



GUIDE TO GREEN ECONOMY KENYA



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Dear Reader,

The constant growth of the Kenyan economy over the last years offers a great range of possibilities.

However, a growing economy requires reliable, secure and affordable energy solutions to meet the steadily rising demand for energy, both by the economy and the population. Kenya as the host country of the United Nations Environment Programme (UNEP) is aware of its role as a pioneer in the field of a green environmental policy in East Africa. We commend Kenya for its ambitious plans to provide 100% green energy by 2020 which testifies for its resolve that successful and sustainable economic development is compatible – and indeed only possible – with green energy supply.

Germany is proud to be a reliable partner for Kenya in implementing its Green Economy Strategy by providing expertise and technological support for various projects throughout the country.



This partnership is also reflected in the "German Embassy Green Economy Cycle" (GEGEC), which was initiated in 2016 by the German Embassy and implemented through the Delegation of German Industry and Commerce in Kenya (AHK). Well recognized events such as seminars, workshops, and the Travelling Exhibition about Germany's Energy Transition – the Energiewende – accompanied by a conference on combatting climate change in June 2018 made GEGEC an acknowledged brand. More than 2,000 participants from local companies, academia, NGOs and both the Kenyan public and private sectors have attended the various events of GEGEC over the last three years.

The brochure you hold in your hands is a compendium of the outcome of these widely attended events. The Guide to Green Economy highlights a number of projects which were put into action in co-operation with German companies and institutions, among other stakeholders. Adapted to local needs, the projects successfully create job opportunities and at the same time help meet climate protection goals.

The GEGEC project stands for Germany's engagement in contributing to a green energy mix in Kenya and is designed to achieve a rising awareness of both the public and the private sector for sustainable economic practices and solutions.

We are committed to further accompanying Kenya on its path to the implementation of climate friendly technologies.

Annett Günther
Ambassador of the Federal Republic of Germany to Kenya

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within the "German Embassy Green Economy Cycle (GEGEC)"

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Thilo Vogeler, Valerie Leisten, Caroline Sawe

Design, Production & Print:
John Allosso, Gilbert Sigey, Tracey Gesare, Peter Mukuria
McAllosso & John Creatives

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Economic Structure

Kenya covers a surface of 580,367 square kilometers, around one and a half times as much as Germany. Its population just surpassed the 50 million mark; still, the formerly fast-paced increase in population already slowed down. Stabilizing birth rates build the foundation for business growth and welfare.

Kenya has been East Africa's economic powerhouse for the last decades. Its diversified economy supplies Africa and the world with high-value products. More than a hundred flower farms export bouquets to the world. East African fruits like mangoes and avocados as well as fresh vegetables and natural fibers are gaining ever higher market shares in overseas markets. The lush highlands offer the most excellent conditions to cultivate coffee and tea likewise – Kenya is the biggest tea exporter in the world and also holds a prime position in the coffee market.

The well established manufacturing sector supplies processed foods, high-quality cosmetics and life-saving medication far over the borders of East Africa. An expanding road and rail infrastructure coupled with the defining ocean and airfreight hubs in the region support the exporting industries and enable a thriving logistics sector.

Nairobi is Africa's most vibrant and productive hub for ventures into new business models. Already a decade ago, mobile payment options had accessed even the remotest regions of Kenya – making life easier, safer and cheaper for all Kenyans. In Nairobi, the future of mobile based services in agriculture, healthcare, finance and industry happens already today.

Last to mention here, the spectacular landscapes and the unique wildlife make Kenya one of the most sought-after tourist destinations globally.

In the past, economic progress often led to ecological disaster – leaving rainforests cleared, coral reefs degraded and wildlife extinct. Kenya's prosperity is not immune against these threats.

Kenya is now shifting its economic practices towards more sustainable practices to provide its natural resources to future generations and to be a first mover when it comes to combining economic prosperity and protecting the environment

The government, institutions of the civil society, local communities, private enterprises are therefore building awareness against the menace of sacrificing its natural resources for short-lasting monetary gain.

These practices are highlighted in this **Guide to Green Economy**. Manufacturing Industries and the energy sector, households and agriculture as well as tourism can all contribute to more sustainable inclusive business practices. These business practices build the foundation to provide every Kenyan with reliable, affordable and safe energy, water, soil, air.

The *Green Economy Strategy and Implementation Plan (GESIP) 2016-2030* guides the country's transition to a sustainable path in five thematic areas: sustainable infrastructure development; building resilience of communities and infrastructure; sustainable natural resources management; resource efficiency and cleaner production; and social inclusion and sustainable livelihoods. The project is funded by the German Ministry of Environment.

A toolkit contains 177 tools for 10 sectors and a detailed step-by-step guide on application of the tools for green economy planning - targeted at the private sector.

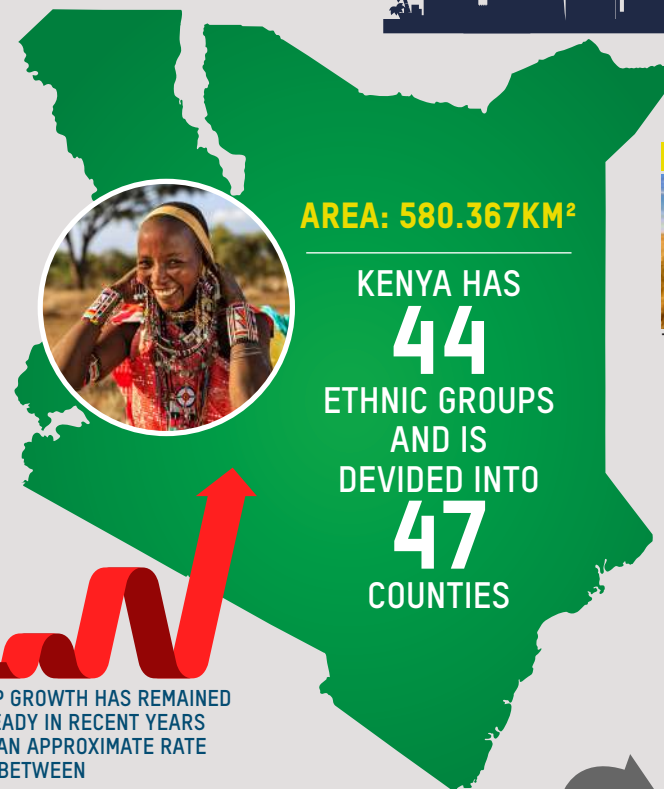
greeneconomyafrica.org/

KENYA IN FIGURES



KENYA'S POPULATION IS APPROXIMATELY
50 MILLION

Over 3 Million people live in the capital, Nairobi



AREA: 580.367KM²

KENYA HAS 44 ETHNIC GROUPS AND IS DEVIDED INTO 47 COUNTIES

GDP GROWTH HAS REMAINED STEADY IN RECENT YEARS AT AN APPROXIMATE RATE OF BETWEEN

5-6% ANNUALLY



KENYA IS NO. 1 WORLDWIDE IN EXPORTING TEA & NO. 4 WORLDWIDE IN EXPORTING FLOWERS

KENYA'S MAJOR ECONOMIC ACTIVITIES



Tourism



Manufacturing



Digital Economy



Agriculture & Livestock

COUNTRY OVERVIEW

ENERGY IN KENYA

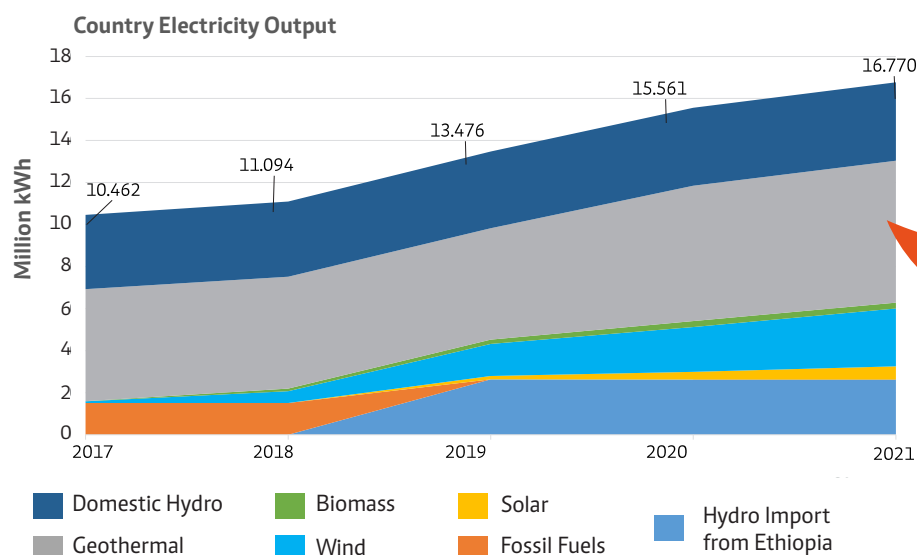
Energy is consumed in different ways. Traditionally in Kenya, wood or charcoal is extracted from forests and savannahs and used for cooking. Many businesses need energy in the form of heat, for boiling or drying in the food industry, to manufacture building materials, among many others. This energy is often derived from industrial boilers run on fossil fuels or wood. Another form of utilizing energy is transport, usually in a car, bus or train – nowadays still fueled by petrol or diesel.

The form of energy with the most diverse use is electricity. Electricity can be used to light homes, to boil water, to run any kind of machines, to drive cars and much more.

In comparison to other sources, like fossil fuels or biomass, electricity is by far the smallest contributor to energy consumption in Kenya.

In the past, all human development came with increased use of electricity, which was traditionally produced mainly by burning coal and other fossil fuels. This progress came at a price of increased pollution and overexploitation of natural resources.

Renewable energies have the potential to solve the problem and Kenya has pioneered in their adoption. Kenya is practically the first country worldwide that runs an entire industrialized economy on electricity from renewable energies.



What is a kilowatt hour (kWh)?

Every electricity consuming device has a capacity, usually stated as Watt (W). A light bulb usually 40 or 60 Watt, a TV 300 to 400 Watt, a fridge 400 to 600 Watt, a shower head up to 3,000 Watt; an iron box or a toaster around 1,000 Watt. Before consumption, electricity is produced in a power plant whose capacity is equally measured in Watts, or usually kW: 1,000 Watts = 1 kW and 1,000 kW = 1 MW.

A device with a stated capacity of 1,000 W consumes 1,000 Watt hours (Wh) = 1 kWh per hour of full operation. A power plant with, for example, 10 kW capacity can, under perfect conditions, produce 10 kWh per hour of operation.

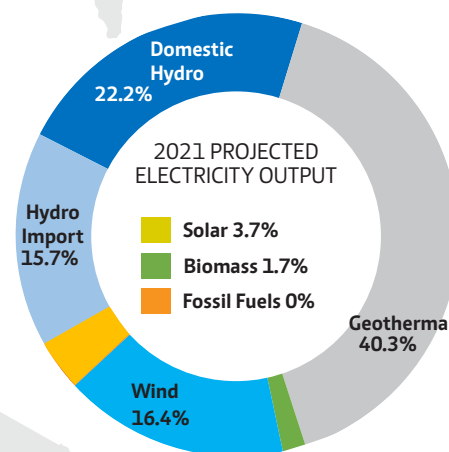
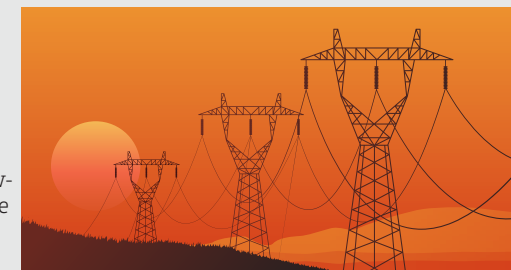
What takes around one kWh?

- Watching TV for around three hours
- Using a laptop all day
- An hour of ironing clothes
- A fridge running for about three hours

Kenya's total installed capacity is approaching

3000 MW

The country has invested heavily in the development of Geothermal Energy, that now covers over 40% of the country's consumption, together with other renewable energy sources. Also Wind and Solar projects have room for development, to add to the existing, more mature Geothermal and Hydro power sources.



In 2018, the connection of Kenya's flagship Wind Farm in Turkana finally cemented its shift to renewable electricity; with fossil fuel energy sources contributing less than a tenth to its electricity consumption, and this figure is projected to drop to zero in 2021.



Grid Connectivity rates in Kenya have scaled up in the past few years – rising from 32% in 2014 to 75% in 2018



The Kenyan Government plans to extend electricity access to all Kenyan households by the end of the year 2020.



All plants on earth - trees, flowers, crops - use photosynthesis processes to convert carbon dioxide into oxygen on the one hand, and biomass on the other. Biomass, wood or other plant material, is a medium to store energy. The same principle applied to so called fossil fuels such as petrol, natural gas or hard coal, where biomass has been stored over a period of hundreds of thousands of years beneath the surface.

Both fossil fuels and biomass contain energy that can be used to produce electricity or heat. Unlike fossil fuels, biomass is a renewable resource. The circle of photosynthesis makes it possible to constantly reproduce biomass in the present. Biomass includes wood, organic waste, manure and other plant and animal substances.

Biomass as an Energy Supplier

The use of solid biomass is of tremendous importance in the supply of energy world-wide. Developing countries in particular predominantly use bioenergy for heating and cooking.

Many industries also use biomass to produce heat. For instance, in the tea sector process heat is required to dry fresh tea leaves, usually provided by firewood. Large amounts of biomass residues result from sugar production, suitable for electricity or heat production.

The utilization of solid biomass can be an environment friendly energy supplier - if grown sustainably. Sustainably means harvested from mixed tree species plantations and not illegally logged from protected areas and water towers.

