



ENERGY SOLUTIONS – MADE IN GERMANY

Innovative smart and sustainable energy technologies around the world

www.german-energy-solutions.de/en

Supported by:



on the basis of a decision
by the German Bundestag

Table of contents

Renewables & Technologies

Italy New tasks for decentralised generation plants4

Poland High-tech infrastructure for today's energy markets...5

Mongolia Clean energy for an agricultural university's satellite campus and research facility.....6

India Smart and affordable access to green electricity8

Colombia An irrigation system powered by kinetic energy.....9

India Solar thermal project in a tech-savvy city.....10

Mexico Highly efficient German inverters in the spotlight..11

Renewables & Energy Efficiency

Vietnam Smart and innovative energy management: A vision for the future of the water sector.....12

Rwanda More sustainability thanks to a flexible energy concept.....14

Japan Wood chips replace fossil fuels and nuclear power...15

Renewables & Financing

Zimbabwe An innovative, transparent and secure way to finance solar systems: blockchain technology.....16

Ghana Green investment: great for investors and users18

Philippines Reducing energy costs by leasing a solar power system.....19

Renewables & Research

Japan Strong effort for longevity: Knowledge exchange in the fields of operation and maintenance20

Uzbekistan Technology and knowledge transfer to central Asia.....22

Brazil Ideal wind farm layout – the key to increasing yields.....23

Renewables & Tourism

Chile Eco-friendly tourism in off-grid regions: Cutting emissions, diesel costs and noise.....24

Philippines Sustainable energy for dream holiday destinations26

Kenya Off-grid solutions for a luxury safari camp.....27

Picture credits: TITLE shutterstock.com/ESB Professional, (4) Next Kraftwerke, (5) Energy2market, (6,7) HEOS Energy, (8) BOS, (9) Smart Hydro Power, (10) Bosch Solarthermie, (11) Steca Elektronik, (12,13) Tilia, (14) OneShore Energy, (15) ECOS Consult/Nolting, (16,17) maxx solar (18) ecoligo, (19) PV² Energie, (20,21) ADLER SOLAR, (22) PRETHERM Solutions, (23) BBB Umwelttechnik, (24,25) KRAFTWERK RPS, (26) vis solis, (27) SUNSET Energietechnik

Introduction

In recent years, the German “Energiewende” has become a significant component of the label “made in Germany“. In addition to high quality, innovation and efficiency, products bearing this mark of origin are increasingly being associated with the energy transition from fossil fuel and nuclear energy to renewable energy solutions.

Due to the energy transition Germany has become a pioneer for smart and climate-friendly energy solutions. Today, German-made energy solutions can be found all over the world. These projects help to decouple economic growth from greenhouse gas emissions and foster innovation, growth and employment while reducing dependency on fossil fuels.

From photovoltaics to wind farms, biomass to virtual power plants, from smart storage to hydrokinetic turbines, renewable energy technologies are increasing their share in the power mix all over the world. This booklet on “*Energy Solutions – made in Germany*” illustrates how innovative, diverse and vibrant the energy industry is and how these technologies can be applied all over the world. Not only do these projects showcase cutting-edge renewable energy generation and storage technologies, their increasing efficiency can help reduce the economy’s appetite for energy and modernise whole sectors.

Beyond technological progress, innovation in the field of smart and sustainable energies can also pertain to their accessibility. A number of creative financing solutions show ingenious ways to overcome the funding hurdle, especially for small- and medium-scale renewable energy projects. For instance, bitcoin technology and crowd-investing show how digitalisation can help leverage funds.

A global energy transition requires more than technology transfer; education and training must be part of the equation. Collaborations with research institutions ensure the transmission of the skills and knowledge necessary to replicate pilot projects, guaranteeing their economic sustainability.

All flagship projects showcased here have been realised with the support of the German Federal Ministry for Economic Affairs and Energy (BMWi) within the German Energy Solutions Initiative as part of the dena Renewable Energy Solutions Programme coordinated by the Deutsche Energie-Agentur (dena) – the German Energy Agency.

Globally, the transition to a low-carbon economy efficiently powered with renewable and climate-friendly energy sources is modernising entire sectors. This booklet should inspire the reader to join the energy transition and should provide ideas on how to integrate reliable, sustainable and affordable renewable energy sources into business models.



Italy

New tasks for decentralised generation plants

The energy transition has set the European electricity markets in motion. In Italy, for example, the market for ancillary services is about to open up.

Not only will large-scale power plants and electricity storage facilities be eligible to compensate for power fluctuations in the network, but in the near future so will virtual power plants, which aggregate the capacities of various (generally renewable) decentralised energy sources. Pooling the generation and storage capacity of small-scale power producers allows them to become active in markets in which they could not previously participate individually due to their intermittency or their size.

Centrali Next, the Italian subsidiary of the Cologne-based company Next Kraftwerke is already active in the Italian power market as an electricity trader. Via an interface, several Italian renewable energy producers are integrated into a

virtual power plant and this pool can be monitored and controlled remotely. Centrali Next retrieves the performance data in real time and can market electricity in line with demand, taking into account, among other things, optimised weather forecasts.

However, the direct marketing of renewable electricity is only part of what a virtual power plant can do. In addition, it is able to compensate for power fluctuations in the network. Next Kraftwerke is hoping to be one of the first companies to contribute to grid stabilisation with a pool of renewable energy plants.

