the generator is only used as a back-up in case of power cuts.

The solar panels (PV panels)

Solar panels (no. 2) are installed on top of the packing hall to collect solar radiation. During the daytime the PV panels generate 440 kWh of electrical energy. The farm uses on average 22.5 kW of electric energy per hour: 35 kW per hour during the day and 10 kW per hour during the night. The energy required to run pumps and motors in the greenhouse can directly be used. Excess energy can be stored in a battery-pack and can be used for energy consumption during the night.

When the battery-pack is fully charged, the surplus electric energy can also be transformed into thermal energy (warm water). This can be

realized via a multi-step heating process in the electrical boiler. The advantage of installing the panels on the roof is that the building below remains cool as no direct radiation reaches the roof surface.

The solar heat collectors

Solar heat collectors (no. 3) are installed to heat three greenhouses totalling 4000 m². The solar collectors catch solar radiation and heat water to 55 degrees Celsius. At this temperature solar collectors reach their optimal efficiency. The warm water is stored in a heat storage tank. During the night the greenhouses are heated by the warm water, which is passed through a piping system. The pipes are installed below the cultivation tables inside the greenhouse.

To heat the greenhouses for 10 hours, approximately 1500 kWh of energy is needed. The largest part of this energy is supplied by the

solar collectors. The rest of the required thermal energy comes from the electrical boiler.

The solar collectors are installed on the roof like the solar panels. No direct radiation reaches the roof surface so the packing hall below remains cool and less energy for cooling is required.

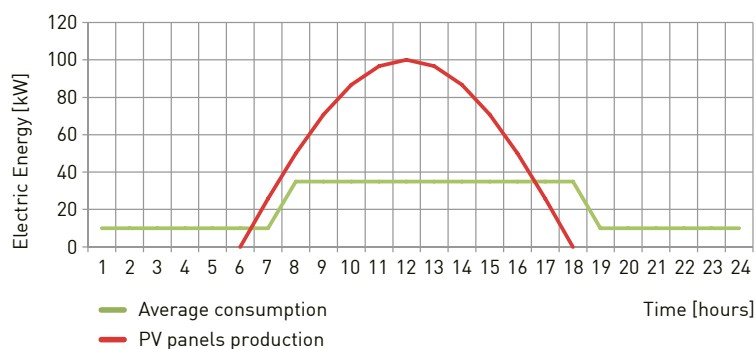
The generator (cogeneration unit – CHP)

A generator has been installed as a back-up for power cuts. It has an extra stainless steel plate heat exchanger in the cooling water system. When it is necessary to run the generator, the water used to cool it down generates thermal energy. This energy is used to heat the water in the heat storage tank up to 95 degrees Celsius.

The thermal energy derived from the cooling-water of the generator is thus combined with the energy generated by the solar heat collectors.

The graph below shows the generated electric energy and the energy consumption during the day. The red line shows the energy produced by the solar panels (PV panels). The green line represents the average energy consumption of the greenhouse. The solar panels generate electric energy from sunrise to sunset. During the daytime the energy is used to run the business and the battery-pack is being charged.

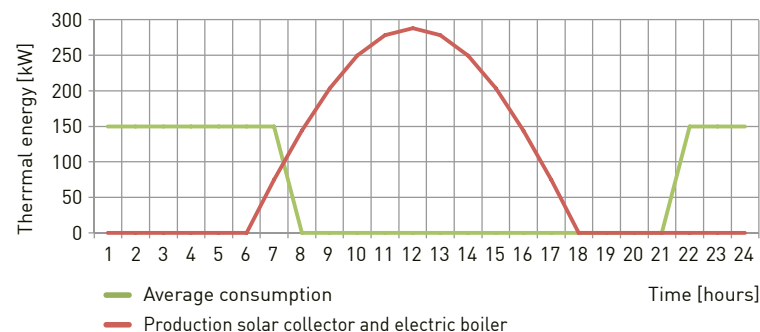
Electric energy generation and consumption during the day



The second graph shows the produced thermal energy and its consumption during the day. The red line shows the thermal energy produced by the solar heat collectors and the electrical boiler. The green line represents thermal energy use in the greenhouse.

The solar heat collectors generate thermal energy from sunrise to sunset. Transformation of surplus electrical energy into thermal energy by the boiler also takes place in the daytime. Greenhouse heating is applied from late evening to shortly after sunrise.

Thermal energy production and consumption during the day



The battery-pack

Excess energy that is produced by the solar panels during the day can be stored in a battery-pack (no. 5). This energy can be used for energy consumption during the early morning and late afternoon hours when the solar panels do not generate enough electric energy to power the greenhouse processes. Energy stored in the battery-pack can also be used during the night hours. The total storage capacity of the installed battery-pack is 264 kWh.