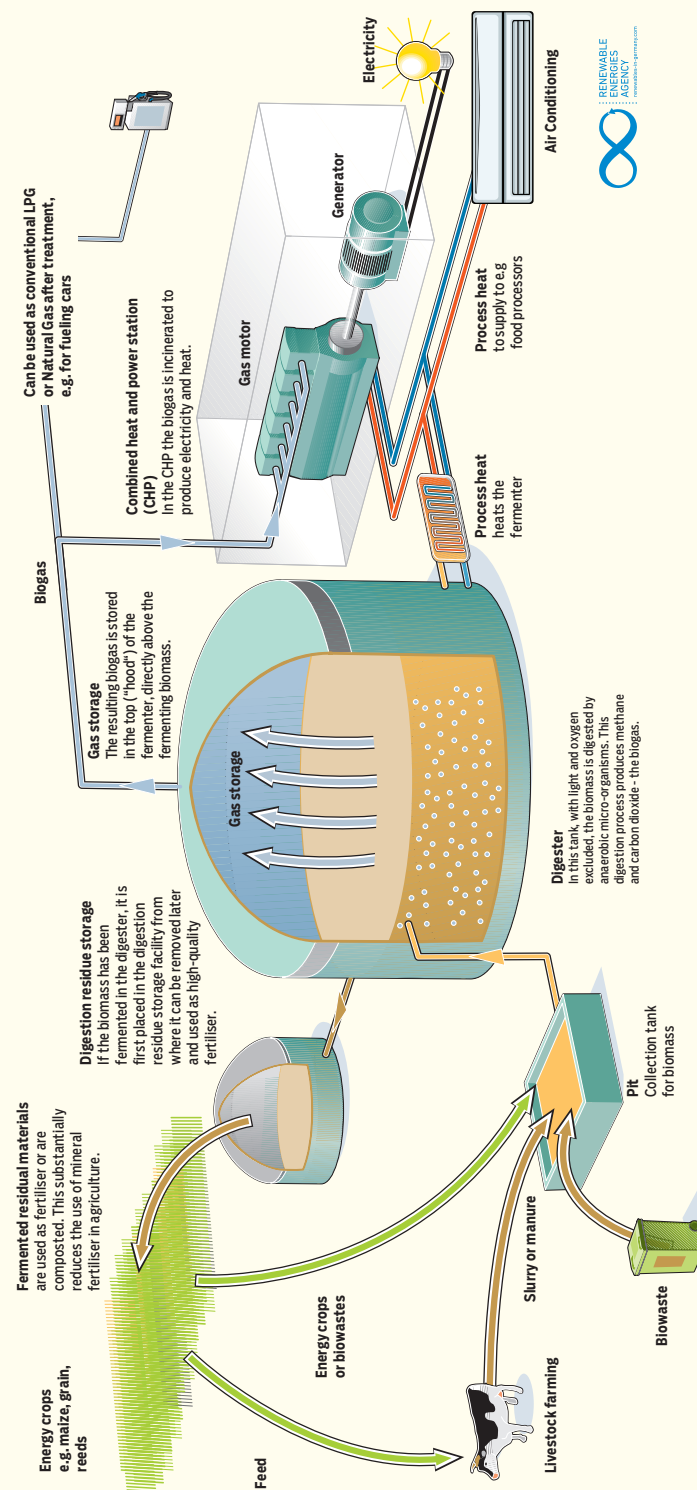
Biogas System

Biogas is a gaseous fuel produced by the fermentation of biomass. With the right production methods, it has similar characteristics like natural gas: In households for cooking, in industries for power generation and also for fueling natural gas vehicles.

Slurry and solid biomass are suitable for biogas production. The manure of an average cow weighing 500 kilograms can be used to achieve a gas yield of around 1.5 cubic metres per day. In energy terms, this equates to around one liter of petrol. After the process, the fermented residual materials are brought back to the crops serving as fertilizer and enriching the soil.

Several factors determine if a biogas station – in principle a conventional power plant with gas engines that produce electricity and heat – can be run profitably. These factors include the price the operator obtains for the sale of electricity to the grid, nearby heat demand, the commercial value of the residues used as fertilizer, the characteristics of the biomass input and the costs for transporting biomass to the biogas station, among others.

Biogas System

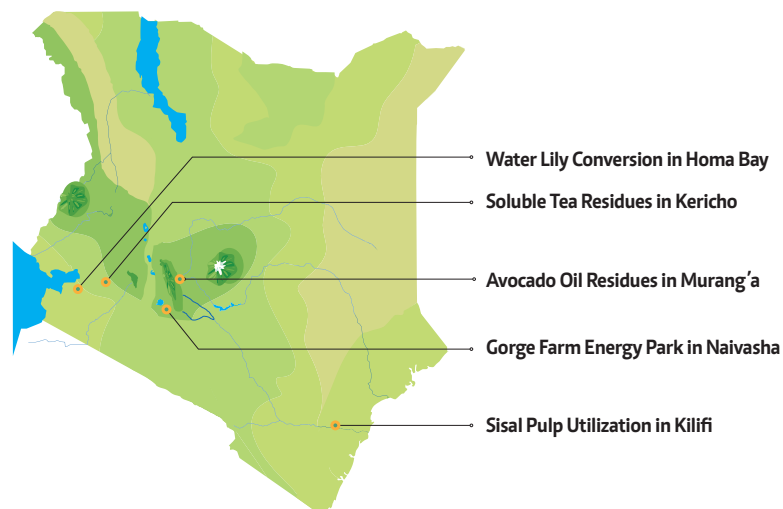


BIOGAS PLANTS IN KENYA

Until today, the utilization of biogas for energy production in Kenya is a niche market. Utilizing fertile soil – suitable for food production – for growing energy crops is understandably not encouraged and therefore not undertaken.

Biogas power stations are limited to industries and agricultural facilities that produce a sufficient amount of biomass residues over the year. The number of potential applications is small including slaughterhouses, the sugar industry, zero-grazing livestock herders, big sisal plantations, a small number of fresh produce processors and – in the near future – the harvesting of invasive species like water lily.

A handful of successful projects are already implemented in Kenya – impressively showcasing the potential to economically convert excess biomass into valuable resources.



Sisal Pulp Utilization in Kilifi

Beneath the Baobabs at Kenya's coast, **Kilifi Plantations** does not only host the annually held **Kilifi Gold Triathlon**; an iconic event that brings together national and international competitors to run, cycle and swim for a good cause. In addition, **Kilifi Plantations** produces sustainable bioenergy. Agricultural waste in the form of cow manure and sisal processing residues is converted into electricity for onsite use. The plant was constructed by the German company **agriKomp** in 2004 and is one of the oldest, still running biogas stations Kenya.

agriKomp.com



Kilifi Gold Triathlon



Anaerobic Digester

Gorge Farm Energy Park, Naivasha

In 2016, **Gorge Farm's** anaerobic digestion plant was the first biogas plant to feed electricity into the national grid. With an installed capacity of 2.8 MW, the company **Tropical Power** runs one of the biggest biogas plants in Africa.

Located at the shores of Lake Naivasha and next to Hell's Gate National Park – a popular tourist destination for weekend trips from Nairobi – residues from the 800 hectare farm are used to produce electricity. With excess heat, greenhouses are being heated, creating possibilities to further increase the yields and save on energy costs.

tropicalpower.com



James Finlay Soluble Tea Residue Biogas Plant

► **The biogas digester has a substrate feeding capacity of about 28 tonnes per day**

James Finlay Limited is one of the biggest tea growing companies in Kenya and East Africa. In order to reduce their ecological footprint, the company took the decision to convert its organic production residues into biogas. James Finlay closely collaborated with the German company **AKUT Partner** for a biogas plant design tailored to the specific feedstock on site.

Commissioned in April 2014, the facility's digester is fed with residues from the production of green and black soluble tea. Saosa Tea Extract plant is the only soluble tea production facility in Kenya. Other feedstock for the biogas plant can include septic waste from across the vast tea plantations around and slaughterhouse waste from nearby Kericho town.

Its average daily gas production amounts to 625 cubic meters. The biogas fires a gas engine with an electrical output of 160 kW. Part of the heat obtained is used to maintain the anaerobic digestion process at 38 to 40 degrees Celsius. Further excess heat is used for process heating duty at the Saosa Tea Extract plant. The fully automated engine runs 24 hours a day constantly supplying James Finlay's facilities with clean, renewable energy.

The slurry is mainly used as organic fertilizer for their organic tea fields, and for adding organic matter back to croplands that are being replanted.

🌐 finlays.net

PHOTO: AKUT Partner/ James Finlay Ltd.



Thika Way Investments



The communities along the shores of Lake Victoria are suffering from the uncontrolled growth of the water hyacinth – an invasive species first introduced into East African Lakes in the late 1980s. By blockage of the water surface, indigenous plants, fish and other animals die from lack of oxygen. Water hyacinths also create excellent breeding areas for disease-carrying mosquitos and choke marine traffic by blocking the ports. Since their inception, the water hyacinth has put the marine economy at Lake Victoria to a standstill.

Thika Way Investments, a German-Kenyan venture, is implementing an approach to solve the water hyacinth's problem. Five biogas stations are being constructed at the coastline of Lake Victoria targeting an initial capacity of 35 MW electricity for feed-in to the national electricity grid. To secure constant operation, sugar production residues sourced from local industries are blended into the water hyacinth input.

The growth rate of the invasive plant allow much higher capacities at a later stage – paving the way for neighboring countries Uganda and Tanzania to also contribute to solving the water hyacinth's problem.

🌐 thikaway.biz

► The communities in Western Kenya not only benefit from the reduction of the water hyacinth population and clean sustainable energy. They also gain access to high-quality fertilizer from the production residues as well as job and training opportunities.



Energy efficiency is the cornerstone to maintaining the wellbeing of future generations and creating wealth for many. All over the country, and especially in the metropolitan areas, Kenya's population is growing rapidly. Consumption patterns largely change from a predominantly rural to a more urban lifestyle. As much as everyone's needs are different, almost every change in lifestyle comes with higher energy needs – used in buildings, transport, commercial activities and manufacturing processes.

Kenya's natural resources – water, energy, cropland, and others – do not grow with the population but become increasingly scarce instead. The only way to satisfy the needs of an ever growing, more urbanized population is to increase energy efficiency in all processes of consumption and production. A good number of Kenyan industries already leads in adopting respective measures – being the vanguard that inspires through new ideas, instead of only copying established practices from more industrialized countries.



Thika Power – Energy Efficiency at the edge of the physical possible

Reliable power sources are essential to address short-term deficits in electricity supply. The **Thika Power** plant is an independent power producer (IPP) generating electricity from Heavy Fuel Oil (HFO). **Thika Power** runs the first power plant in Africa that uses a combined cycle (CC) solution from German **MAN Diesel & Turbo**.

The integrated steam turbine converts excess heat from the engines into electricity. The steam turbine generates an additional 6.8 MW electricity.

Without the steam turbine, this excess heat would dissipate into the air without any use.

The fossil fired power plant only runs at consumption peaks when geothermal and hydro power stations, located farther away from Nairobi, are not fast enough to supply the required electricity load. If the plant has to be switched on, the combined cycle steam turbines lower both environmental impact and the power bills of each and every Kenyan by burning fuel at maximum efficiency.

powerplants.man-es.com



The MARC®2 steam turbine generates an additional **6.8 MW** electricity at Thika Power

DID YOU KNOW?

Steam turbines are among the most complex machinery ever built by mankind. High operating temperatures coupled with the running speed of the movable parts put extreme demands on engineering, materials and precise manufacturing. Only a handful of companies worldwide have the expertise to produce industrial steam turbines.



BASF – exponential gains: better stability with less concrete

Decent shelter for everyone is one of the highest prioritized goals for the Kenyan government.

The construction sector has the responsibility to contribute to this goal by offering cost efficient solutions. This can be translated into huge amounts of cement required for the projects in the coming years.

In response to East Africa's increasing demand for construction materials, the global leading chemical company **BASF** opened in 2011 a concrete admixtures production facility in Mlolongo near Nairobi.

The plant produces custom-made concrete admixtures. Cement and other concrete raw materials are locally sourced and used to make the final product custom-tailored to meet the client's needs.

 basf.com



The innovative admixture allows to partly replace the expensive cement in the concrete mix and requires at least 20% less water. At the same time, customers receive 20% stronger concrete. This is only one example that showcases the efficiency potential the construction industry can achieve by applying cement admixtures.

DID YOU KNOW?

Concrete – a mixture of cement and other materials like sand or water – is one of the most indispensable materials for human development. Only with concrete, it is possible to build water dams for hydro electricity and irrigation, to construct bridges that cross borders or skyscrapers that define the world's capitals. The downturn of concrete are the massive greenhouse gas emissions during the cement production process. The energy intense production is often powered with fossil fuels. Additionally, the mere production process itself sets free big amounts of carbon dioxide accelerating global climate change. Where possible, traditional building materials like for example clay or sustainably sourced wood are preferable. If the specific attributes of concrete are mandatory, the cement volume should be reduced as much as possible.



KAPA Oil Refineries

▶ Practically all manufacturing industry on the plant relies on compressed air solutions for its production processes, and 80% of an Air Compressor's cost is only occurring after the first purchase, in the form lifetime costs like maintenance and electricity consumption.

KAPA Oil Refineries, a major food processing company based in Nairobi installed a combination of hardware and software from German manufacturer **KAESER**. The air management system determines the best configuration for pressurized air supply at all times to match demand with most efficient operations and lowest electricity costs. This results in 10 million Kenyan Shillings less on the electricity bill – every year.

 kaeser.com



Maisha Flour Mills – stable voltage through high-tech equipment

Hardly any Kenyan makes it through the day without eating ugali, chapati or mandazi – to name just three of the most popular Kenyan dishes. All are prepared from flour – flour that is milled from grain. The Kenyan milling industry is one of the most vital and most professionalized industrial sector in the country. Every percentage of energy efficiency achieved in the milling process will also reflect in fuller purses for Kenya's citizens.

Maisha Flour Mills is an industrial grain processing facility in Nyeri. To tackle the challenge of fluctuating energy supply, **Maisha Flour Mills** installed a Voltage Regulations System by German specialty supplier **A. Eberle**. High voltage fluctuations in the national electricity grid especially challenge the manufacturing industry. Most production machinery require a stable voltage supply to run efficiently.

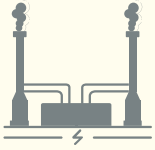
 a-eberle.de

The installation of the voltage regulator allows the factory to maintain a constant voltage level at 230V and reduces electricity supply costs by more than 10%. Additional decrease of maintenance and downtimes by

50%.



