



Solar Magazine

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Power for Africa: solar hybrid systems for rural electrification

Developing and third-world countries are the losers of accelerated climate change. These countries that largely rely on agriculture are severely affected by extreme weather conditions and changes in climate conditions. However, they do not have the money to adapt accordingly. And the increasing scarceness and rising prices of fossil fuel oil hamper their development. It is against this background that rural electrification with reasonable renewable energy becomes of particular importance, because decentrally generated electricity allows access to clean water, to health care services, education and economic development.

Solar Energy System of the Month as [PDF-Document](#)



Solar power system on the roof of a church in Mbinga (Tanzania); Solar modules, inverters and batteries ensure power supply far away from the electricity network. Photos: Energiebau Solarstromsysteme GmbH

The Cologne-based company Energiebau Solarstromsysteme GmbH and the development organisation Internationale Weiterbildung und Entwicklung gGmbH (InWEnt, Bonn) developed a concept for electricity supply with photovoltaic systems and vegetable oil generators and successfully implemented this hybrid technology in numerous reference projects. In January 2007 they received the "Roy Family Award 2007" for their achievements. This prize is awarded every two years by the Harvard University (John F. Kennedy School of Government). The award recognises successful public-private partnerships in the field of environmental protection. As solar system of the month of February 2007, the Solarserver presents the solar power system combined with a vegetable oil generator operated by the Vincentian Sisters in Mbinga (Tanzania). This solar hybrid system provides clean electricity day and night to 140 people in various institutions run by these sisters.



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Only a few rural regions in Africa and the Third World are connected to the electricity network. Decentralised power supply from solar and biological energy is an economically and ecologically feasible alternative. Picture, right: nuts of the oil-yielding jatropha plant. Photos: Energiebau Solarstromsysteme GmbH

Many regions without electricity; diesel for generators is expensive and uneconomical

Around the world 1.5 billion people must live without electricity. In the rural areas of Africa electricity, if generated at all, is produced with diesel generators, since the establishment of a central power supply with a network of power lines is economically not feasible and far too expensive. Self-sufficient solar power systems that do not depend on a grid offer a reliable alternative. If, however, besides solar radiation diesel fuel is continued to be used as a second combustible, the people will remain dependent on this fossil fuel that is generally transported over long distances. The price for diesel in Tanzania amounts to approx. one euro per litre, i.e. a price that is comparable to that in Europe. Income, however, is significantly lower. The dramatically increased crude oil and diesel prices are an enormous burden for many countries in Africa and Asia, particularly in the rural areas.



People living in developing countries generally pay similar prices for imported crude oil products as Europeans do, but earn significantly less. Picture, right: press to manufacture vegetable oil from jatropha nuts. Photos: Energiebau Solarstromsysteme GmbH

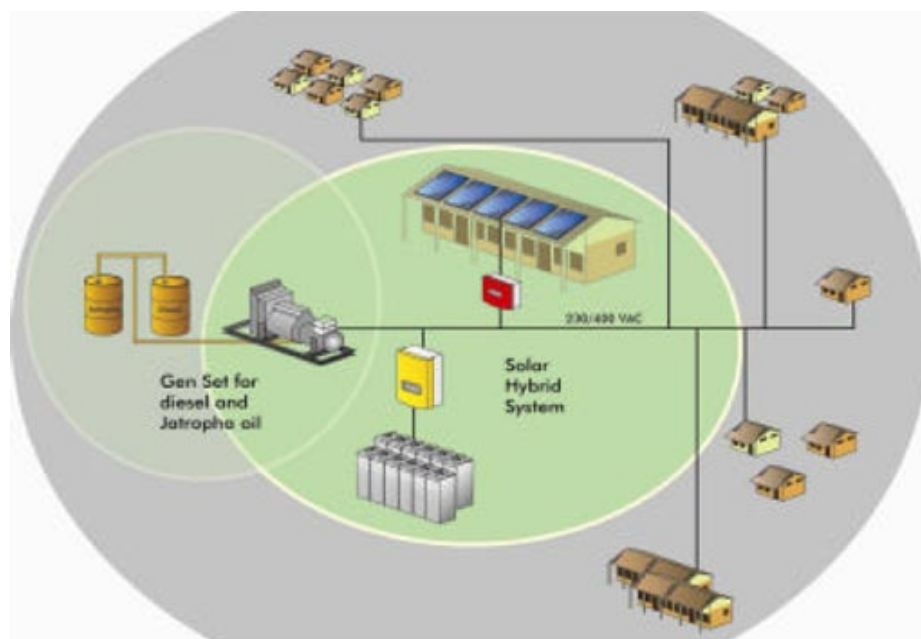
Jatropha plantations replace oil imports