Virtual power plant Italy

<i>Company:</i>	<i>Next Kraftwerke GmbH</i>
<i>Maximum capacity:</i>	<i>scalable</i>
<i>Inauguration:</i>	<i>13 September 2018</i>

Poland

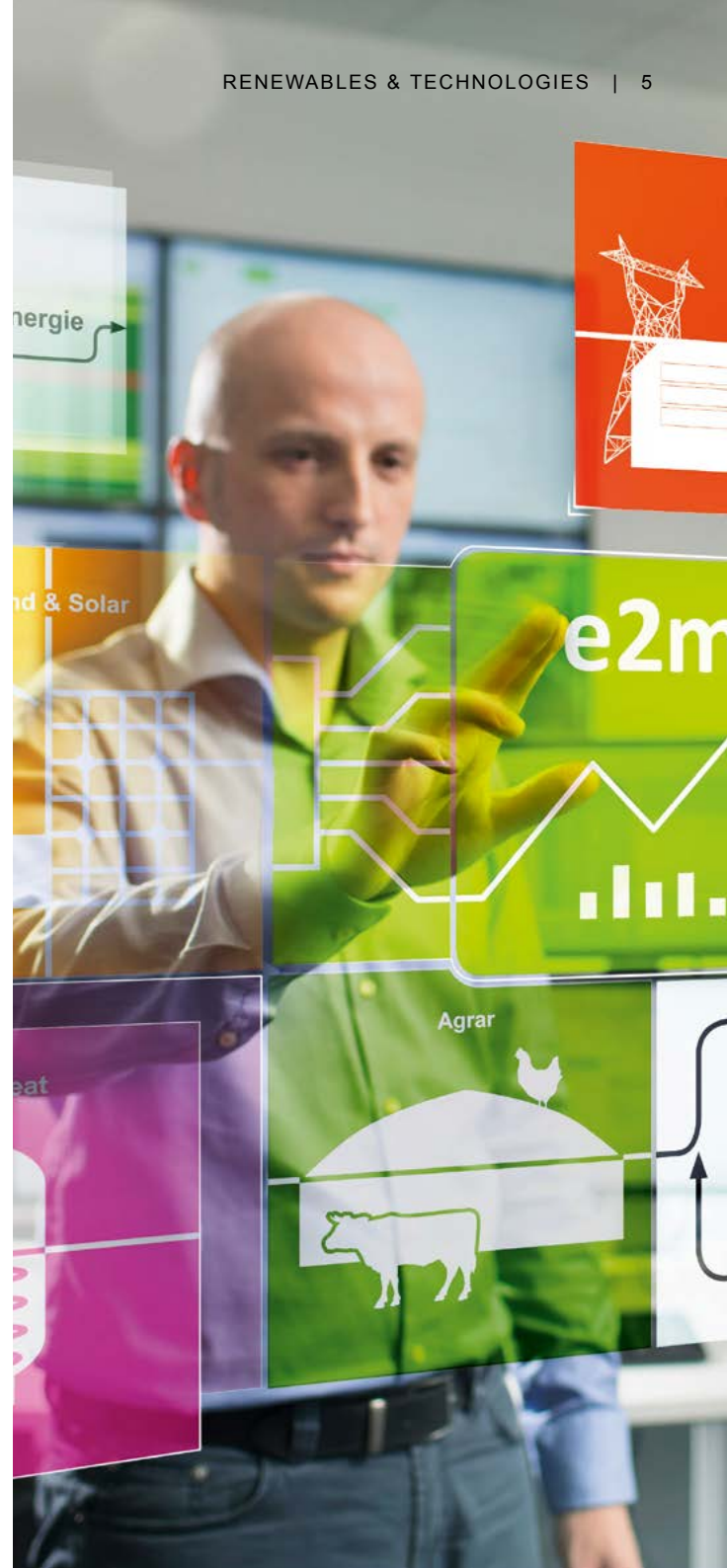
High-tech infrastructure for today's energy markets

Since the Renewable Energies Act came into force in Poland in July 2016, electricity producers generating power from renewable energies have had to assume new responsibilities and market their product themselves. However, it is often difficult for individual power plant operators to competitively take part in power trading or to contribute to stabilising the national grid. The solution: virtual power plants in which the capacity of different power plants such as photovoltaic systems, biogas cogeneration plants, wind farms or hydroelectric plants is pooled and which allow plants to be remotely managed 24 hours a day.

The German company Energy2market had already developed a virtual power plant for the domestic market and saw a commercial opportunity to start implementing this system in Poland. Right from the outset, the focus was on optimising existing decentralised power generation plants and increasing their flexibility. An online portal adjusted to the Polish market requirements can be used to check the availability of the power plants and their current electricity generation or to remotely control them. This reference project is of strategic importance to increase the integration of decentralised renewable power plants into the European market and to stabilise the grid.

Virtual power plant Poland

Company:	Energy2market GmbH
Maximum capacity:	approx. 60 MW
Inauguration:	10 October 2016





Mongolia

Clean energy for an agricultural university's satellite campus and research facility

Mongolia's excellent conditions for wind and solar energy convinced the German company HEOS to set foot in this market. The goal was to present an off-grid hybrid system as a reference project for small villages, tourist camps in remote areas or for scouting teams in the mining industry – in a nutshell, for locations where a connection to the power grid would not be economically viable.

As a local partner institution, HEOS won over the Mongolian University of Life Sciences with their campus in Nart Töv. Until then, researchers and students at the research facility more than 100 kilometres north-west from the capital only had electricity from a diesel generator. The electricity is needed to draw drinking water and irrigation water and to power small electrical appliances.

For their pilot project, the experts of HEOS started by analysing the current and future energy needs of the research centre – because both over and undersizing would have led to extra costs. Finally, the system consists of a small wind turbine with an output of 15 kilowatts and a solar system with components made in Germany. As a backup, the engineers installed a battery system and a fuel-powered generator for emergency purposes. The use of renewables thus brought clear environmental benefits, significantly reducing greenhouse gas emissions and noise.



Environmentally friendly logistics

The execution of the project was driven by environmental considerations. The components were transported from Germany – except for the very last kilometers – via rail freight. They were packed in a container, which upon reaching the site was reused as a substructure for the smaller control container and as a warehouse and workshop space. This creative solution permitted an optimal use of resources respectful of the overarching eco-friendly concept. Since June 2015, the custom-tailored hybrid system has been up and running. It is an example of the German “Energiewende” helping to convince tomorrow’s agricultural experts in Mongolia of the benefits of renewable energies.