GEOTHERMAL ENERGY



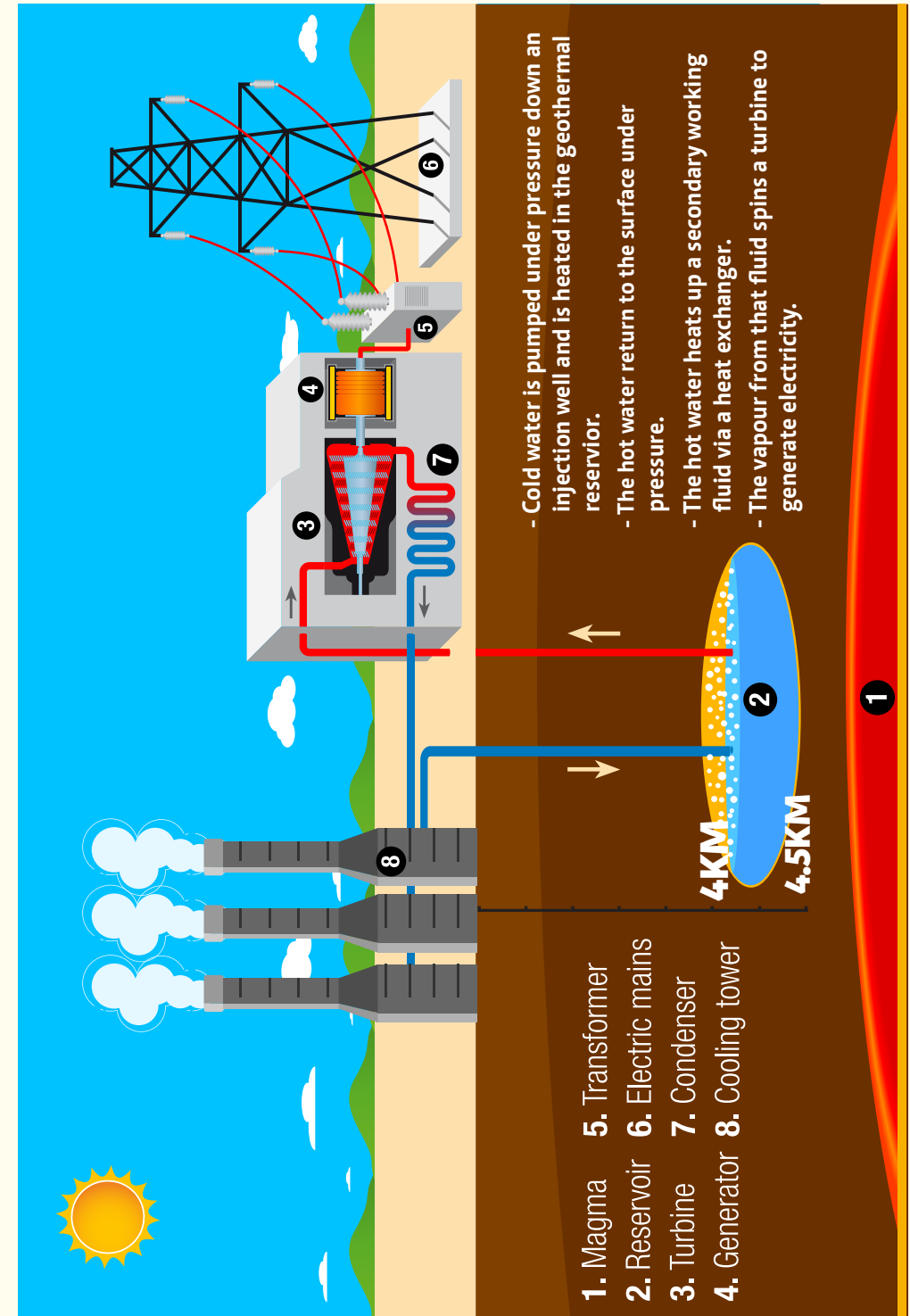
The term geothermal refers to Earth's Heat. The technology entails producing energy from the internal heat of the earth and has historically been limited to areas around volcanic and tectonic plate boundaries. With water from hot springs, geothermal energy has been used for bathing since Paleolithic times and for space heating since ancient Roman times, but it is now better known for electricity generation.

Recent technological advances have drastically expanded the range and size of viable resources, especially for applications such as home heating, opening a potential for widespread exploitation. Worldwide, electricity from Geothermal power replaces around 15 big coal or nuclear power stations.

Geothermal Energy can be utilised in different ways. **Direct Use** includes applications such as heating systems using the hot water extracted from the earth, and require no additional equipment to function. Additionally, direct geothermal heating capacity is installed for district heating, space heating, spas, industrial processes, desalination and agriculture. **Geothermal heat pumps (GHP)** are used to moderate heat in residential buildings, by cooling or heating, depending on the requirement in the different periods of the year. For **Electric Power Generation**, steam extracted from the earth is used to turn turbines on a generator, hence producing electricity. Geothermal energy is a reliable and consistent source of power as plants operate 24/7. It therefore generates base load power.

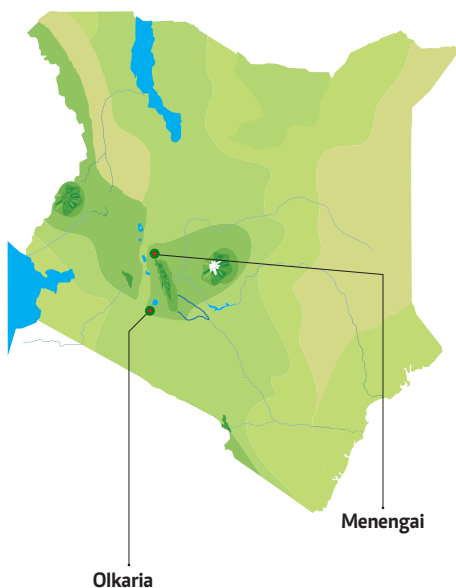
The Earth's geothermal resources are theoretically more than adequate to supply humanity's energy needs, but only a very small fraction may be profitably exploited. Drilling and exploration for deep resources is expensive, it is therefore important to carry out feasibility studies for accuracy when drilling. Forecasts for the future of geothermal power depend on assumptions about technology, energy prices, subsidies, plate boundary movement and interest rates.

Geothermal power is cost-effective, reliable, sustainable, and environmentally friendly. It is free of carbon and its carbon footprint offsets competing sources, among them Coal, Heavy Fuel Oil (HFO) and Natural Gas manifold.





The Geothermal Spa, located within Hell's Gate National Park, is a tourist and medicinal value attraction spot. The spa's water temperature lies between 37 and 40 degrees Celsius.



Since a few years, Geothermal sources are the major electricity provider for Kenya, having surpassed hydro power plants since 2016. The Geothermal electricity generation capacity will further grow in the coming years and soon exceed 50% of all electricity produced in the country.

Kenya was the first country in Sub-Saharan Africa to exploit Geothermal based power on a relevant scale. Kenya tops in Africa in the sector and is ranked 8th worldwide, way ahead of Germany, which is currently ranked 18th with significantly lower capacities.

The Geothermal sources are concentrated in the Great Rift Valley, where the country's volcanic line is located. All the Geothermal power stations are currently located in close proximity to Lake Naivasha, 90 km away from Nairobi. In 2020, Geothermal generation in Kenya will further expand through the set-up of the first of several power plants in Menengai crater, closer to Nakuru town.

Though initial exploration of Olkaria started in 1955, commercial generation of electricity took off only in 1981; back then with an installed capacity of 15 MW in Olkaria. The majority of plants are owned by formerly state-owned electricity producer **KenGen**; some are also operated by Independent Power Producer **OrPower**.

Upcoming Geothermal reservoirs yet to be developed in the next few years in Kenya include Suswa, Longonot, Akiira and Baringo Silali in addition to the expansion of the existing Olkaria plants and Menengai Crater.

The German Development Cooperation together with investment specialists from DEG support Kenya with innovative finance solutions in exploiting its geothermal resources thus producing green, emission-free electricity.

🌐 kengen.co.ke

🌐 deginvest.de/International-financing/DEG/

DID YOU KNOW?

At the Oserian Development Corporation, the biggest grower of quality flowers in Kenya, a private hot spring well is used to heat greenhouses. This geothermal heating gives constant temperatures, reduces humidity to below 85% and prevents diseases, so fungicide sprays don't need to be used. Even when taking into account airfreighting, the carbon footprint of each of Oserian's roses is one sixth of a rose grown in Europe.

🌐 oserial.com





Today, Hydro energy is the most widely used renewable energy source for generating electricity worldwide – and there is significant potential for expansion. The general principle of Hydro energy is quite simple: Water flows through a turbine and the mechanical energy from its rotation is transformed into electricity.

The sweet spot about Hydro power is the total lack of greenhouse gas emissions for the electricity generation. Greenhouse gas emissions occur practically only during the construction phase. Often, Hydro power plants even bring additional benefits like flood protection.

Nevertheless, the construction of a hydro plant always entails ecologic and social impacts by flooding land and blocking the natural flow of the streams. With technical measures, clever engineering and committed involvement of affected communities, many of these effects can be mitigated. The decision for a new hydro development must therefore be based on a thorough assessment to ensure that benefits outbalance damages.

Hydro energy has one feature that differentiates it from other renewable energy sources like wind and solar. The production can be managed according to the demand regardless of the day's weather conditions.

Nevertheless, long term weather patterns like draughts or floods can have a significant adverse effect on Hydro energy. Climate change, which likely comes with less predictable rainfalls, will negatively affect the reliability of Hydro electricity. As with all energy sources, Hydro therefore maximizes its potential if coupled with other renewable energies like Solar, Wind or Geothermal.

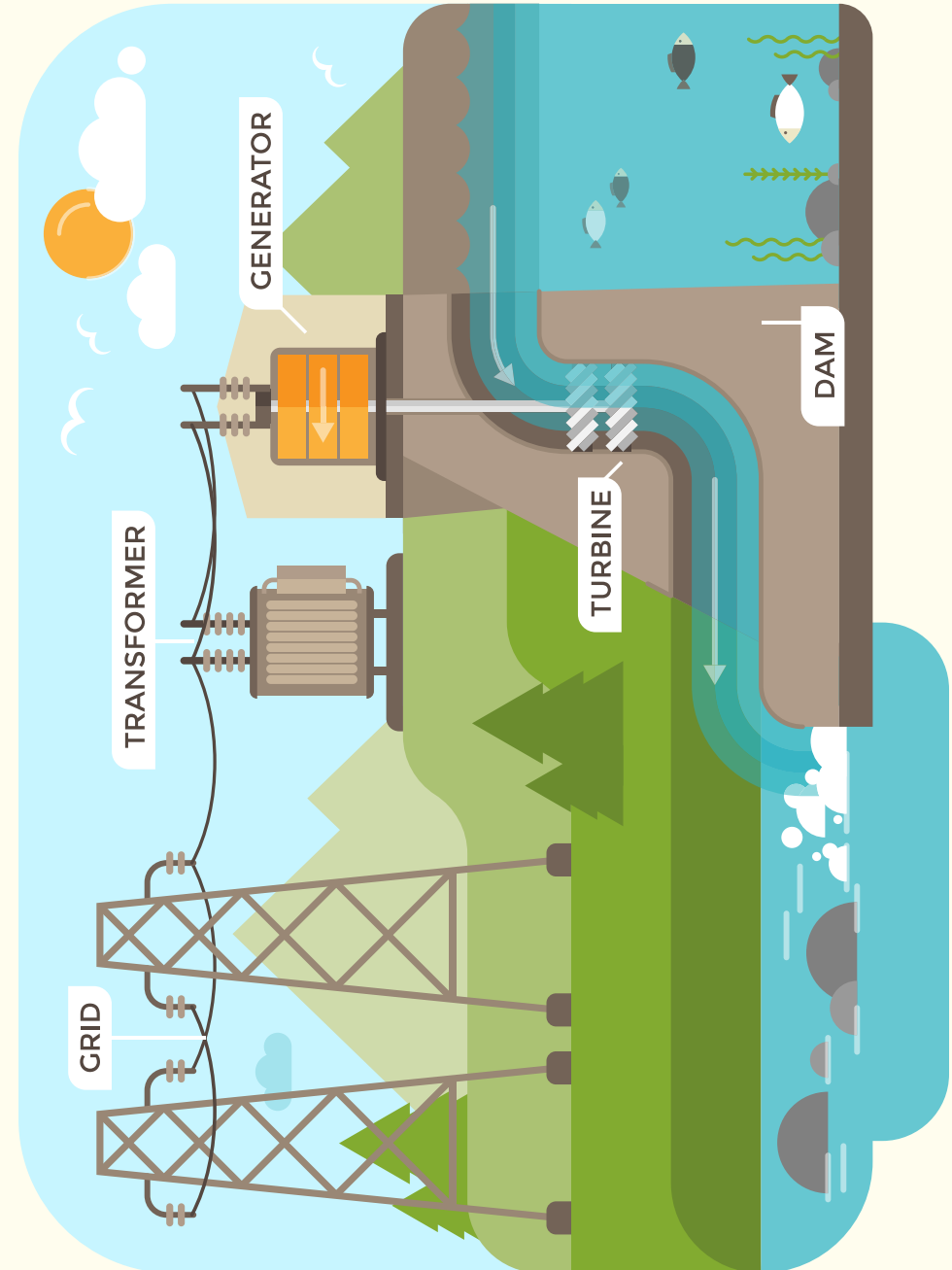
TYPES OF HYDRO PLANTS

The most common Hydros are **Run-of-the-river Power Plants**: Basically, a turbine is installed at a river and uses the energy of the river flow to produce electricity. The dam built is usually small and the impact on the environment little. The designs are as diverse as our environment. An uncountable number of different run-of-the-river plants are installed in thousands of rivers all over the planet. The biggest disadvantage of these kind of power plants is their very limited capacity to store energy.

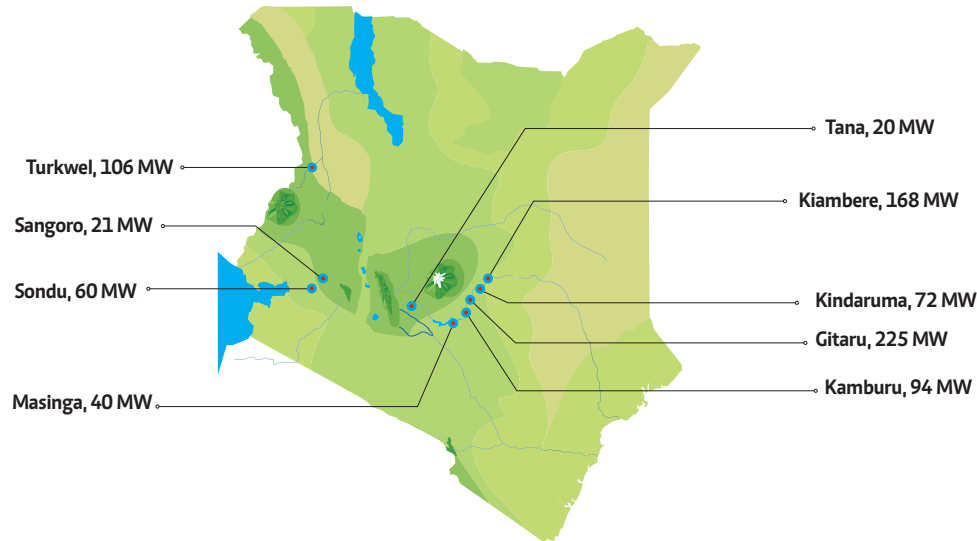
Reservoir Hydro Plants dam a flow into a reservoir and additionally extract power from the difference in height. Water can also be pumped from down the stream into the reservoir. The power production can therefore be regulated according to the energy needs.