The electrical boiler

From the moment the battery-pack is fully charged, any surplus electric energy can be transformed into thermal energy. This can be realized with the electrical boiler (no. 6) via a multi-step heating process. The electrical boiler is connected to the solar panels and battery-pack by computer. When there is an energy surplus it reacts automatically to their signals and starts up a step-wise process of using the surplus electric energy to heat water inside the boiler. This warm water is then stored in the heat storage tank and is used for heating.

Optimizing energy management

To manage the energy flows and processes, special software has been installed on the computer. This enables optimal use of the electrical energy stored in the battery-pack and the hot water in the heat storage tank. The computer software feeds the energy management programme with local weather predictions to ensure optimal energy generation and consumption planning.

Prognosis

The Green Farming demonstration project is not only interesting for Kenyan horticulture, but also for other cultivation concerns in East Africa. In most horticultural businesses in East Africa, installation can take place without large modifications.

There are no signs that the electricity price in Kenya will decrease over the next few years, on the contrary. The same applies to surrounding countries. In Ethiopia the electricity price is lower than in Kenya: 5 cents per kWh against 17 cents in Kenya (October 2013), but even there the price has doubled over the last few years.

It is expected that with the solar installation, Olij will be largely self-sufficient in respect of electricity and heating for the 4000 m² for which the solar heat collectors are used. Only the artificial lighting system is now connected to the grid. This could also be powered by a generator. In the long run, Olij expects not to receive any electricity bills. The company also expects better production results thanks to the heating.

An added advantage of generating own energy is that the quality of the energy is better and the supply is more reliable. In Kenya – and to a greater degree in Ethiopia – electrical installations are damaged by ‘dirty’ energy. Power cuts create higher operating costs.

The expectation is that the project will stimulate horticultural entrepreneurs to use solar energy for covered crops as it is not only financially interesting but also contributes towards a more sustainable production process.

During 2014 and 2015, Green Farming will gather and process the results and share them with the horticulture sector in East Africa.

Significance for the sector

The East African horticultural sector is eager to start using alternative energy sources. Horticultural businesses are really interested in bringing their electricity bills down. Many entrepreneurs are familiarizing themselves with solar power in order to reduce their immediate operating costs. They are eager for test results and innovative technology that has proven itself in practice. Just like the Green Farming Water Management demonstration project, the solar-powered greenhouse demonstration project shows what is actually achievable in African practice.

Generating thermal energy by solar collectors is not new in Kenya and the surrounding countries, but it is the first time that three techniques have been combined: converting solar energy to electricity, storing it in a battery-pack and also using it for heating. Storing surplus capacity in the form of heat ensures more efficient use of the solar panels, no energy is lost. This produces a faster payback time.

Compared to other businesses, Olij has extensive equipment; it has heating and artificial lighting in part of the business. Most flower production farms in East Africa are not heated, so using solar energy for that purpose is something for the future. Also the use of artificial light is not common practice. Because Olij is an atypical horticultural company, the results of the three different techniques that are used will be monitored and reported separately. This will allow entrepreneurs to extract from the demonstration project exactly the information that can be applied to their businesses.

Project partners



Bosman

Bosman BV is a business-to-business turnkey solutions provider. With more than 90 years of experience, Bosman BV has been active in the horticultural and agriculture industry providing solutions through design and construction for commercial greenhouses, installation technologies, and solar solutions. In East Africa Bosman BV focuses on providing water technology solutions as an answer to market demands. To insure quality support and service in the region, Bosman BV has established an office in Kenya.

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DLV Plant

DLV Plant is a leading, independent international advisory and research partner for the agricultural and horticultural sectors. Its activities are aimed at cultivation advice, research and projects in the Netherlands and abroad. DLV Plant has more than 175 knowledge-driven consultants working worldwide, with offices in Africa, Latin America and Europe, and has a strong network within the agricultural, horticultural and affiliated sectors.

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Hoogendoorn Growth Management

Hoogendoorn is known as the most innovative supplier of process automation in the horticultural industry and has worldwide experience in greenhouse automation projects. Our user-friendly irrigation, climate and energy software is customized for farms and 'open field' projects in East Africa. Energy and water savings combined with an optimum climate are easy to achieve with Hoogendoorn's products. To guarantee 24 hours service, maintenance and spare-parts, Hoogendoorn works with local partners in Ethiopia, Kenya and South Africa.

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Van Zaal

From the Greenport Aalsmeer, Van Zaal develops, manufactures and installs a wide range of technical systems for greenhouse horticultural and commercial-industrial sectors around the world. The company is divided into three business units: Logistics, Climate & Energy and Service & Advice. For East Africa Van Zaal supplies engineering, installation, operation and maintenance of sustainable energy solutions such as complete solar energy systems and bio installations.

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Partners for Perfect Solutions

Connecting horticultural networks
of the Netherlands, Kenya and Ethiopia

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This publication is printed on FSC® certified paper.



October 2013

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