System data (off-grid)

<i>Company:</i>	<i>HEOS Energy GmbH</i>
<i>Wind turbine type:</i>	<i>HEOS V15</i>
<i>Inverter (wind):</i>	<i>Smart!Wind SW-10</i>
<i>Installed wind capacity:</i>	<i>15 kW</i>
<i>PV capacity:</i>	<i>6.44 kWp</i>
<i>Module type:</i>	<i>Heckert Solar 230 Wp</i>
<i>Inverters (PV):</i>	<i>SMA Sunny Island 6.0-11</i>
<i>Batteries:</i>	<i>Pb-Gel, 48 V</i>
<i>Annual yield (wind & PV):</i>	<i>48,500 kWh</i>
<i>Annual CO₂ savings (Wind & PV):</i>	<i>34 t</i>
<i>Inauguration:</i>	<i>30 June 2015</i>



India

Smart and affordable access to green electricity

Sustainable and reliable energy solutions for remote villages are what the German companies BOS and Fosera provide. For a reference project, they chose a village in India (Sarvantara in Uttar Pradesh) where the population had no access to electricity at all. In this village of approximately 100 households, the BOS engineers equipped several buildings with photovoltaic modules, a storage system and a monitoring device. Each of these energy stations connects 15 households; the energy stations are interconnected and can share electricity if needed.

The renewable electricity produced covers the households' basic electrification needs. Highly efficient DC appliances by Fosera (such as LED lamps and fans) keep power consumption low. The hybrid storage system consisting of lithium batteries and lead acid batteries combines the advantages of both battery types and ensures an affordable long-term storage solution. In addition, a solar-powered

water pump was installed to allow CO₂-free irrigation of the fields around the village.

System data (off-grid)

<i>Companies:</i>	<i>BOS Balance of Storage Systems AG and Fosera Solarsystems GmbH & Co. KG aA</i>
<i>PV capacity:</i>	<i>4.5 kWp (grid), 2.6 kWh (pump)</i>
<i>Module type:</i>	<i>Solarnova, 24 V, 160 Wp Poly</i>
<i>Operating voltage:</i>	<i>24 V</i>
<i>Hybrid storage:</i>	<i>BOS AG HS500 Lithium-ion 656 Wh, Exide lead 100 Ah</i>
<i>Monitoring:</i>	<i>SMA CLCON 10</i>
<i>Annual yield (PV):</i>	<i>21,549 kWh</i>
<i>Annual CO₂ savings:</i>	<i>21.5 t</i>
<i>Inauguration:</i>	<i>6 June 2017</i>

Colombia

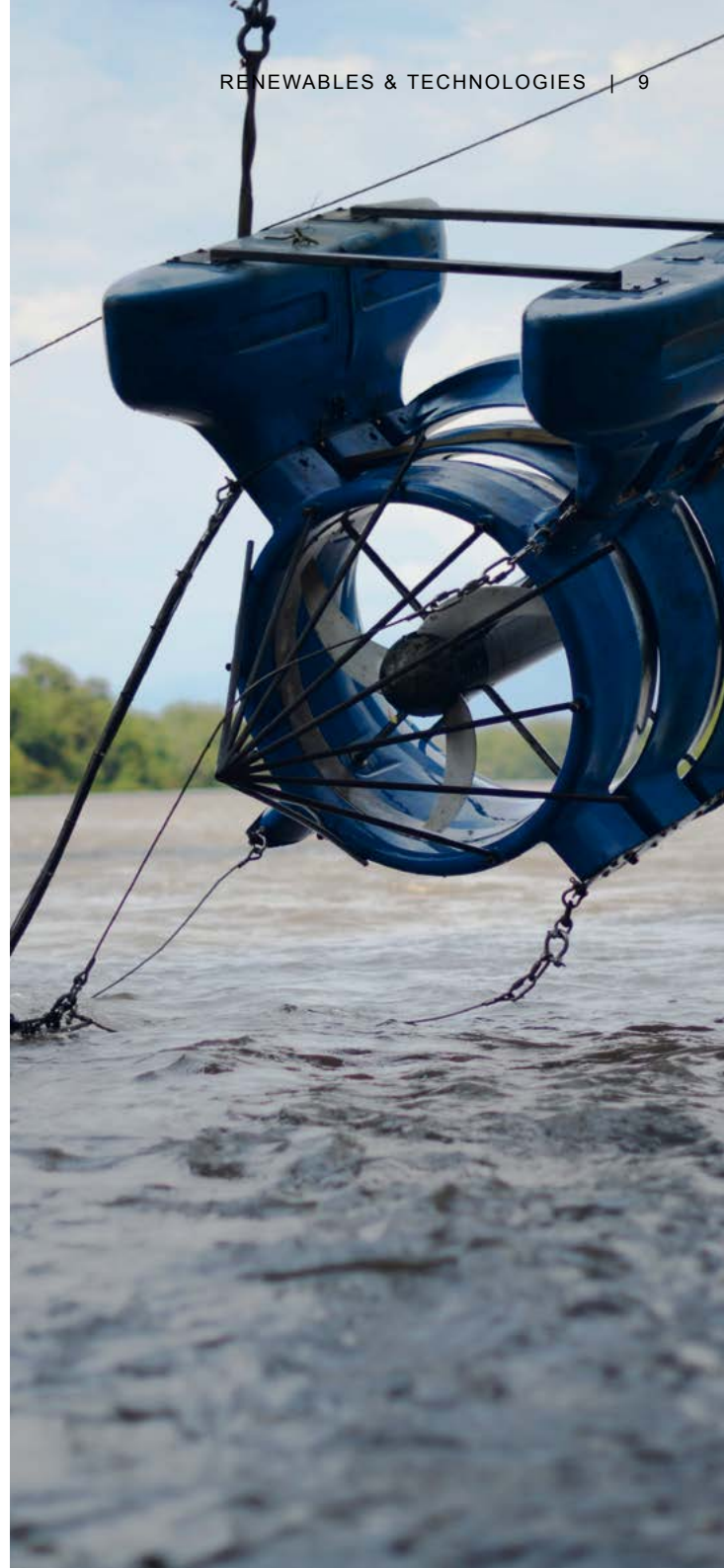
An irrigation system powered by kinetic energy

In many regions around the globe, farms are located along rivers. While these locations are convenient for crop irrigation, they are often remote and not connected to the grid. German turbine manufacturer Smart Hydro Power has developed an affordable energy solution for this scenario: a hydrokinetic turbine for base load. Using the kinetic energy of flowing water, such turbines don't require dams or other expensive and environmentally harmful infrastructure. The course of a river remains in its natural state.