Pump Storage Hydro Plants mainly serve for balancing fluctuations in electricity production and consumption through a pond into which water is pumped.

Unlike chemical batteries – that are commonly used for cars, torches, cellphones, portable computers and the like – Hydro plants with storage capacity use gravitation to store energy. In times of low electricity demand, surplus power in the grid is used to pump up water into a dam. When electricity consumption peaks, this water can be released producing electricity when it is most needed. Until now, far more than 90% of the electricity's storage potential in the world is made up of Hydro power plants and not of what we call "batteries". This figure is projected to only change slowly over the next decades. This highlights the tremendous importance of Hydro energy for clean electricity generation in the foreseeable future.



BIG HYDRO POWER PLANTS

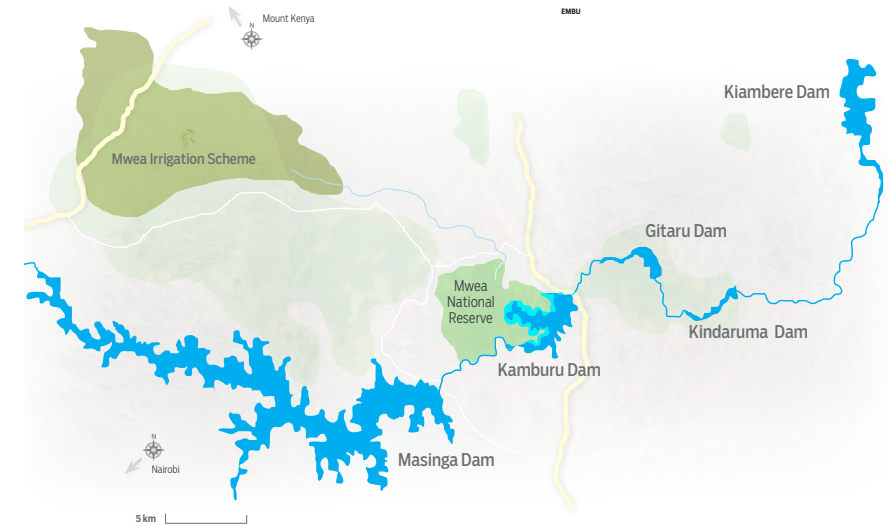


In Kenya, big Hydro power stations generate a total capacity of over 800 MW, contributing around a third to Kenya's electricity mix. The Hydro plants are located at the biggest rivers in different parts of the country, offering a stable supply of clean energy to its economic hubs.

The development of big Hydro plants in Kenya has largely come to an end. Despite some more promising sites – at the Tana River alone, original plans from the 1960s foresaw the development

of eleven big Hydro plants – of which only five ones have been realized. Ecological impacts of big dams are weighed against alternatives and Kenya's other renewable energy sources, including Geothermal, Wind, Solar and Small Hydros, already offer abundant potential for meeting the country's future electricity demand. Still, in the foreseeable future, the current big Hydro stations will remain a crucial pillar of Kenya's green electricity supply.

Tana River Cascade



Rooting in the Aberdares and also fed from Mount Kenya's slopes, Tana River is, with more than a thousand kilometers length, the longest river in the country. It is a lifeline for much of Kenya's population – and essential for its electricity production.

Just before Kenya's independence, plans for the construction totaling to eleven hydro stations on Tana River were laid out. Until today, a cascade of currently five power plants has been developed.

DID YOU KNOW?

Only a few potential big Hydro sites remain undeveloped. Still, the existing big Hydro Stations will stay paramount for Kenya's electricity supply in the foreseeable future.





PHOTO: Masinga Hydroelectric Power Station/ KenGen

Built in 1981, Masinga's own electricity production is of less importance than its irrigation purposes as well as the water stream regulation for the four dams down the river. The two turbines in the dam were built by **Andritz Hydro**, a company based in the Southern German town of Ravensburg. Masinga generates a combined 40 MW of electricity, relatively little in comparison to other Kenyan Hydros. But the dimensions of Masinga look different if the water surface of up to 120 square kilometers is taken into account.

The next dam in the cascade, Kamburu, covers since its commissioning in 1978 way less surface, but with 94 MW it contributes more than twice as much to Kenya's electricity supply. Visitors can best experience the scenic beauty of the lake by having a picnic at its shore within Mwea National Reserve, a serene insider secret among wildlife spotters known for its large giraffe populations.

andritz.com/hydro-en



PHOTO: Kamburu Dam/ Ministry of Energy Kenya

Following Masinga and Kamburu, three more dams are located farther down the stream of Tana River.

Gitaru is the third dam within the cascade and the biggest hydro power station in Kenya – generating electricity with a capacity of 225 MW in a run-of-the-river-plant. The two 75 MW turbines were originally delivered in 1978 by German specialist company **Voith Hydro**. A third **Voith**-turbine was added in 1999.

Today, Kindaruma is a medium sized hydro plant in Kenya. Back in 1968 it was the first significant power station in the country – being a cornerstone for Kenya's economic and

social development and securing its place as an independent nation. Since its upgrade in 2010 – financed by German Development Cooperation through **KfW** – its capacity stands at 72 MW. The three turbines were built by German-Austrian **Andritz Hydro**.

The last dam in the cascade was also the last one to be commissioned in 1988. Kiambere has a capacity of 168 MW making it the second biggest hydro power station in Kenya. Similar to the first dam of the cascade, Kiambere's second purpose is water storage for irrigation purposes.

voith.com

kfw-entwicklungsbank.de



PHOTO: Kindaruma Dam/ KenGen



DID YOU KNOW?

Today, Kindaruma is a medium sized Hydro plant in Kenya. Back in 1968, it was the first significant power station in the country.

Turkwel Arch Dam



In proximity to the Ugandan border, the sheer endless plains of Northern Kenya can be spotted from Turkwel Power Station. With more than 150 meters stands the highest wall among all Kenyan Hydro stations. Against securing electricity supply for Kenya's densely populated West, the breathtaking views have nevertheless been the minor reason for its construction back in the early 1990s. The multi-purpose dam can generate 106 MW of electricity and additionally serves for irrigation, fishing and as one of the most iconic tourist attractions in this part of Kenya.

Tana Power Station

For any Nairobi driving towards the popular holiday locations around Mount Kenya and the Eastern Aberdares, a construction of meter-thick metal tubes is a familiar landmark soon after having entered Murang'a County – and has been so for generations already; clean electricity for Kenya can be traced back to the first construction of a dam at this site in the 1930s – being today one of the smaller Hydro plants in Kenya with a capacity of 20 MW.

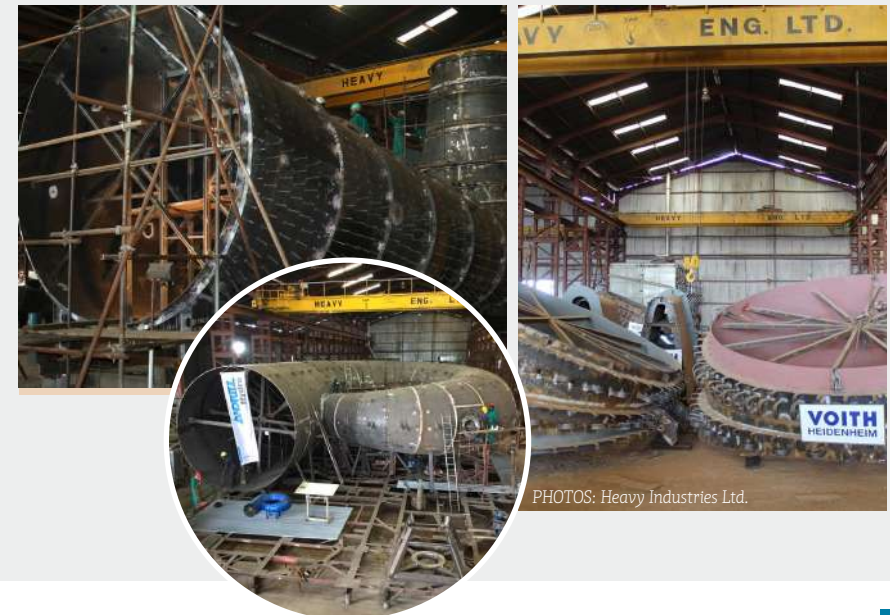


PHOTO: Masinga Hydroelectric Power Station/ KenGen

Did you know?

Opposite of the new train station in Nairobi's Syokimau district, a more traditional address of Kenya's Green Economy is located: Over the last decades, Kenyan manufacturer **Heavy Engineering Ltd.** has created jobs by assembling the turbines for every single big hydro plant in East Africa – even exporting to places as far as Afghanistan. Some core components of the water turbines are being imported usually from Germany, whereas the bulk of the works – including the construction of the turbine cases and the commissioning – is done onsite.

heavyengineering.co.ke

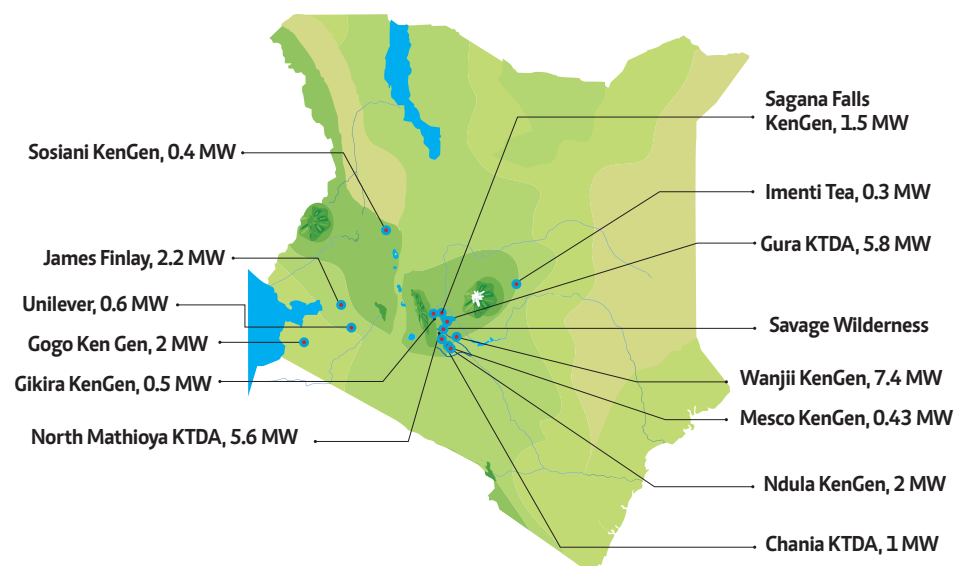


PHOTOS: Heavy Industries Ltd.

SMALL HYDRO POWER PLANTS

Smaller plants are today considered as the future of Hydro power. The construction of Small Hydros entails relatively little environmental impact. Unlike big Hydro stations, where the most feasible sites in Kenya are already utilised, there is potential for constructing tens to hundreds of small Hydro power stations – next to a handful that have already been built. Small Hydro power plants meet the energy demand in proximity to the consumption thus building local value chains and fostering economic growth.

The economically thriving tea growing areas in Kenya often offer perfect conditions for constructing small Hydro power plants: Water resources are available on the one and sufficient residential, commercial and industrial electricity demand exists on the other hand.



FACTS

Although there is no international consensus on the actual size of small hydropower plant, thresholds according to electricity generation capacity have become generally accepted. The Kenyan Ministry of Energy uses the following classification:

- Below 5 kW: Pico hydro for onsite use
- 5 to 100 kW: Micro Hydro for powering some households up to a village.

- 100 to 1,000 kW/ 1 MW: Mini Hydro for supplying electricity to a mid-sized factory or a few villages; usually connected to the public grid
- 1 to 3 MW: Small Hydro already on industrial scale and a significant regional contributor of electricity for the public grid
- Medium Hydro ranges from 3 to 30 MW; everything above is classified as Big Hydro and of national importance.

Savage Wilderness



Kayaking at Sagana

Still far upstream from the Tana River Cascade of big Hydro dams, Sagana adds its part to make Kenya one of the most diverse tourist destinations on earth. Adventurers can feel the sensation of sliding down waterfalls and enjoying the breathtaking experience of a wild river raft under the acacia canopies of Central Kenya.

The *Savage Wilderness Camp* pioneered white water rafting in Kenya – and keeps on spearheading the pathway to green economy by utilizing an onsite micro Hydro turbine. Producing electricity just for onsite use, it does show how also private initiatives can make productive use of water resources – safeguarding our precious planet from harmful emissions of other energy sources.

savagewilderness.org

Kenya Tea Development Agency Small Hydro Projects



Worldwide, Kenya has positioned itself as the number three tea producer and number one tea exporter, with Mombasa hosting the second largest tea auction on the planet. The tea sector is of paramount importance for the country's foreign trade and provides the main source of income for around two million people, hereby only counting the direct employees.

The most important institution in the tea sector and the entire Kenyan economy is the **Kenya Tea Development Agency (KTDA)**. KTDA takes over important activities within the tea sector such as the cultivation control. It offers services for the purchase of equipment and farm inputs, organizes the collecting, processing and marketing of the tea leaves. All Kenyan small farms are legally obliged to market their tea through this parastatal.

On behalf of more than half a million tea farmers, KTDA operates 68 tea factories processing around two thirds of Kenyan tea harvest. Together, these factories demand about 40 MW of electricity – summing up to significant electricity bills that effectively are paid by the tea farmers.