The above reasons led Energiebau Solarstromsysteme GmbH to develop a technology in which generators can also be run on pure vegetable oil that is won on site with a simple mechanical press from the oil-producing jatropha plant. This plant originating from South America even grows in very dry regions in barren soil. Jatropha nuts contain high degrees of oil but are inedible for humans and animals. Thus, neither on agricultural fields nor among fruits, competition is created between the cultivation of food and these energy-yielding plants. Jatropha oil not only solves the problem of high fuel costs; also the inefficient transport of diesel fuels over long distances as well as the environmental hazards posed by diesel, can be avoided. Furthermore, the rural population can generate additional income from planting and

selling jatropha. Thus, on the basis of renewable energy, reliable and sustainable energy supply can be established.

Electricity from sunlight and vegetable oil

The solar hybrid system of the sisters consists of a photovoltaic system for the direct conversion of solar energy to electricity in a generator that runs on pure vegetable oil, as well as inverters and batteries. Since the end of August 2006 the solar vegetable oil system provides electricity to the educational centre of the Vincentian Sisters in Mbinga that consists of twelve buildings. In their convent the "Good Vincentian Sisters" thus lead the way for sustainable development, because they also do without diesel and produce the oil required for the generator themselves from jatropha nuts.



Schematic presentation of a solar hybrid system for basic electricity supply with a (vegetable oil) generator for peak loads. Graphics: Energiebau Solarstromsysteme GmbH

If the field of solar modules and the capacity of the battery system are designed accordingly, maximum supply security can be achieved even in times of less sunshine, which however occur less frequently in Africa than in Central Europe. 81 'Schott ASE 100' solar modules with a total peak performance of 8.1 kW (kWpeak) supply solar direct current to 6 'SMA Technologie AG' inverters. These three 'SMA SI 4248' and three 'Sunnyboy SB 3800' convert the solar power into alternating current, as we know it from our sockets here at home too. The modules cover a surface of approx. 80 m² and were mounted on the roof with a 'LORENZ PLUS' supporting structure manufactured by Energiebau Solarstromsysteme GmbH. According to calculations by Energiebau the investment in solar energy production under Africa's sun will have paid off after 10-15 years, so-called energetic amortisation is achieved even faster: within two to five years, the solar power system will have produced as much energy as was required for its manufacturing.

A model for the whole of Africa

During assembly of the solar power system, the sisters in Mbinga gained some hands-on experience and acquired knowledge and skills to conduct maintenance work on the existing and future smaller photovoltaic systems in other institutions. They don't want their pupils to lag behind modern technology and unrestricted power supply provides new perspectives in achieving this goal. For the Vincentian Sisters, who are concerned about the economic and ecological development of their country, reliable, economic and ecological power supply is a big gain. "Generating electricity from solar energy and jatropha will be a great help for Tanzania. This can become a model for the whole of Africa," Sister Kaya says.



Sisters assembling solar modules on the church roof; a practical introduction to solar technology. Photos: Energiebau Solarstromsysteme GmbH

The vegetable oil generator by the manufacturer Kuboto that is only switched on during particularly high power consumption peaks, was adapted by Energiebau Solarstromsysteme GmbH to run on jatropha oil rather than diesel. Its output is 30 kilowatt (kW) at 1 500 rotations per minute and a consumption of 0.34 litres to produce one kilowatt hour of electricity. The photovoltaics system alone produces a daily output of 35-40 kWh of clean electricity. The vegetable oil generator thus only runs for about 2.5 hours a day. The total solar hybrid system cost the sisters approx. 100 000 euro. Every litre of jatropha oil saves almost one euro in comparison to diesel.