A pilot project – consisting of a hydrokinetic turbine, photovoltaic panels and a diesel generator as a backup – was installed in Neiva, Colombia, in 2015. The operators of a rice farm situated on the Magdalena River are now able to reduce their dependency on diesel to irrigate their fields thanks to the new system.

System data (off-grid)

<i>Company:</i>	<i>Smart Hydro Power GmbH</i>
<i>Turbine capacity:</i>	<i>5 kW nominal power at a flow rate of 2.8 m/s</i>
<i>Generator:</i>	<i>permanent magnet generator</i>
<i>Inverter:</i>	<i>TriStar MPPT-60-600V-48</i>
<i>PV capacity:</i>	<i>2 kWp</i>
<i>Inverter:</i>	<i>Studer XTM-400</i>
<i>Annual yield (PV):</i>	<i>2,815 kWh</i>
<i>Pump:</i>	<i>Pedrollo Hf-60 B</i>
<i>Annual CO₂ savings (pump + PV):</i>	<i>11.5 t</i>
<i>Inauguration:</i>	<i>4 July 2015</i>





India

Solar thermal project in a tech-savvy city

An Indian metropolis known for its tech-savviness and two hotels under one roof, sharing utilities, including hot water: This looked like an ideal setting for the German company Bosch Solarthermie to install a reference project and present their highly efficient solar water heating system in a fast-growing market.

Installed in Marathahalli, a suburb of Bengaluru, on the roof of the ibis and Novotel Bengaluru Techpark, the new solar water heating solution was the first of its kind in India. It is designed to provide hot water at a temperature of 60 °C to the 215 guest rooms, the laundry rooms and the hotel kitchens.

With the new customised solution – 100 collectors absorbing heat from the sun to heat 12,000 litres of water per day – the hotels could halve their annual diesel consumption linked to water heating and reduce their annual CO₂ emissions by 30 tonnes. This makes the new solar thermal facility an asset from an economic and environmental perspective.

System data (own use)

Company:	Bosch Solarthermie GmbH
Collector surface area:	208 m ²
Collectors:	Bosch Solar 3000 TF
Buffer tank:	6,000 l
Annual yield:	194.58 MWh
Annual CO ₂ savings:	30 t
Inauguration:	23 December 2014



Mexico

Highly efficient German inverters in the spotlight

The German company Steca used their newly developed inverters for grid-connected solar power systems in reference projects in Mexico, where such systems are very popular. Steca's single-phase inverters are designed to feed into single-phase power grids. They are highly efficient and easy to install, have a long service life and offer numerous monitoring options for solar power systems.

Several smaller grid-connected photovoltaic installations with a 10 kilowatt peak in the federal states of Jalisco and Morélos demonstrate the performance of the StecaGrid inverter series.

The biggest photovoltaic system was tailored for the the nursery of the German school in Guadalajara. A second plant was installed at the Instituto de Investigaciones Eléctricas at Cuernavaca, the national electricity research centre. An off-grid photovoltaic-wind hybrid

system showcases the performance and efficiency of a sustainable energy solution for remote locations.

System data (grid-connected)

<i>Company:</i>	Steca Elektronik GmbH
<i>PV capacity:</i>	10 kWp
<i>Module type:</i>	SUNSET PX 245/60, PX 250/60 and 140/36, Siemens PT-75
<i>Inverters:</i>	StecaGrid 2300, StecaGrid 3010, StecaGrid 3600
<i>Solar charge controller:</i>	Steca PR2020
<i>Wind generator:</i>	Rutland FM910-4
<i>Wind charge controller:</i>	CA-11/46
<i>Annual yield (PV):</i>	21.5 MWh
<i>Annual CO₂ savings:</i>	35 t
<i>Inauguration:</i>	8/9 November 2014

Vietnam

Smart and innovative energy management: a vision for the future of the water sector

The German company Tilia is a specialist in the fields of drinking water, wastewater, energy, waste management and environmental services. Tilia's business focus lies on helping regional and local utilities, authorities and other public agencies as well as industrial companies improve their efficiency and increase their competitiveness.

In Soc Trang in the Mekong Delta, Tilia installed a reference project, the first of its kind in Vietnam: water treatment powered by photovoltaics. From 2015 to 2017, Tilia and the local sewage treatment facility had already worked together on a joint project to optimise the city's wastewater management. In late 2017, they extended their partnership and designed a photovoltaic system with an innovative energy storage concept. The aim was to cover 50 percent of the wastewater plant's energy requirements with renewable energy sources.

Smart and highly efficient energy management is the core of the system, which was built and inaugurated in 2018: the innovative storage solution maximises power savings and minimises electricity costs and environmental damage. The state-of-the-art storage system can be charged in two ways: During the day, when solar radiation is high but consumption is low, the batteries are charged with solar energy; at night, when electricity



prices are low, the storage systems can be charged from the public grid. Subsequently, during daytime peak hours, when grid prices are at their highest level, a large part of the electricity required can be supplied by the solar modules and the battery.

Sustainability and innovation

The sector offers great potential for follow-up projects. Indeed, optimising the energy management of wastewater treatment plants not only reduces running costs, but it also enhances the value of the infrastructure. Energy-efficient technological solutions “made in Germany” can thus help modernise and increase the sustainability and the profitability of plants all over the world.

System data (grid-connected)

<i>Company:</i>	<i>Tilia GmbH</i>
<i>PV capacity:</i>	<i>28.8 kWp</i>
<i>Module type:</i>	<i>Q.Peak-G5 300</i>
<i>Inverter:</i>	<i>SMA STP 25000 TL</i>
<i>Batteries:</i>	<i>BMZ ESS 9.0 Li-NCA, on the whole 20.4 kWh</i>
<i>Battery Inverters:</i>	<i>Sunny Island 4.4M</i>
<i>Energy management:</i>	<i>Sunny Home Manager 2.0</i>
<i>Display:</i>	<i>Solarfox SF-300</i>
<i>Annual yield (PV):</i>	<i>37.5 MWh</i>
<i>Annual CO₂ savings:</i>	<i>23 t</i>
<i>Inauguration:</i>	<i>6 November 2018</i>



Rwanda

More sustainability thanks to a flexible energy concept

In rapidly developing countries such as Rwanda, electricity supply from the grid is often unstable and insufficient. Many local manufacturing companies therefore rely on their own diesel generators for additional power, even though diesel is expensive and long transport routes cause even more environmental damage.