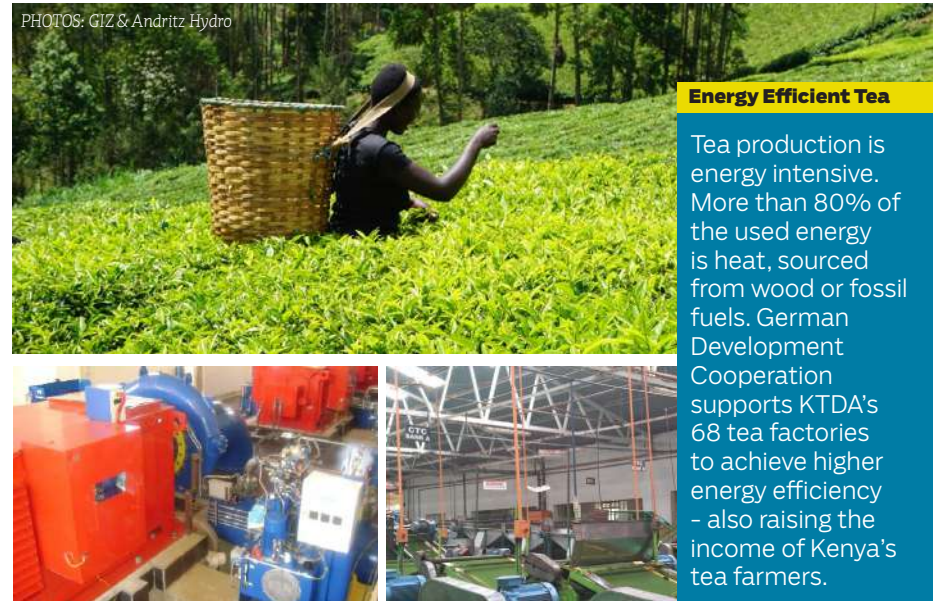
In order to reduce costs and shift its operations green, **KTDA** is running and developing several small hydropower plants across the different tea growing regions. The goal is to reduce the cost of energy for each tea factory, which currently forms their single biggest cost component, and to shift to a more environmental friendly energy supply. The excess power generated is sold to the national grid, providing farmers with an additional revenue stream. The installed capacity varies from less than 1 MW to 6.5 MW.

ktdateas.com

KTDA North Mathioya Dam

The tea estates of the Aberdare Range stand at an altitude of 1,700 to 2,200 meters above sea level. This catchment is home to one of Kenya's key tea belts, extending from Kiambu all the way to Nyeri, and also covering Murang'a tea zone. In North Mathioya, additionally to tea clean electricity is produced. This dam is among the first of **KTDA's** projects to set up seven new small Hydros, generating electricity since beginning of 2019.

PHOTOS: GIZ & Andritz Hydro



Energy Efficient Tea

Tea production is energy intensive. More than 80% of the used energy is heat, sourced from wood or fossil fuels. German Development Cooperation supports KTDA's 68 tea factories to achieve higher energy efficiency – also raising the income of Kenya's tea farmers.

The three turbines as the core component are delivered from Germany by the company **Andritz**. These turbines can transform the water flow into electricity with an efficiency rate of up to 92.99% – scratching the edge of the physically possible. Even the most modern coal fired power plants hardly work at more than 40% efficiency. That means that in a coal station, far more than half of the energy is wasted unproductively on the one hand, still accelerating climate change on the other, whereas in the case of Hydro, the gross majority of a stream's power can be converted into electricity.

Other Small Hydros

KTDA's project to utilize green energy on a bigger scale is just the latest effort to incorporate small Hydros into the country's electricity consumption. Besides the big dams run by KenGen, a number of smaller Hydro plants are providing electricity to the grid. The current 15 MW will soon be doubled counting in the various projects under construction and development.



The power of the sun is an abundant resource everywhere on the planet – and it is for free, for everyone.

All trees and crops on earth use Photosynthesis to grow: The word derives from “Phos” for Light and “Synthesis” for Creation in ancient Greek language. With Photovoltaics, mankind invented a technology to use the sun’s energy for generating electricity – “Volts”. The first applications of Photovoltaics already date some decades back. With sharp gains in the production efficiency over the last years, the technology has now reached its commercial viability, meaning that it can produce green, emission-free energy at competitive costs.

The basic element and producer of electricity within a Solar PV system is a Solar cell. Solar cells are manufactured similarly to microelectronic components such as computer or smartphone processors. Like these semiconductors, they mainly consist of the element silicon. The process of converting raw silicon resources into highly precise and pure materials is technically complicated and costly – also driving the price for solar cells.

Several Solar cells are combined and connected to each other on a so called Solar panel. A Solar panel also includes protection and mounting equipment and can be transported and stored with little risk of damage. A typical Solar panel measures around 1 by 2 meters, consists of around 60 Solar cells and has a capacity of 230 to 260 Watts (0.23-0.26 kW).

Will costs for solar always decrease?

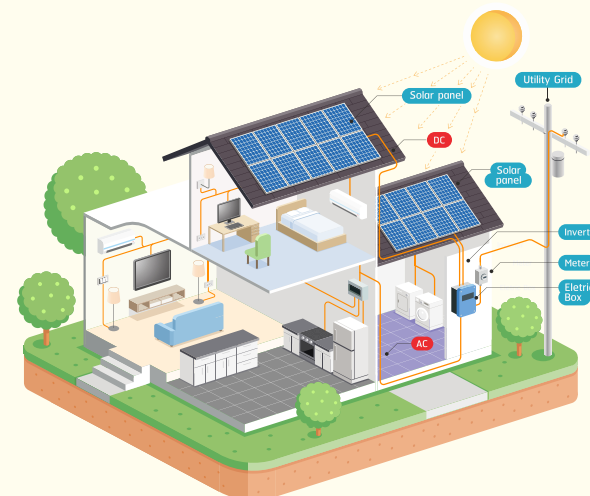
Over the last years, the technical progress with less material loss and more efficient workflow in the manufacturing process has led to drastic price decreases for Solar PV cells. At the moment, the production processes nevertheless scratch the physical limits. Since around 2015, the price decrease for Solar cells happens at a much slower pace than over the years before. A Solar system consists of much more than Solar cells – cables and inverters, design and commissioning, among others. Even with further decrease in PV cells, the current prices for an entire system will remain relatively stable over the next years.



Solar cells do produce electricity – but not in a way that it can be directly consumed by most electric devices. For most applications, Solar direct current (DC) electricity has to be converted into alternating current (AC) electricity – the same principle applies for batteries. Next to the solar panels, DC-AC inverters are the other core component of a Solar PV plant.

A common inverter capacity for industrial and commercial solar power plants is around 3 kW up to 25 kW; for residential applications also smaller inverters are used. Every bigger Solar PV system usually consists of several coupled inverters: This enables the system to continue producing electricity even in case of damage on one of the inverters and reduces wiring works.

For every Solar PV plant, the peak capacity is always used as a reference. This is the electricity that can be generated at perfect sunshine conditions, for example on a sunny day at noon. In the morning and evening hours or during cloudy conditions, electricity is produced below this peak capacity with no production at all during the night.



Solar is not Solar. Two different Solar applications have to be distinguished. Solar PV, the aforementioned, is used to produce electricity, whereas Solar Thermal uses the sun’s power to directly heat water. **Simply said, Solar PV is installed by an electrician and Solar Thermal is set up by a plumber.** Solar Thermal is a simpler technology with lower component costs. For supplying hot water in residential buildings or in the hospitality sector, Solar Thermal is by far the most efficient technology. In order to achieve lowest energy costs, a mixture of both Solar PV and Solar Thermal is usually the way to go.

! The technical principle behind a Solar PV plant is simple – its implementation nevertheless needs experience, technical knowledge, electrical skills and relies on quality components.

For example, even the most efficient German inverter technology, nowadays working at more than 99% efficiency, relies on the input of the solar panels.

Rogue contractors commission solar systems stating the inverters’ capacity but utilizing sub-standard panels with low output and short lifetime – widening

the gap in between stated and actual capacity and flushing the customer’s money down the toilet. Despite a massive decrease in costs over the last decade, solar panels are still the costliest component.

A panel’s performance can only be assessed utilizing specialized electrical testing equipment. Therefore, a well established brand should be preferred against a no-name panel. Experienced contractors never fully rely on the manufacturer – but use their specialized equipment to sample performance assessments. Picking a reliable Solar contractor is mandatory!

OFF GRID APPLICATIONS

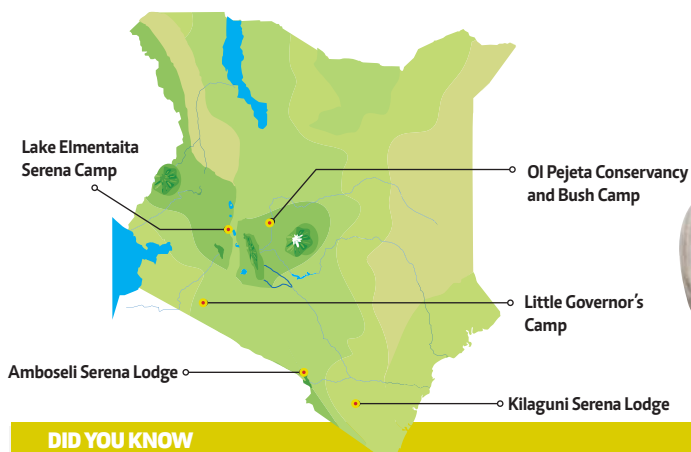
East Africa in general and Kenya in particular are the most iconic Safari tourism destinations in the world. In world-renowned protected areas like the Maasai Mara as well as in smaller conservancies and parks, tourists from all over the world travel to spot the diversity of animals and to pursue the serenity of an African sunset.

With the remote locations of Safari Camps comes a disadvantage in infrastructure access. Electricity lines are non-existent and the constant operation of diesel generators doesn't fit the experience of nature tourism. Nowadays, more and more wildlife lodges aim at closing the loop and offer an environmentally more sustainable experience by incorporating Solar

! In Off-Grid applications, energy storage is often the weakest point. The right inverters with advanced battery management software, training on maintenance and the – indeed costly – investment in quality batteries increase the system's lifetime drastically and save costs on the long run.

in their energy supply. Or they go farther and fully scrap their diesel generators.

Every lodge is different and so are the solar solutions that suit the most. Experienced suppliers offer a tailored combination of Solar water pumping, Solar Thermal and Solar PV fitting to the specific energy needs.



DID YOU KNOW

Ecotourism Kenya unites those hotels that are aware of their ecological footprint and aim at causing the best possible environmental and social impact. The 78 members, both safari lodges and beach hotels, are actively implementing measures to reach this goal.

Ecotourism Kenya rates its member facilities following criteria like resource utilization, community involvement and energy consumption. Sustainable energy sources, Solar as the most prominent among them, are one of the main criteria to access the prestigious Gold rating, currently held by 38 facilities.

ecotourismkenya.org



Ol Pejeta Conservancy



Ol Pejeta Conservancy, covering 360 square kilometers in Laikipia, is home to the world's last two Northern White Rhinos. It is also the only place in Kenya where Chimpanzees can be seen and it hosts the largest Black Rhino sanctuary in East Africa.

Visitors staying at **Ol Pejeta** can enjoy the full big five game safari experience in Kenya whilst causing little environmental impact. The conservancy has committed itself to run its entire facilities exclusively on renewable energy by 2023. In the year 2016 **Ol Pejeta** converted the first of its ten diesel powered water pumping stations to Solar. Once the conversion of all stations is completed, around 7 million Kenyan

Shillings spent on fossil fuels per year can instead be used to intensifying wildlife conservation efforts and community development.

Within the conservancy, a number of hotels, lodges and guesthouses guarantee unforgettable experiences for those who stay overnight. Among them is the **Sweetwaters Serena Camp**. Since February 2018, the camp, together with its sister facility at Rift Valley's Lake Elmentaita, went online with a grid-tied solar system set up by Kenyan Solar company **OFGEN**. This marks another step in supporting **Ol Pejeta's** efforts towards greener tourism.

olpejetaconservancy.org

ofgen.co.ke

Ol Pejeta Bush Camp

Set on the banks of the conservancy's water vein, Ewaso Nyiro River, **Ol Pejeta Bush Camp** offers guests the opportunity for one of the most intimate Safari experiences in Kenya. Since October 2016, the bush camp's diesel generators are at standstill.



The bush camp is equipped with a solar water supply with an integrated pressure pump system that pumps around 40 cubic metres of water daily, which is then heated by Solar Thermal power.

German Solar manufacturer **Sunset Energietechnik** proved its capacities by installing a pilot project that allows the bush camp to run on 100% Solar energy. A Solar PV mini grid with battery storage ensures electricity supply around the clock. To prove what is technically possible, a small Wind Turbine complements the Solar system.

The bush camp is also equipped with a Solar Thermal syphons with an integrated pressure pump system. Each day, the Solar pump provides around 40 cubic metres of water, which can then be heated by Solar thermal syphons. The project was supported by the **German Ministry for Economic Affairs and Energy**.

🌐 sunset-solar.de 🌐 asiliaafrica.com

Serena Hotels' Off-Grid Lodges

Serena Hotels is East Africa's biggest operator of hotels and resorts, running luxury facilities in five East African and three Central Asian countries. The management strives to focus on innovative programmes that respond to the needs of the environment, economy and communities within which it operates – the fundamental tenets of sustainability. The demand from eco-travelers is growing and **Serena** continues to adapt its business best practices model to meet the ecological travel experiences and expectations of today's guests.

The latest effort was the conversion of two of its off-grid properties to Solar; **Amboseli Serena Safari Lodge** that runs the largest battery system in East Africa, and **Kilaguni Serena Safari**, located amongst the world's greatest population of African Elephants in Tsavo National Park.

🌐 serenahotels.com

Little Governor's Camp

A flagship among the **Governor's Camp** Collection, **Little Governors' Camp** is located on the edge of the Maasai Mara. Just 17 luxury tents are tucked around a watering hole that teems with constant wildlife activities by both birds and mammals. After having approached the camp by a boat ride across the Mara River, guests share the space with a family of resident warthogs and may need to make way for elephants which sometimes visit the camp at lunch time.

After a detailed analysis of the guests' and the staff needs, **Little Governor's Camp** opted to shift its energy supply to 100% solar.

Since the end of 2017 a vacated generator house shows the latest effort of joining Kenya's pathway to Green Economy – only one 60 kW generator, out of formerly three with a total capacity of 300 kW, is still in operation as a rarely used backup. **Little Governor's** partnered with German **Sunset Energietechnik** that delivered all key solar components 100% **Made in Germany**.

The shift to 100% solar energy supply was the last step missing to achieve the prestigious Gold certificate from **Ecotourism Kenya**.

🌐 governorscamp.com 🌐 sunset-solar.de



Little Governor's partnered with German **Sunset Energietechnik** that delivered all key solar components – panels, inverters, thermal syphons, central boilers – 100% **Made in Germany**.

SOLAR IN NAIROBI

Commercial Solar PV projects are becoming increasingly attractive, particularly in urban regions such as the Nairobi Metropolitan Area – the undisputed economic and political center of East Africa. Here, reliability of electricity supply from the grid is usually secured. But in the future, electricity prices will rather rise than decrease. Already now, diversifying energy supply with Solar PV reduces power bills through less grid consumption.

Some years ago, the first pioneering projects in the field of Solar PV in Nairobi were driven by ideology - mainly aimed at reducing the environmental footprint. With more experience in the industry and smart load management, Solar PV has reached the level of commercial viability even in grid connected areas.