Solar power covers base load, generator covers peak loads

During times of low electricity consumption and high solar radiation, the batteries are loaded. Thus the solar power system was not designed to cover peak loads; it serves to cover the basic electricity demand. Peakloads, for example when machines are operated, are covered by the generator.



Generator control panel (left foreground). About two dozen batteries guarantee power supply around the clock. Photos: Energiebau Solarstromsysteme GmbH

By combining a solar system with a photovoltaic system, the photovoltaic system can be significantly smaller. The costs of the overall system are thus lower than in a pure solar power system. And the fuel costs are reduced to a minimum.

On the way to total independence from crude oil

The list of institutions established in Tanzania by the Vincentian Sisters in the past 40 years is long: it includes a maternity ward, nursery schools, general schools, as well as schools of home economics and agriculture. 18 of these institutions were successfully built up in Africa by sisters from the Swabian village Untermarchtal since 1960. Today seven German and 183 local sisters live and work here. The convent of sisters in Mbinga is fully self-sufficient. The sisters run numerous workshops, e.g. a carpentry workshop, a metal workshop and a book-binding workshop as well as a textile processing workshop in which local sisters receive thorough training in the various trades.

Workshops and schools cannot be operated successfully without reliable power supply. The Vincentian Sisters, however, were no longer prepared to spend an ever increasing share of their financial means for diesel fuel in order to be able to run

generators, particularly since this money, to the largest degree, consists of donations. Eventually high fuel costs even led to certain machines and urgently required equipment only being run on an hourly basis. Now the energy required comes from heaven – and from the earth.



The future with renewable energy: nursery school in Mbinga, jatropha plantation.
Photos: Energiebau Solarstromsysteme GmbH

Two years ago already the Vincentian Sisters started planting jatropha. With the cultivation of the nut and the production of oil the sisters initiated a local value-adding chain with additional income opportunities for the people in and around Mbinga. In their agricultural school they now teach their pupils about planting and cultivating this energy plant and thereby make a contribution to the sustainable development of the country. Up until today the sisters have planted about 30 000 bushes. A further 30 000 bushes are to follow. "50 000 jatropha plants will allow us to be fully independent from diesel fuel throughout the year and we can then independently produce power for all institutions here in our convent in Mbinga," Sister Kaya explains.

Energy from renewable sources: technically possible and economically feasible

"The project in Mbinga shows that the use of renewable energy in African rural areas that are far removed from the electricity network is technically possible and economically feasible. In the long run the regenerative energy supply systems will drive ahead sustainable and decentralised energy supply in Africa," Michael Schäfer, Managing Director of Energiebau Solarstromsysteme GmbH, explains. In order to achieve this goal, Energiebau and InWEnt organises training seminars on the cultivation of jatropha in numerous regions of Africa.



Solar power system (close-up), Dusk in Mbinga. Photos: Energiebau Solarstromsysteme GmbH

Other reference projects in Ghana, Tanzania and Indonesia

Specialists from Energie Solarsysteme have already successfully put their concept for decentralised electrification into practice in Ghana, Mali and Tanzania. Furthermore, in co-operation with InWEnt and within the framework of development co-operation a network of partners was established in these countries that can install and maintain such systems. The Federal Ministry for Economics and Technology (BMWi) supported the project in Tanzania through the Deutsche Energie-Agentur (dena) on the grounds of its referential character.

In Ghana (Busunu) a solar hybrid system with a vegetable oil generator supplies a village of 360 houses with electricity. In Matemanga (Tanzania) a water pump is driven by a jatropha generator and a solar power system supplies the local clinic with electricity. In Indonesia a solar hybrid system with a vegetable oil generator transformed a training centre on Sumba Island into an independent electricity producer.

Further information on decentralised supply with renewable energy (german only)

[Erneuerbare Energien in intelligenten Netzen, statt Dauerblackout für 2 Milliarden Menschen](#)


[Projekt zur Elektrifizierung entlegener ländlicher Gebiete im Südwesten Chinas](#)

[Solar- und Windstrom für Afghanistan: Modellprojekt zur autarken Versorgung mit erneuerbaren Energien.](#)







Contents and pictures: Energiebau Solarstromsysteme GmbH. Editor: Solarserver, Rolf Hug

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