OneShore Energy and consortium partner BayWa r.e. developed a system to suit the requirements of one of the country's leading tea manufacturers, Sorwathe Ltd. in Kinihira. Their goal was to design a reference installation for clean and efficient energy. A solar system was integrated into the site's existing energy supply network, which consisted of a mains supply and several diesel generators. Based on load measurements and detailed calculations, OneShore planned the optimum dimensions of the photovoltaic installation. The new custom-made photovoltaic-diesel hybrid system enables Sorwathe to

significantly reduce its diesel and mains power consumption and puts German innovation in the spotlight.

System data (grid-connected)

<i>Company:</i>	<i>OneShore Energy GmbH and BayWa r.e. renewable energy GmbH</i>
<i>PV capacity:</i>	<i>50 kWp</i>
<i>Module type:</i>	<i>SolarWorld SW 260 poly</i>
<i>Substructure:</i>	<i>BayWa r.e. novotegra</i>
<i>Inverters:</i>	<i>SMA STP 35000 TL</i>
<i>Hybrid controller:</i>	<i>DEIF Automatic</i>
<i>Monitoring:</i>	<i>OneShore Energy</i>
<i>Annual yield (PV):</i>	<i>71,400 kWh</i>
<i>Annual CO₂ savings:</i>	<i>22 t</i>
<i>Inauguration:</i>	<i>25 March 2016</i>

Japan

Wood chips replace fossil fuels and nuclear power

After the reactor accident in Fukushima, Japan was forced to rethink its energy policy. Subsidies for renewable energies were increased at national and local levels with a new focus on domestic resources.

At Teshiogawa Onsen, the hot springs with bathing facilities on the island of Hokkaido are geothermally preheated but the water does not have an ideal bathing temperature. The buildings also needed extra heating.

The German furnace manufacturer Nolting, together with ECOS Consult, developed a tailor-made energy solution. Assuming that on the densely wooded island, short transport routes make the use of biomass like wood chips particularly appropriate, they designed a wood-fuelled heating system for the spa. With a capacity of 350 kilowatt hours, this system guarantees pleasant temperatures and creates regional value. The wood chips originate from the immediate environment and the ash is used locally as a fertiliser.

System data

<i>Companies:</i>	<i>Nolting Holzfeuerungstechnik GmbH and ECOS Consult GmbH</i>
<i>Capacity:</i>	<i>350 kW</i>
<i>Wood biomass boiler:</i>	<i>Nolting LCS-RV 350</i>
<i>Fuel volume:</i>	<i>516 t/a</i>
<i>Generated heat:</i>	<i>485,000 kWh/a</i>
<i>Annual CO₂ savings:</i>	<i>163 t</i>
<i>Inauguration:</i>	<i>31 October 2014</i>





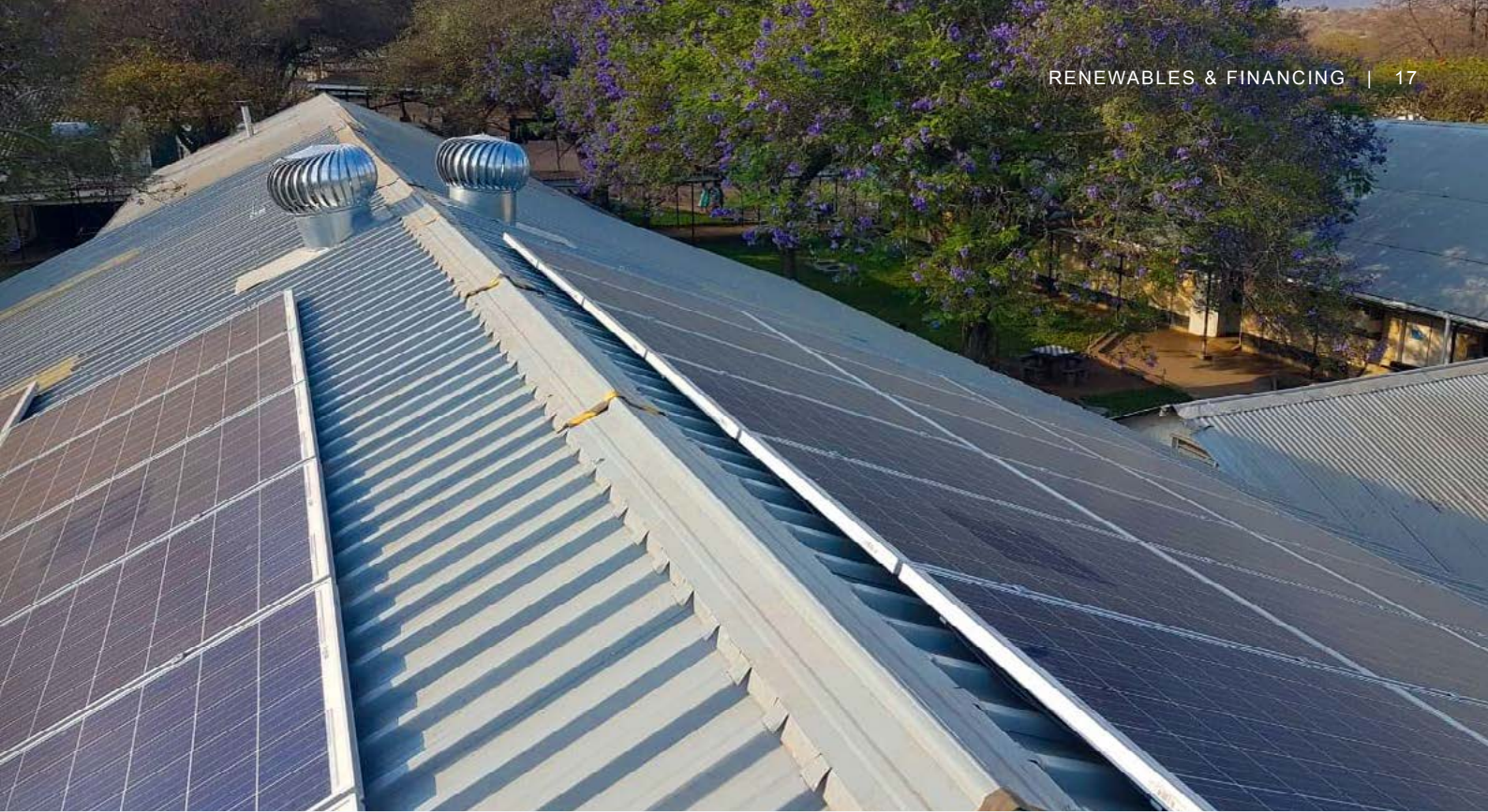
Zimbabwe

An innovative, transparent and secure way to finance solar systems: blockchain technology

The German company maxx solar has developed an innovative concept to help companies and institutions in developing countries overcome the financial hurdle of the initial investment in a solar system. In order to link people with money and people who want a photovoltaic (PV) system in a transparent and easy-to-handle way, maxx uses blockchain technology.