Strathmore Energy Research Center

One pillar of Nairobi's ever stronger position as a hub in logistics, industry, technology, finance, healthcare and more in East Africa is often forgotten by outsiders. Its excellent education institutions starting from schools and including several region-leading public and private universities. **Strathmore** is one of the first addresses in higher education in Kenya. Consequently, the university also hosts the **Strathmore Energy Research Center (SERC)**, the leading Solar training center in East Africa. With state of the art equipment and the support of the German Development Corporation, hundreds of solar technicians in East Africa have been enabled to learn hands-on what it takes to set up a long lasting Solar PV system, covering grid-tied and off-grid applications.

strathmore.edu/serc



! The Solar Panel is the single most costly component of a solar system and determines the entire performance. Rogue companies and connen swamp the Kenyan market with Sub-Standard quality affecting a project's economic viability – and the reputation of the whole industry. At Strathmore's Energy Research Center (SERC), the performance of Solar Panels - invisible with the bare eye - can be tested using specialized equipment.

PHOTOS:
Strathmore
School

UNEP'S Solar Roof

The *United Nations Environmental Programme (UNEP)* is headquartered in Nairobi's Gigiri district. Pioneering in green energy, the building is supplying its entire offices with sustainable, carbon free electricity. The roof mounted Solar PV has a capacity of 550 kW. The plant was set up in 2011 and is still one of the biggest Solar PV installations in Nairobi.

UNEP did not stop in going green by incorporating Solar PV. The whole building is also designed to safeguard natural resources, including rainwater harvesting from the roof for the garden fountains and irrigation. Going green and decreasing carbon emissions – the *UNEP* offices in Gigiri lead as an example for national and international organisations.

unenvironment.org



Garden City Mall

Garden City Mall on Nairobi's Thika Road is an integrated space for residential and office space as well as over 100 retail stores. Since its opening in 2015, it is a popular shopping destination for Kenyan families.

Garden City Mall has put a strong focus on green energy solutions and has implemented green technologies to generate electricity in an energy efficient and clean manner. The upper level car parking deck is equipped with a 858 kW Solar PV system - generating electricity as well as providing shade for the vehicles. Fuel Save Controllers from German *SMA* allow the system to operate in parallel with standby generators.

Its water for irrigation is sourced from rain collected from the building roof. The whole shop floor is naturally ventilated, requiring no extra energy for cooling or heating. *Garden City Mall's* choice of sustainability solutions is estimated to save at least 25% energy in comparison to conventional construction and significantly reduces greenhouse gas emissions.

gardencity-nairobi.com/mall sma.delen



KENYA GREEN BUILDING SOCIETY

The Kenya Green Building Society (KGBS) is registered with the World Green Building Council as its Kenyan Chapter. This non-profit membership society certifies the built environment, advocates for green buildings and trains green building professionals. The overall aim for Kenya is to have environmentally sustainable buildings and to achieve healthy and efficient environments.

kenyagreenbuildingsociety.co.ke



Here For Good – also in Green Energy: Standard Chartered Bank

British based *Standard Chartered Bank* has one of the widest international footprints of all banks worldwide. It has gone through all ups and downs in Kenya – loyally serving its customers' needs since the year 1911.

In 2017, *Standard Chartered* brought more life to its slogan "here for good" by installing a Solar PV system on the rooftop of one of its offices in Westlands district.

Kenyan Solar specialist *Knights Energy* installed the grid-tied Solar PV plant. It provides a capacity of 80 kW and sets benchmarks in quality. With German *SMA* Solar inverters and *Schletter* mounting systems, only the best components available on the market have been used. It also helped



Standard Chartered understand the benefit of a solar system. Businesses and individuals seeking financing solutions for green energy can now count on an even more experienced partner.

knightsenergy.co.ke

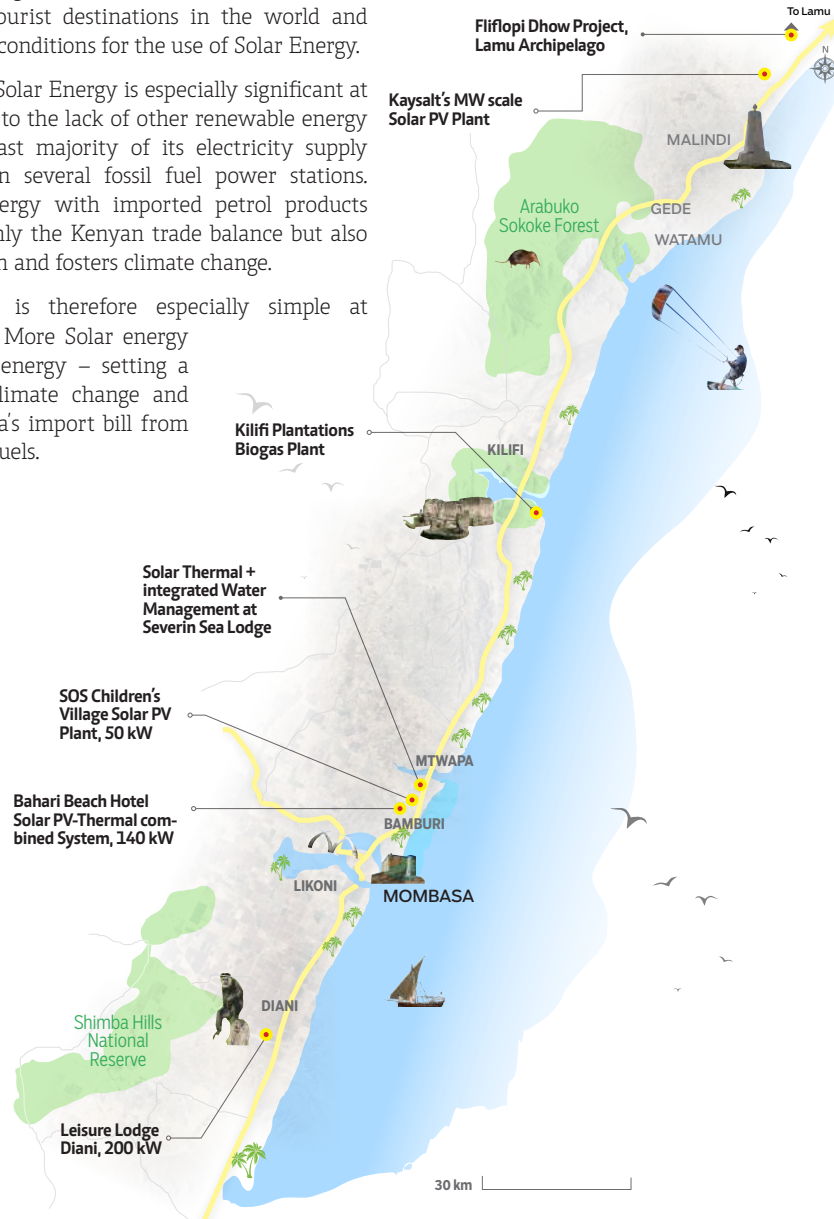
schletter-group.com

SOLAR ENERGY AT KENYA'S COASTLINE

More than 500 kilometers of Kenya's serene coastline, stretching from Tanzanian border in the South to the Lamu Archipelago in the North, are one of the most sought after tourist destinations in the world and offer excellent conditions for the use of Solar Energy.

The switch to Solar Energy is especially significant at the Coast. Due to the lack of other renewable energy sources, the vast majority of its electricity supply is generated in several fossil fuel power stations. Generating energy with imported petrol products burdens not only the Kenyan trade balance but also causes pollution and fosters climate change.

The equation is therefore especially simple at Kenya's Coast: More Solar energy replaces fossil energy – setting a sign against climate change and reducing Kenya's import bill from foreign fossil fuels.



Kaysalt's MW-scale Solar Power Plant

Kenya's Swahili coast may stand in the shadow of its Southern neighbour Zanzibar in producing exotic spices like cinnamon, cardamom or cloves. But it stands at the forefront in supplying the most basic and essential of all flavours to the whole of East Africa – Salt.

North of Malindi, Kenya's two biggest rivers Galana and Tana end their journey into the Indian ocean. In between the river mouths, tens of kilometers of salt pans stretch along the road that leads to Lamu. In several salt works, the Indian Ocean's water is first evaporated. The remaining salt is then collected, refined, packed and will later be applied on dishes everywhere in East Africa - Kenya, Tanzania and Uganda,

and even in places as far as Congo, Rwanda, Burundi or Northern Malawi.

In addition to using sunshine for evaporating the Indian Ocean's water for salt production, the sun also produces clean electricity. **Kaysalt** is East Africa's biggest, greenest and most progressive salt producer, employing 700 permanent and another 2,000 seasonal workers. **Kaysalt** partnered with German Solar inverter manufacturer **SMA Sunbelt** to prove the viability of a MW-scale solar power plant in East Africa. Just shy of 1 MW capacity, **Kaysalt's** Solar PV plant now covers around a quarter of its electricity demand.

kaysalt.com sma.delen



Integrated Solar PV-Thermal system at Bahari Beach Hotel Mombasa



Just a few minutes away from Mombasa's City Center in Nyali, the vibe of Mombasa can be felt when couples take romantic weekend walks along the charming coast of Nyali Beach. *Bahari Beach Hotel* was originally famous among German tourists who sought to avoid European winter's coldness. By now, its legacy of hospitality equally attracts domestic travellers.

First steps for a more sustainable energy supply have already been taken some years ago through installing Solar Thermal syphons. Encouraged by the massive cost savings, the grid-connected resort chose German *Sunset Energietechnik* to go full-scale solar in 2017.

The Solar panels and thermal syphons – all 100% **Made in Germany** – are installed on the rooftop of the previously empty gym section without covering precious land. The combination of both Solar PV, with a capacity of 140 kW one of the biggest systems at the Kenyan Coast, and Solar Thermal was optimized to save most on energy costs. The Solar Thermal syphons are specially designed to withstand the corrosive conditions at Kenya's coast. Outside the hotel, a panel showcases the system's performance in real time, thus effectively promoting the use of Solar energy among the Coast's tourism industry.

🌐 baharibeach.net

SOS Children's Village Mombasa

In 1971, Kenya was one of the first African countries where *SOS Children's Villages* became active, in order to take care for orphaned and abandoned children. Children whose families cannot take care of them can find a loving home in one of Kenya's five *SOS Children's Villages*. Apart from giving children a new home, *SOS* enables children who are at the brink of losing family care to grow up in a caring family environment.

In the end of 2018, *The Delegation of German Industry and Commerce (AHK Kenya)* refurbished a 60 kW Solar PV system at the *SOS Children's Village* in Mombasa. The system was originally constructed in 2011 to serve as

a lighthouse project to showcase the capabilities of German technology for solar energy – aimed at efficiently managing *SOS Children's Village* energy needs and to help the children's home save money that can be spent on its core mission, supporting children who lack parental care.

For the upgrade, renowned Kenyan Solar company *Knights Energy* was brought on board to carry out the works on site. The recommissioned plant is also fitted with the latest technology built to withstand coastal conditions for longer periods thereby requiring minimal maintenance.

🌐 sos-childrensvillages.org

🌐 knightsenergy.co.ke



Solar PV System at Leisure Lodge Diani

35 kilometers South of Mombasa, the world famous Diani Beach was rated among the top 10 beaches in Africa 2018. Apart from white sands, unforgettable sunsets and an expansive golf course *Leisure Lodge Diani* boasts the single biggest Solar PV system at a hotel on Kenya's Coast, supplying 200 kW capacity.

🌐 leisurelodgeresort.com

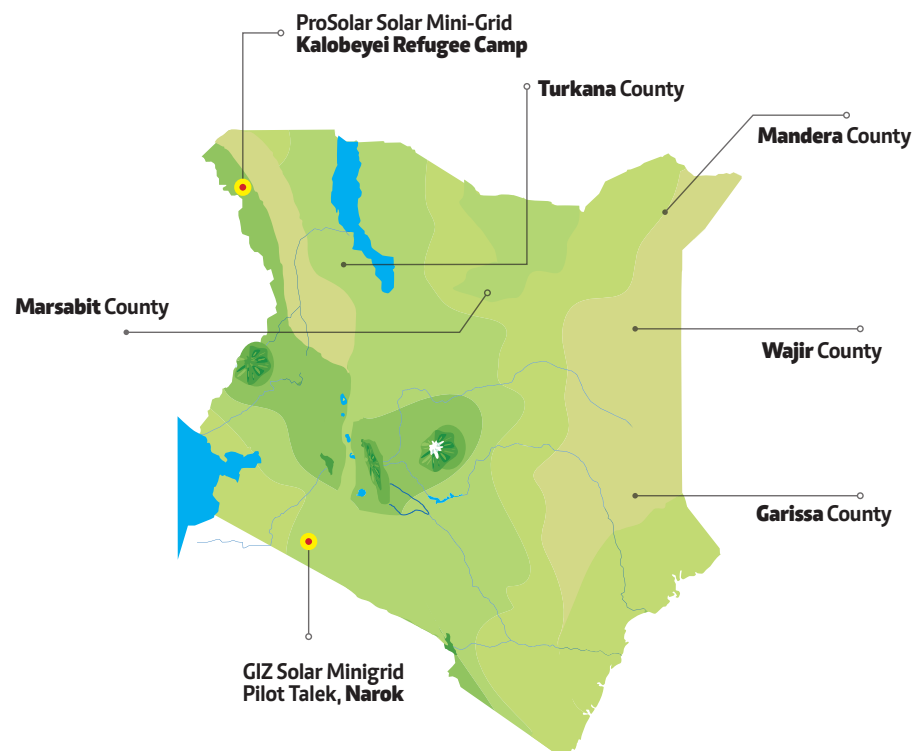
SOLAR HYBRID MINI GRIDS

Over the last years, more and more Kenyans have been connected to the national electricity grid. Despite that, vast and sparsely habituated areas especially in Kenya's North and Northeast are still far away from any power line. In line with the national goals of universal electrification, residents of these regions have an equal right to access electricity.

Expanding the national grid would overstretch available resources which is why isolated grids gain importance. A so called mini grid generally shares the characteristics of the national grid – with the exception that it serves way less people and extends over a much smaller area. Despite high investments for set-up and operation in challenging environments, in certain areas the implementation of a mini grid is still more cost-efficient than erecting hundreds of kilometres of power lines to just connect a few rural dwellers.

Additionally, in mini grids, the future vision of 100% solar energy supply can be piloted already today. Different development agencies, in close collaboration with the **Kenyan Energy Regulatory Commission (ERC)** and the **Rural Electrification Authority (REA)**, are setting up a number of mini grids in sparsely inhabited areas – supporting Kenya's national goal of universal electrification.