In this model, PV systems are connected to a smart meter that records electricity production and documents it in a blockchain protocol. A blockchain can be compared to a collective memory on the internet. The memory is saved on many different computers, each of which owns a full copy – making it almost impossible to manipulate the record. Information can be accessed online for project participants, offering maximum transparency for investors and donors as well as ensuring a high degree of automation in the project management process. That way, the blockchain technology functions as a transparent, secure and easy link between investors and clients.

For their flagship project, maxx chose Zimbabwe, a country where financial transactions are difficult due to a longstanding currency crisis. The German company installed a PV system with battery backup for Karanda



Mission Hospital. To improve medical care, the hospital wanted to reduce its dependency on the grid's unreliable power supply, while also cutting its diesel costs and power bills. Together with Sunergy Zimbabwe, maxx raised funds to finance the PV system. Part of the funds were donations and a smaller share was investment.

Karanda Mission's monthly payments for the electricity generated by the PV system are partly used for operations and maintenance. Carried out by an experienced local partner, maintenance ensures that the project remains appropriate for investors and donors. The rest of the electricity payments flow into a fund contributing to future projects. Thus, sustainability is built into the financing model.

System data (off-grid)

<i>Company:</i>	<i>maxx solar & energie GmbH & Co. KG</i>
<i>PV capacity:</i>	<i>14.31 kWp</i>
<i>Module type:</i>	<i>REC Peak Energy 265 Wp</i>
<i>Substructure:</i>	<i>IBC Top Fix 200</i>
<i>Inverters:</i>	<i>Steca PI 1500</i>
<i>Batteries:</i>	<i>Hoppecke VL2-1370FC(OPzS)</i>
<i>Battery inverters:</i>	<i>Steca Solarix PLI5000-48</i>
<i>Display:</i>	<i>Tablet with live data</i>
<i>Annual yield (PV):</i>	<i>23.5 MWh</i>
<i>Annual CO₂ savings:</i>	<i>8.41 t</i>
<i>Inauguration:</i>	<i>19 October 2018</i>



Ghana

Green investment: great for investors and users

In emerging markets, raising money for solar energy projects is often a challenge. International financing focuses on large-scale projects, while local loans are often too costly. Crowdfunding can help bridge this funding gap.

The German company ecoligo provides a fully financed solar-as-a-service solution for businesses in emerging economies. With a complete digital platform to finance solar projects and good business relations with high-quality German component manufacturers such as SMA and Heckert Solar, ecoligo was able to implement photovoltaic systems at three branches of Stanbic Bank, one of Ghana's largest banks.

The solar systems in Dansoman, Kasoa and Tema, with capacities of 20, 10 and 10 kilowatt peak respectively, cover 30 percent of the branches' electricity needs.

System data (three systems, own use)

Companies:	<i>ecoligo GmbH and SMA Sunbelt Energy GmbH</i>
PV capacity:	<i>40 kWp in total</i>
Module types:	<i>Heckert Solar NeMo® 2,0 60 P 270 Wp</i>
Inverters:	<i>SMA Sunny Tripower 10000 TL</i>
Display:	<i>Solarfox SF-300 43"</i>
Monitoring:	<i>Meteocontrol blueLog X Series/ webapplication VCOM</i>
Annual yield (PV):	<i>57,570 kWh</i>
Annual CO₂ savings:	<i>27 t</i>
Inauguration:	<i>13 July 2018</i>



Philippines

Reducing energy costs by leasing a solar power system

For businesses with high electricity consumption in countries with rising energy prices, it can be beneficial to become – at least partly – independent from the electricity supplier. Thanks to the high solar irradiation in the Philippines, photovoltaic (PV) systems are an ideal solution for companies preferring a mostly independent, cheaper and cleaner energy supply. The German company PV² Energie has developed a leasing concept for companies that want to avoid high upfront investment. PV²'s offer includes to individually design a solar power plant for the commercial roof or ground of their customer, and to fully finance, install and operate it. The lessee can use the electricity generated by the solar power plant and pays a monthly leasing rate to PV² Energie.

The first reference project, a 500 kilowatt peak PV system, was installed by PV² in 2017 on the roof of a production hall of the cold foam mattress manufacturer, plastics

producer and automotive supplier Uratex in Muntinlupa City in the Greater Manila area.

System data (own use)

<i>Company:</i>	<i>PV² Energie GmbH</i>
<i>PV capacity:</i>	<i>500 kWp</i>
<i>Module type:</i>	<i>Canadian Solar CS6P-265P</i>
<i>Substructure:</i>	<i>Creotecc & PV² in-house development</i>
<i>Inverters:</i>	<i>SMA Sunny Tripower 20000TL-30 and 25000TL-30</i>
<i>Monitoring:</i>	<i>SMA Solar Cluster Controller CLCON 10</i>
<i>Annual yield (PV):</i>	<i>665,000 kWh</i>
<i>Annual CO₂ savings:</i>	<i>400 t</i>
<i>Inauguration:</i>	<i>25 April 2017</i>



Japan

Strong effort for longevity: knowledge exchange in the fields of operation and maintenance

In 2017, Japan became the third largest photovoltaics (PV) market worldwide for its installed capacity – narrowly beaten to second place by the USA, while China continued to dominate the global PV market. By then, 49 gigawatt out of the globally installed 405 GW PV capacity was located in Japan, requiring specific services for operation and maintenance without which trouble-free operation and maximum yield could not be expected over a PV plant's entire life-cycle.