🌐 erc.go.ke 🌐 rea.co.ke



ProSolar - Promotion of Solar-Hybrid mini grids in Northern Kenya

Together with authorities in Marsabit and Turkana Counties and the **British DFID**, German Development Cooperation through **GIZ** is facilitating the implementation of 14 mini grids by four private companies, with a combined Solar PV capacity of 430 kW. The target beneficiaries in the 14 off grid villages are 7,000 people in total who gain access to clean, reliable and affordable energy. Trainings to build solar knowledge in the rural areas particularly focus on women.

A first pilot mini grid project was implemented in Talek, handed over to Narok County government and is currently being operated by a private firm – with a similar model of Kenyan private sector engagement also applied within the other mini grid sites.

One of the mini grids will serve the Kalobeyei refugee settlement. The settlement has a total population of 38,179 as at end of 2018. In a first phase, a capacity of 60 kW with battery storage and generator backup will be implemented. An upgrade to 170 kW is already planned.

The German Development Cooperation's objective is to improve rural electrification in Kenya through mini grids with the participation of the private sector. Mini grid implementation tools and handbooks have been developed and disseminated to the public and private sectors. The hand books provide information on mini grids site selection, system sizing, licensing, operations and maintenance, and financing.

🌐 gov.uk/dfid 🌐 git.de/en

World Bank Mini Grid Project



Example of a REA Solar-Hybrid mini grid built by Knights Energy



Talek Pilot mini grid project

As part of its effort to electrify rural Kenya, the **Rural Electrification Authority (REA)** with the support of the **World Bank** is setting up mini grids that run 100% on solar energy. Five Counties, Wajir, Mandera, Marsabit, Turkana and Garissa have been selected for the first phase of 25 similarly designed grids, each one comprising of 60 kW Solar PV capacity and an adequately sized energy storage. In most of the projects, high-quality German components like **Hoppecke** batteries and **SMA** inverters are being applied to fulfil the vision of an emission-free electricity access for all Kenyans.

🌐 rea.co.ke 🌐 knightsenergy.co.ke 🌐 sma.de/en 🌐 worldbank.org 🌐 hoppecke.com

EnDev: Improved Cookstoves and Solar Home Systems



Institutional stove and a Stove technician fabricating a stove

Energising Development (EnDev) Partnership is a global energy access programme currently financed by six donor countries, among them Germany. The programme promotes access to modern energy services through a commercial approach, specifically improved cookstoves and small Solar systems, for households, social institutions and small businesses particularly in rural areas.

Especially in Kenya's rural areas, cooking is usually done with firewood or charcoal as it saves money in comparison to electricity. **EnDev Kenya** supports access to modern cooking energy by promoting sustainable production, marketing, installation and use of improved cookstoves. These stoves are produced locally, are affordable and save up to 50% fuel as compared to traditional three stone fire.



Children studying at home using a small solar home system, PHOTO: GIZ

EnDev Kenya supports access to modern lighting through promotion of high quality, affordable and efficient small Solar Home systems. These systems provide good quality lighting and basic electricity services such as mobile phone charging and powering of small radios and other devices. The systems are useful, particularly where neither the national grid nor mini grids have reached yet or for those Kenyans who live as pastoralists or herdsmen without permanent settlements.

Since 2006, German Development Cooperation supported the sale of more than 2.9 million improved cookstoves. Basic electrification has been provided through the additional sale of 370,000 small solar home systems. Annually, this saves more than 570 thousand metric tonnes of firewood, reducing exploitation of Kenya's precious forest and savannah ecosystems. It has also created income generation and employment for about 5,000 stoves and solar entrepreneurs.

endev.info/content



Kenya's population urbanizes rapidly and with higher living standards, more processed products come along. Consumption from crop to stove becomes less of a standard and every bite of food, every sip of soda, every spoon of sugar, every piece of furniture, every smartphone and everything else consumed is wrapped in even more layers of plastics.

Unregulated waste poisons water bodies, soils and the air. As a result, both domestic and wild animals consume improperly disposed plastics. Ultimately, it ends up in the human food chain. Openly disposed in the ocean or transported there by rivers, plastic threatens marine life. Climate change and waste management, two topics that are closely connected to each other, are the 21st Century's key challenges for humanity.

DID YOU KNOW?



In Kenya the use or manufacture of the prohibited plastic bags risks a fine of up to **four million shillings (€32,000)** and/ or a jail term of up to **four years**.

In 2017, Kenya prohibited the manufacture, retail, distribution and importation of plastic bags for commercial and household packaging. Primary packaging - for fresh, perishable or other loose food is however still tolerated. With one of the most stringent plastic bag ban enacted, Kenya joins more than one hundred countries worldwide with some kind of plastic usage regulation – and still has a long way to go.

Until a proper waste management framework is fully set, and countries all over the world have a long way to get there, individuals can make a difference. By questioning the amounts of waste necessary, by purchasing equipment that lives long and needs replacement only after years of operation and by disposing waste in the most responsible way available.



Waste to Energy – does it pay off?

The simple answer is – no. Nowhere in the world does a waste combustion plant operate profitably by selling electricity to the grid. The attributed costs – transporting the waste and operating the plant – are simply too high for that.

With a comprehensive legislative framework, waste collecting companies are required by law to safely dispose waste. In best-case, most of the waste is recycled or composted and only few remaining fractions unsuitable for either are burned in professionally operated waste combustion plants.

The waste combustion plant bridges the gap between costs of burning and income from electricity generation through a so called gate fee. Waste collectors pay money to have the combustion plants take care of the waste that can't be recycled or composted.

Waste Electrical and Electronic Equipment (WEEE) Centre



PHOTO: Kenyan Waste Electrical and Electronic Equipment Centre



Electronics such as watches, fridges, smartphones and computers are high-tech products with dozens of different materials: (heavy) metals, plastics, chemicals, rubber, acids – among others. Many of these materials are resources that can theoretically be reused. But if these devices are disposed without the right precautions, their former benefits become a nightmare for humans, animals and plants by severely polluting soil, water and air.

The challenge with electronic waste also comes from the technical progress. With smaller devices at more competitive prices, the single materials are used in less quantity. Whereas it is relatively easy to disassemble a fridge and sort the fractions, getting the same task done for a mobile phone requires

knowledge, precision - and patient handling of tweezers. The committed individuals of **WEEE Centre** refused to accept the lack of proper disposal for e-waste in Kenya and East Africa. Based in Embakasi, Nairobi's **WEEE Centre** as a company focuses on bringing the precious resources of electronic equipment to a second life preventing damage for the environment and human health.

By now, **WEEE Centre** has expanded its footprint beyond the border of Kenya and serves neighboring countries, as well as proving how the Green Economy of the future contributes to economic growth and employment.

weeecentre.com

Kamongo Waste Paper

In comparison to new paper, recycled paper reduces water pollution by 35% and air pollution by 74%. Recycling paper contributes to reduction of tree cutting, saving of energy, and uses less water than manufactured paper.

Paper recycling has also created 3,000 fulltime jobs in Kenya, as well as giving others the opportunity to make a business out of collecting and selling waste paper and transportation. Paper recycling is not a new venture in Kenya. **Kamongo Waste Paper** had already been founded in 1990, starting with one van collecting cardboard from street collectors, supermarkets, printing and packaging companies. The business grew over the years, leading by now to the monthly handling and processing of around 4,000 tons of paper and cardboard.



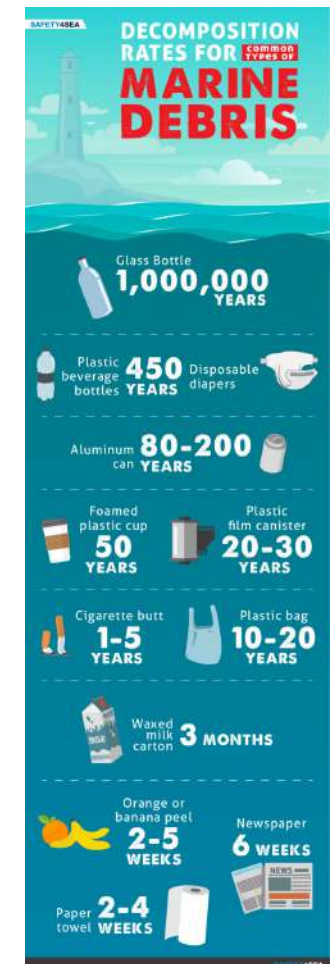
kamongo.co.ke

Mr. Green Africa

Mr. Green Africa, a plastic recycling company, incentivises informal waste pickers by offering premium prices and added benefits to collected plastics, to provide a continuous supply of valuable recyclables while simultaneously creating a positive environmental impact.

Mr. Green Africa processes the recyclable material into valuable raw material and feeds it back into plastic manufacturers' supply chain to enable them to achieve their circular economy goals, and benefit from raw material cost savings.

mrgreenafrica.com



Courtesy: safety4seas.com

TakaTaka Solutions



During a walk in Nairobi, it can sometimes be forgotten that one is strolling through one of the most dynamic capitals in Africa hosting thriving start-up sectors and many other industries.

Spoiled with sunshine and mild temperatures during almost the entire year, it could be easy to blend out the environmental downside of Kenya's thriving capital – the dysfunctional waste management.

There is no proper system of handling, recycling and reusing the growing amounts of waste. In case waste is not burned in gardens or on the streets, it is carried to massive landfills

like the one in Dandora or even disposed into one of Nairobi's many rivers directly.

Founded in 2011, the entrepreneurs of **TakaTaka Solutions** wanted to change the status quo in the city of Nairobi. Within just a few years of operation, more and more companies and institutions have engaged **TakaTaka Solutions** to ensure a responsible and environmentally friendly disposal of waste, spanning from residential properties to hotels and bars to Kenya's economic flagship **Safaricom**. Almost on a daily basis, more landlords and institutions choose **TakaTaka Solutions** for collecting their waste.

Waste collection is just the starting point at **TakaTaka Solutions**. Its main task is sorting the recyclable parts of waste into more than 45 fractions within their 2 sorting sites. Organic waste, amounting to around 80% of Nairobi's waste volume, is turned into compost – well known among gardeners and farmers under the brand name **SoilPlus**. Most of the remaining fractions are then sold to specialized companies that can reuse it. For only around 5% of the waste volume, a second lifecycle cannot be established.

TakaTaka Solutions sets standards that are not met anywhere in Europe with a recycling rate of 95%, protecting the environment while creating local value chains – and employment.

 takatakasolutions.com



The Flipflop Dhow



Kenya's current waste problems are most visible at the Coast. More and more plastic waste pollutes the white sands and the traditional scenery of local fisherman cruising on their traditional Swahili boat, called Dhows. Waste destroys the lush beauty of the beaches and menaces marine wildlife.

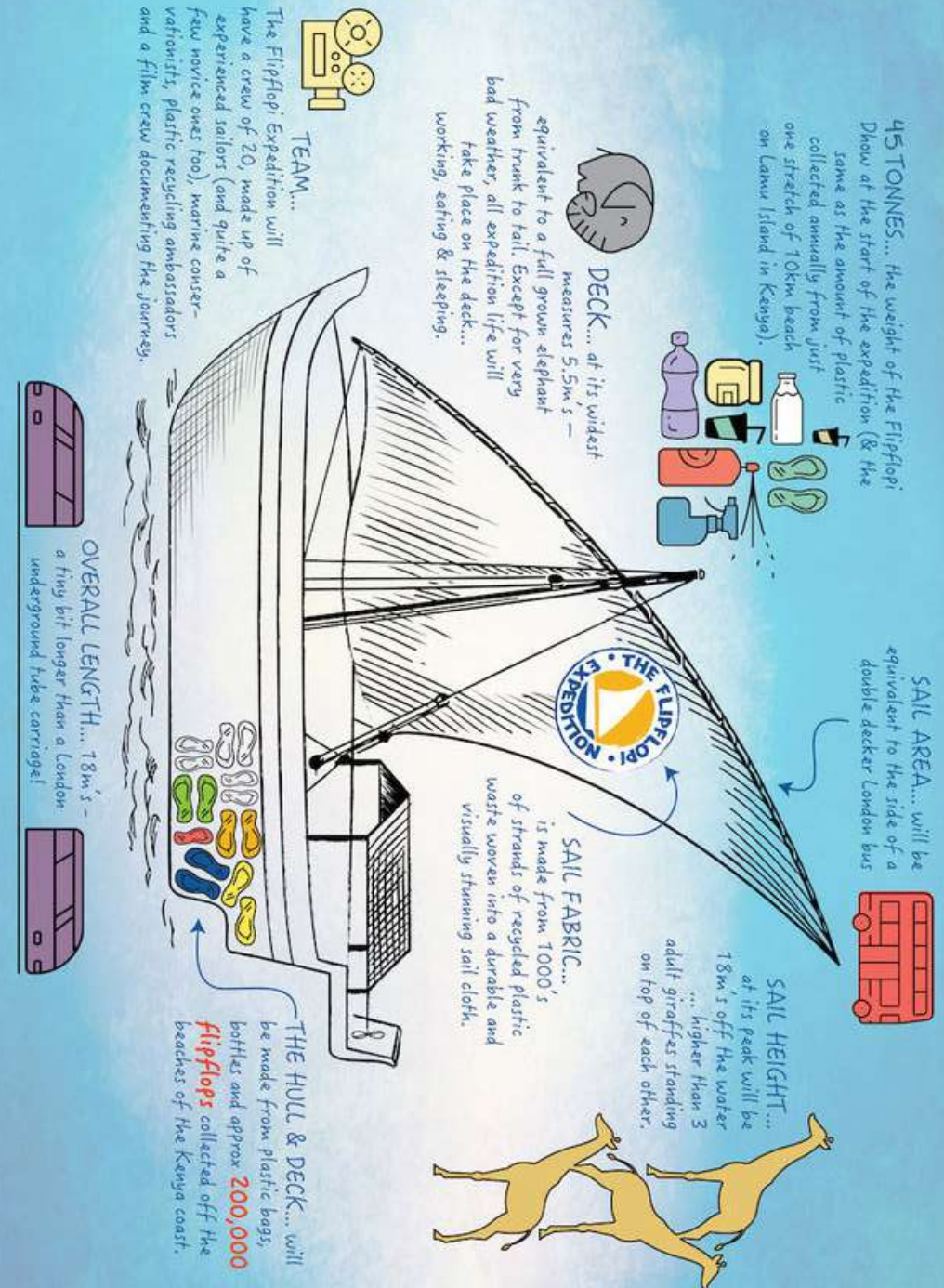
In 2016, in Lamu, a **UNESCO World Heritage Site**, a group of volunteers wanted to inspire change through a visible sign against the growing pollution. As a prototype, they set out to build a 9 meter Dhow, made entirely from plastic waste collected on beach clean-ups.