As early as 2015, the German company ADLER Solar identified Japan as a promising market and saw an opportunity to export its expertise in the field of PV services. Together with Yokohama Kankyo Design, ADLER Solar founded the joint venture ADLER Solar Works in order to develop its presence in Asia. This partnership allowed a mutually beneficial exchange of knowledge. As the first specialist PV service provider on the market, ADLER Solar wanted to demonstrate how qualified operation and maintenance can optimise the performance of solar power plants over 20 to 25 years. Meanwhile, ADLER Solar benefited from its partner's knowledge of the local market.

Training centre for Japanese specialists

A warehouse in Yokohama, Japan's second largest city, was chosen as the location for a training centre with a reference PV power plant specifically designed for train-



ing purposes. In late 2015, preparations started. Training concepts adjusted to the needs of the Japanese market were developed and tested, while a bespoke PV plant was designed and installed.

The new PV training centre was inaugurated in spring 2016 and has been offering training opportunities for operations and maintenance to ADLER Solar Works' own staff as well as to specialists from partner or customer companies since. Besides theoretical classes on photovoltaics, the curriculum focuses on practical training. The grid-connected PV plant includes the most commonly used module types in Japan. A scientific weather station and an extended monitoring system complete the new training centre's high-end equipment.

System data (grid-connected)

<i>Company:</i>	<i>ADLER Solar GmbH</i>
<i>PV capacity:</i>	<i>16.61 kWp</i>
<i>Module types:</i>	<i>Tetra Sun 300, REC 275 Twin Peak, Solar World 260 plus, First Solar 4100</i>
<i>Inverters:</i>	<i>SMA SunnyBoy 4500-Jp-22</i>
<i>Monitoring:</i>	<i>Solar Log 200 PM</i>
<i>Weather station equipped with:</i>	<i>pyranometres, temperature sensors and reference cells</i>
<i>Annual yield (PV):</i>	<i>16.47 MWh</i>
<i>Annual CO₂ savings:</i>	<i>4.43 t</i>
<i>Inauguration:</i>	<i>30 May 2016</i>



Uzbekistan

Technology and knowledge transfer to central Asia

Uzbekistan has great potential for photovoltaic (PV) projects. With almost 300 days of sunshine per year, it enjoys comparable solar exposure to Spain. But with an economy still dominated by fossil fuels, the country is in the early days of its energy transition. This was a great opportunity to export the German Energiewende to central Asia, which Berlin-based companies PRETHERM Solutions and BAE Batterien were able to seize.

A global energy transition requires more than technology transfer. Projects in collaboration with universities or other education and research institutions are therefore particularly significant because of their multiplier effect. This is why the German companies' partnership with the Tashkent State Technical University was so significant. It allowed them to install a PV plant with battery backup in a location enabling research and development. This PV system offers a chance for a new generation of engineers

and technicians to be trained in the field of power generation from renewable energy sources and power storage, using state-of-the-art technology such as highly efficient PERC (passivated emitter and rear cell) modules.

System data (own use)

<i>Companies:</i>	<i>PRETHERM Solutions GmbH and BAE Batterien GmbH</i>
<i>PV capacity:</i>	<i>17.4 kWp</i>
<i>Module type:</i>	<i>Meyer Burger FS Sky 290 Wp</i>
<i>Inverters:</i>	<i>SMA Tripower 2000TL-30</i>
<i>Batteries:</i>	<i>BAE 6PVV 660</i>
<i>Battery inverters:</i>	<i>SMA Sunny Island S14.4M-11</i>
<i>Annual yield:</i>	<i>26.72 MWh</i>
<i>Annual CO₂ savings:</i>	<i>17 t</i>
<i>Inauguration:</i>	<i>23 September 2016</i>

Brazil

Ideal wind farm layout – the key to increasing yields

Acquiring a precise knowledge of a project site's wind conditions at the beginning of a wind farm development is of vital importance. However, wind speed and direction are traditionally measured with mechanical sensor technology. For the assessment of the wind profile and wind speed, extrapolations are necessary, but are fraught with a considerable degree of uncertainty.

This is why BBB Umwelttechnik wanted to present their latest technical developments, highly precise remote sensing devices such as the LiDAR (light detection and ranging) system, in the fast-growing Brazilian wind market. In order to spread their knowledge, BBB established a partnership with the University of São Paulo. A LiDAR system was provided as part of a wind energy research cluster on the campus, enabling engineers and students to improve predictions, optimise project layouts and develop further expertise in wind resource evaluation.

System data

<i>Company:</i>	<i>Ramboll GmbH, vormalis BBB Umwelttechnik GmbH</i>
<i>Wind measurement range:</i>	<i>40 – 200 m, 12 programmable heights</i>
<i>Data sampling rate:</i>	<i>1 s</i>
<i>Speed accuracy:</i>	<i>0.1 m/s</i>
<i>Speed range:</i>	<i>0 – 60 m/s</i>
<i>Direction accuracy:</i>	<i>2°</i>
<i>Size incl. transport case:</i>	<i>685 x 745 x 685 mm, 75 kg</i>
<i>Inauguration:</i>	<i>9 June 2015</i>





Chile

Eco-friendly tourism in off-grid regions: cutting emissions, diesel costs and noise

The Atacama Desert, an area of more than 100,000 square kilometres with the highest solar irradiation worldwide, is one of Chile's top three tourist destinations. It already hosts several large solar power plants, but only a few innovative systems designed for self-consumption or for tourist facilities.

This is exactly why the German companies KRAFTWERK Renewable Power Solutions and QINOUS wanted to present themselves in this market with a custom-tailored photovoltaic (PV) diesel hybrid system with an intelligent lithium-ion battery storage. Their customer, Tierra Atacama Hotel & Spa, is located far away from the power grid. Its management had already gathered significant experience in the use of renewables, since KRAFTWERK had installed a small PV hybrid system for them back in 2013. Four years later, the existing power plant was extended by 133 kilowatt peak PV capacity and a lithium-ion battery storage capacity of 335 kilowatt hours.

Software balancing three energy sources

The core of the system, which delivers 100 percent of the hotel's energy needs during the daytime, is the software solution that controls the extended PV plant, the



battery storage and the diesel generators. Intelligent management of the various system components enables the hotel to shut down its diesel generators for eight to nine hours during daytime and for several hours at night. This investment, with a payback period of six years, significantly reduces diesel costs, greenhouse gas emissions and noise – all significant benefits for a luxury hotel.

The inauguration of the pilot project in October 2017 was a great success. Not only did the hybrid system attract a lot of political and media attention, it also provided the basis for future business development for the two German companies. Shortly afterwards, they were asked for individual offers by several hotel groups.

System data of the plant extension (off-grid)

Companies:	<i>KRAFTWERK RPS GmbH and QINOUS GmbH</i>
PV capacity:	<i>133 kWp</i>
Module type:	<i>Astroenergy ASM6610P, 270 Wp</i>
Inverters:	<i>SMA Sunny Tripower</i>
Battery system:	<i>QINOUS ESS QCompact L, 180kW/335 kWh</i>
Batteries:	<i>Lithium-ion, Samsung SDI Mega E2</i>
Annual yield (PV):	<i>286 MWh</i>
Annual CO₂ savings:	<i>340 t</i>
Inauguration:	<i>13 October 2017</i>



Philippines

Sustainable energy for dream holiday destinations

Located about ten degrees north of the Equator between the West Philippine Sea and the Sulu Sea, the Philippine province Palawan is a rare global treasure and an attractive destination for a growing number of domestic and international eco-tourists. Reducing diesel consumption and creating a sustainable, eco-friendly and affordable source of energy is essential to meet the economic needs of the capital city, Puerto Princesa, and to protect the thriving eco-system.

In order to support Palawan Province in its ambitious goal of covering its entire electricity needs from renewable energy sources, the German companies Vis Solis and Solmotion developed a showcase project in the capital. The rooftop of the newly built Puerto Princesa City Hall complex, a 500 square meter steel deck roof overlooking the harbour, was equipped with a photovoltaic installation. The 78 kilowatt peak system reduces the

town hall's energy costs by about 20 percent and its CO₂ emissions by more than 70 tonnes per year.

System data (own use)

Companies:	<i>vis solis GmbH and Solmotion GmbH</i>
PV capacity:	<i>78 kWp</i>
Module type:	<i>Astroenergy ASM6610P-260 W Poly</i>
Substructure:	<i>Schletter Rapid2 FixT-System</i>
Inverters:	<i>SMA Tripower 20000 TL Economic Excellence</i>
Monitoring:	<i>Meteocontrol</i>
Annual yield (PV):	<i>105 MWh</i>
Annual CO₂ savings:	<i>71.4 t</i>
Inauguration:	<i>24 April 2015</i>

Kenya

Off-grid solutions for a luxury safari camp

Many bush camps in wildlife reserves want to attract safari tourists by offering sustainable conservation practices as well as a comfortable stay. It seems quite obvious that the use of diesel generators as their primary electricity source does not fit into this concept. Ol Pejeta Bush Camp in central Kenya was able to find a partner to design a sustainable energy concept: SUNSET Energietechnik came up with a complete solution using various technologies. A photovoltaic system with battery storage guarantees electricity supply for the guests' tents. Furthermore, the bush camp was equipped with a solar water supply. The integrated pressure pump system and solar thermal power make even hot showers after long safari days possible. A hybrid solar and wind system contributes to the guests' comfort by providing electricity for fridges, freezers and further electrical appliances.

System data (off-grid)

<i>Company:</i>	<i>SUNSET Energietechnik GmbH</i>
<i>PV capacity:</i>	<i>30 kWp in total</i>
<i>Module type:</i>	<i>Sunset PX 106-6, Sunset PX 130/55</i>
<i>Inverters:</i>	<i>SUN3 Grid 5000-02, SUN3 Grid 3000-02</i>
<i>Solar heating system:</i>	<i>SUNblue 21</i>
<i>Batteries:</i>	<i>Hoppecke solar.bloc power.com</i>
<i>Battery inverters:</i>	<i>SUNisland Xtender XTH 8000-48</i>
<i>Wind generator:</i>	<i>Rutland WH 914i</i>
<i>Annual CO₂ savings:</i>	<i>34.28 t</i>
<i>Inauguration:</i>	<i>11 October 2016</i>



Deutsche Energie-Agentur (dena)

dena is Germany's centre of expertise for energy efficiency, renewable energy sources and intelligent energy systems. As Agency for Applied Energy Transition we help achieve energy and climate policy objectives by developing solutions and putting them into practice, both nationally and internationally. In order to do this, we bring partners from politics and business together, across sectors. dena's shareholders are the Federal Republic of Germany and the KfW Group.

www.dena.de/en

German Energy Solutions Initiative

The transfer of energy expertise, the promotion of foreign trade and the facilitation of international development cooperation are part of the German Energy Solutions Initiative, which is coordinated and financed by the German Federal Ministry for Economic Affairs and Energy. The initiative offers networking and busi-

ness opportunities in Germany and abroad, it showcases reference projects and facilitates know-how exchange.

www.german-energy-solutions.de/en

dena Renewable Energy Solutions Programme

The dena RES Programme was developed by the Deutsche Energie-Agentur (dena) – the German Energy Agency. This programme, supported by the Federal Ministry for Economic Affairs and Energy within the German Energy Solutions Initiative, helps German renewable energy companies enter new markets. Within the framework of the programme, reference and demonstration projects are installed in cooperation with prestigious institutions. The installation is accompanied by comprehensive PR, marketing and training programmes. These projects showcase high-quality German renewable energy technology and help participating companies gain a foothold in new markets.

www.german-energy-solutions.de/en/res

Publisher

Deutsche Energie-Agentur GmbH (dena) –
German Energy Agency
Chausseestrasse 128 a, 10115 Berlin, Germany
Tel: +49 (0)30 66 777-0
Fax: +49 (0)30 66 777-699
E-mail: info@dena.de

Contact

Gabriele Eichner
Team Leader, International Pilot Projects
Renewable Energies and Mobility
Tel: +49 (0)30 66 777-714
E-mail: eichner@dena.de
res@dena.de

Date 2018

All rights reserved. Any use is subject to consent by dena.