They covered the entire boat in one of the most prevalent components of plastic waste on beaches – flipflops - instantly turning it into a multi-coloured and eye-catching sight.

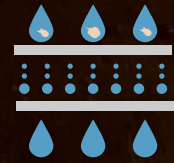
The keel, ribs and structural elements are made from recycled plastic products including bottles and bags.

The Dhow started its first expedition to Zanzibar in January 2019 with the mission to educate local communities along the East African coast about marine plastic pollution and engage them in its reduction. As the world's first boat made from plastic waste, the **Flipflop** project has captured the hearts and minds of a global audience. The initiators intend to build the next Dhow with a length of 18 meters, capable of sailing around the world, to continue its pioneering work and share the simple universal message – we need to rethink our consumption patterns, especially with single-use plastics, in order to save our planet for future generations.

theflipflop.com



graphic by www.black-artists.co.uk



Sewage treatment is a sensitive and rather novel concept in Kenya. Only about one in ten Kenyans is connected to the sewage system. On top of that, not a single sewer exists outside Kenya's urbanized areas. The lack of appropriate sewage networks leaves the waste water situation unsolved. Thus the nine out of ten people in that situation have to find alternative ways of waste water disposal. Septic tanks present a viable solution whereas disposed openly, wastewater causes environmental damage and pollutes soils and rivers.

DID YOU KNOW?

In Kenya, uncontrolled disposal of waste water is an environmental offense and strictly forbidden, including the irrigation of crops meant for human consumption. The **National Environment Management Authority (NEMA)** is in charge of enforcing environmental laws and preventing harmful practices. The **Water Regulatory Authority (WRA)** regulates the use of all water resources. By law, both sourcing of water and disposal of any substance into a water body require its approval.

Severin Sea Lodge



For tourists who seek a dream destination, Mombasa's beaches offer perfect conditions. Less than 15 kilometers away from the busy town centre and the even busier harbour – the gate to and from East Africa for practically all seafreight – **Severin Sea Lodge** is a name to national and international visitors.

Severin Sea Lodge offers excellent cuisine, a phenomenal service and a lush beach – as a handful of other hotels in Mombasa do, too. Outstanding is its engagement for a sustainable and inclusive operation.

A beach hotel like **Severin Sea Lodge** requires up to one hundred thousand liters of fresh water daily and most of this would end up as wastewater afterwards – but not so at **Severin Sea Lodge**.

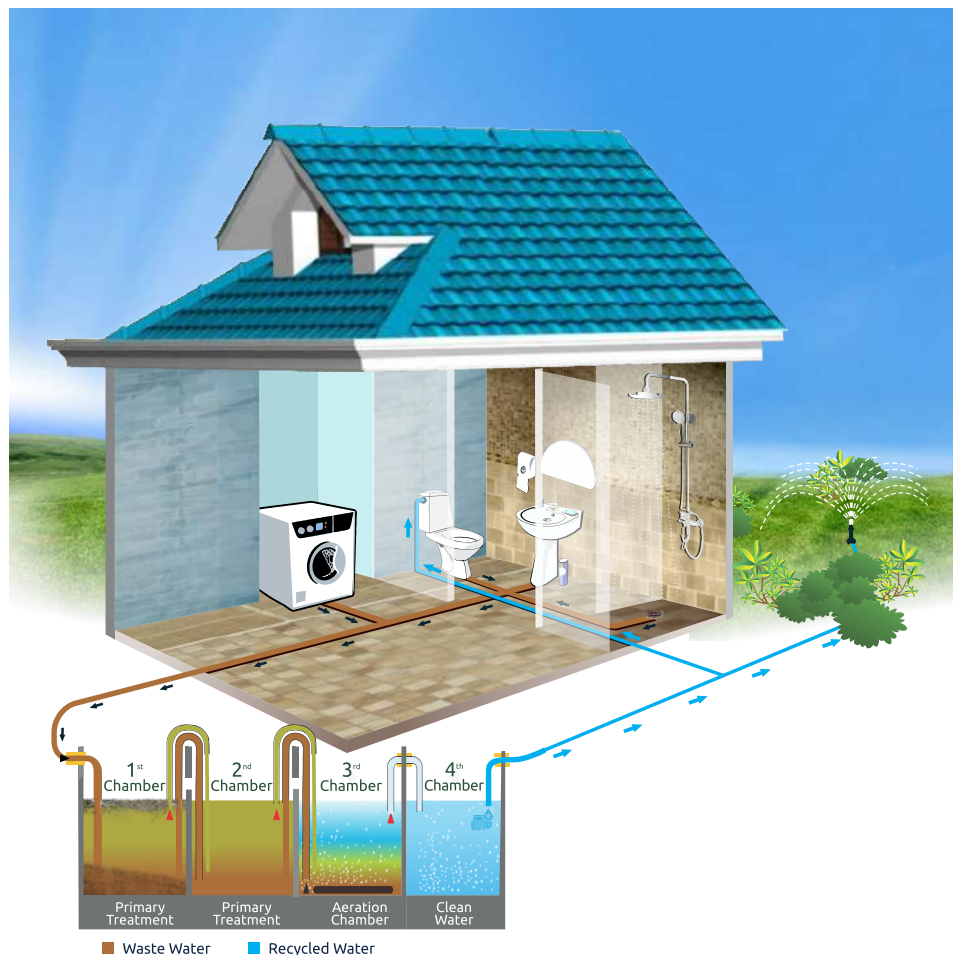
In addition to its desalination plant for drinking water provisions, a biological waste water treatment plant is in operation. All of the hotel's waste water from the public toilets, showers and basins as well as from the rooms is collected and then treated, so it doesn't pose a threat to the environment any more.

Back in 1991, **Severin Sea Lodge** was the first hotel at Kenya's Coast and one of the first institutions in the whole country to build such a plant. This impressively showcases **Severin's** commitment, and the longevity of such an investment. With the right maintenance, waste water treatment plants have a lifetime of decades, helping save the environment every single day of their operation.

severinsealodge.com



Ecocycle's KLÄRMAX® solution



With only a small fraction of Kenya's population having access to a public sewer on the one hand, and strict environmental regulations on the other, the private sector offers much needed creativity for contributing to better wastewater management in Kenya.

With proven abilities of German technology, Kenyan **Ecocycle Ltd.** began as a startup in 2014. By now, it is an established company with over 115 onsite Waste water systems installations mainly in Kenya as well as in Tanzania, Somalia and Rwanda. **Ecocycle** has developed into a center of technical competence and specialized knowledge in this frontier. **Ecocycle's** waste

water treatment plants range from individual installations for small family homes as well as large scale developments like gated residential communities, office blocks, apartments, hotels and other institutions with one hundred to one thousand users.

After treatment, the waste water is reused for secondary purposes like toilet flushing, lawn and greenery irrigation, car cleaning, or simply discharged to public drainage. All projects together translate to more than 1.2 Million liters of reusable and odorless water recycled from sewage, per day.

Ecocycle is the sole exclusive appointed dealer and partner of German **Reinhardt GMBH** for Eastern Africa – the company that has invented the technical concept. The key technical components are supplied by **Reinhardt**, while additional materials to complete the entire installation up to reticulation for reuse are sourced locally in Kenya. All the works are executed onsite by competent, trained and skilled inhouse **Ecocycle** Kenyan Engineers and technicians.

ecocycle.co.ke
reinhardt-gmbh.net/en



KLARO



PHOTO: Sathya Sai School

Sathya Sai Organisation is a spiritual movement founded in 1960s by Bhagawan Sri Sathya Sai Baba in India. The movement now has followers in more than a hundred countries worldwide. Following the objectives of its founder, the Kenyan **Sathya Sai Center** also respects the environmental concerns – impressively proven by its approach to manage their waste water.

In 2017, the **Sathya Sai School** in Nairobi's Kisaju district assigned German specialist supplier **KLARO** to retrofit and extend an old septic tank with an additional buffer to be able to reuse the treated waste water for lawn irrigation.

KLARO is specialized in intelligent waste water solutions for small scale use as well as bigger installations. Application fields are residential houses, apartment blocks, community projects, hotels, schools and office buildings.

en.klaro.eu



Extreme Clean Carwash – The Hub



A Sunday drive to Karen often passes by **The Hub Mall**. While the whole family enjoys itself at the foodcourt, the various shops and the water playing area, it is the perfect time to have one's car washed, in a way that precious water resources are saved.

Extreme Clean Carwash uses a technology called Filament twisting system (**Filatwist**) to filter and purify oil free waste water. Hundreds of synthetic filaments are twisted together to form a filter through which the dirty water is routed. The filaments are loosened for backwashing so that they can be thoroughly cleaned with relatively little water.



Ultimately, this solution provided by German company **Kärcher** enables a reduction of up to 85% on fresh water consumption. Fresh water is only necessary for vehicle rinsing during the washing process. The system in **The Hub Mall** is the first one installed among the six outlets of **Extreme Clean Carwash** in Nairobi, so far.

extremeclean.co.ke kaercher.com/int

2030 Water Resources Group

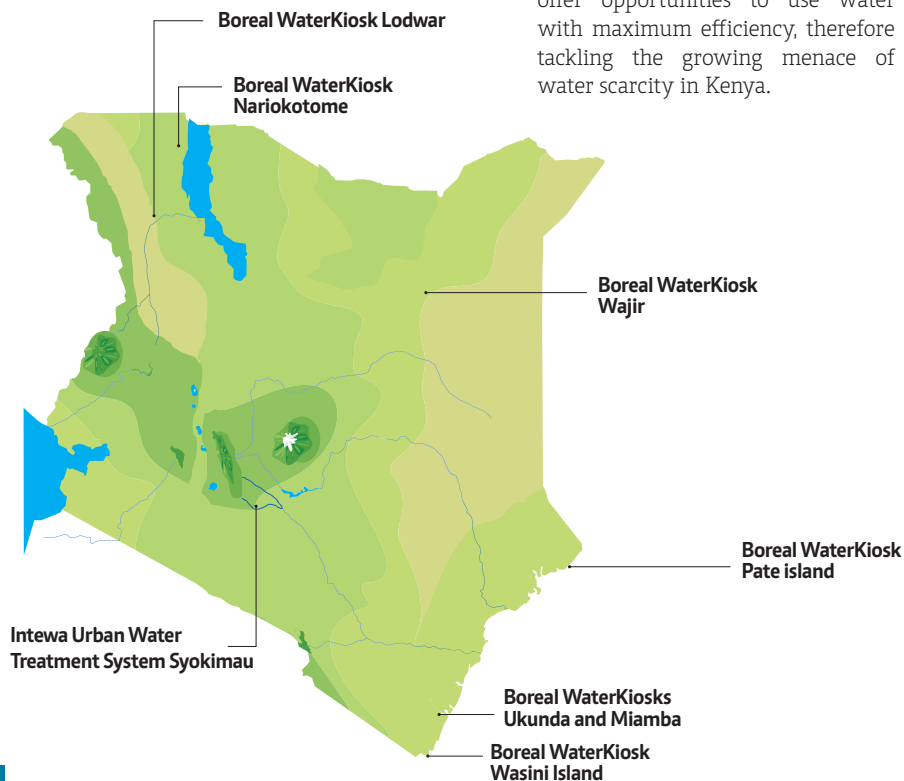
In addition to waste water directly produced from households, industrial waste water also plays a significant role. Unless associated with agricultural processing, these waste waters are usually more contaminated with chemicals or heavy metals, requiring special water treatment. **2030 Water Resources Group** unites both industries and public sectors to find solutions for industrial water and waste water use, in line with the Kenyan government objectives on waste water management.

2030wrg.org/kenya



Water is the most essential element for all life on earth. Human beings, wildlife, agriculture and industry all have their specific demand on water. Innumerable sources of pollution make it necessary to implement water treatment technologies in order to meet the challenge of always providing water in the desired quality.

For human consumption, the absence of poisonous contents is as important as meeting the highest hygienic standards. Many industrial applications – cooling water for machinery and power plants for example – require minimal salt contents on the other hand. There is no “one-fits-all” solution but a number of different applications and techniques. If combined, they offer opportunities to use water with maximum efficiency, therefore tackling the growing menace of water scarcity in Kenya.



INTEWA water purification system

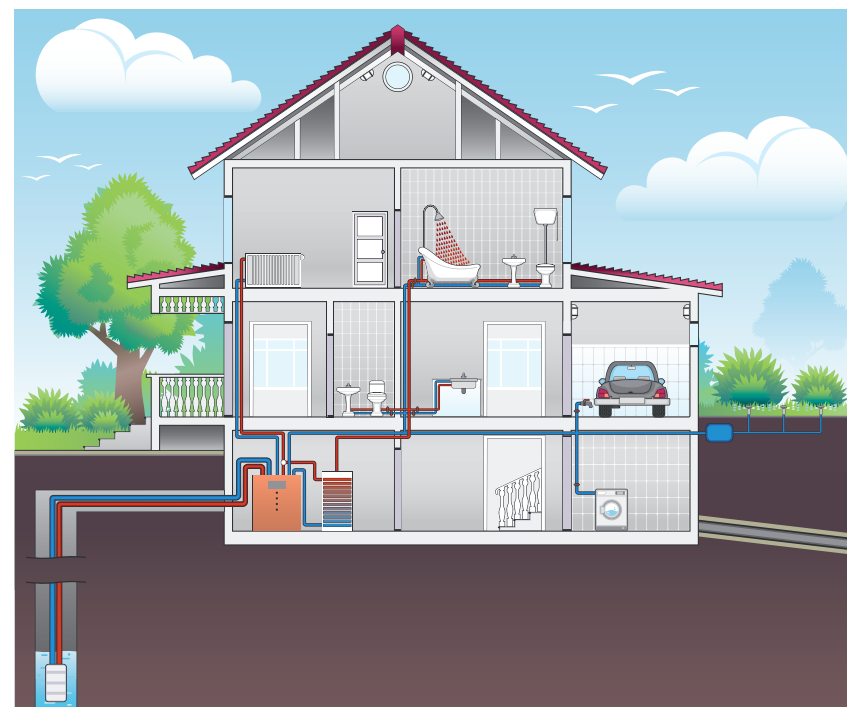
More and more Kenyans move to the outskirts of Kenyan cities. Especially water infrastructure does not always keep pace with the speed of new residential developments. For example, the same water lines that were laid out to supply single houses are now used to connect dozens of households within bigger apartment blocks. And usually neither boreholes nor the public water supply deliver drinking water quality. Residents are therefore required to either boil water before consumption or get bottled water from street vendors or the supermarket. Neither of the two ways guarantees safe water and the use of PET plastics is maintained, therefore raising environmental questions.

Among the fastest growing urban areas, Nairobi's Syokimau district is located in close

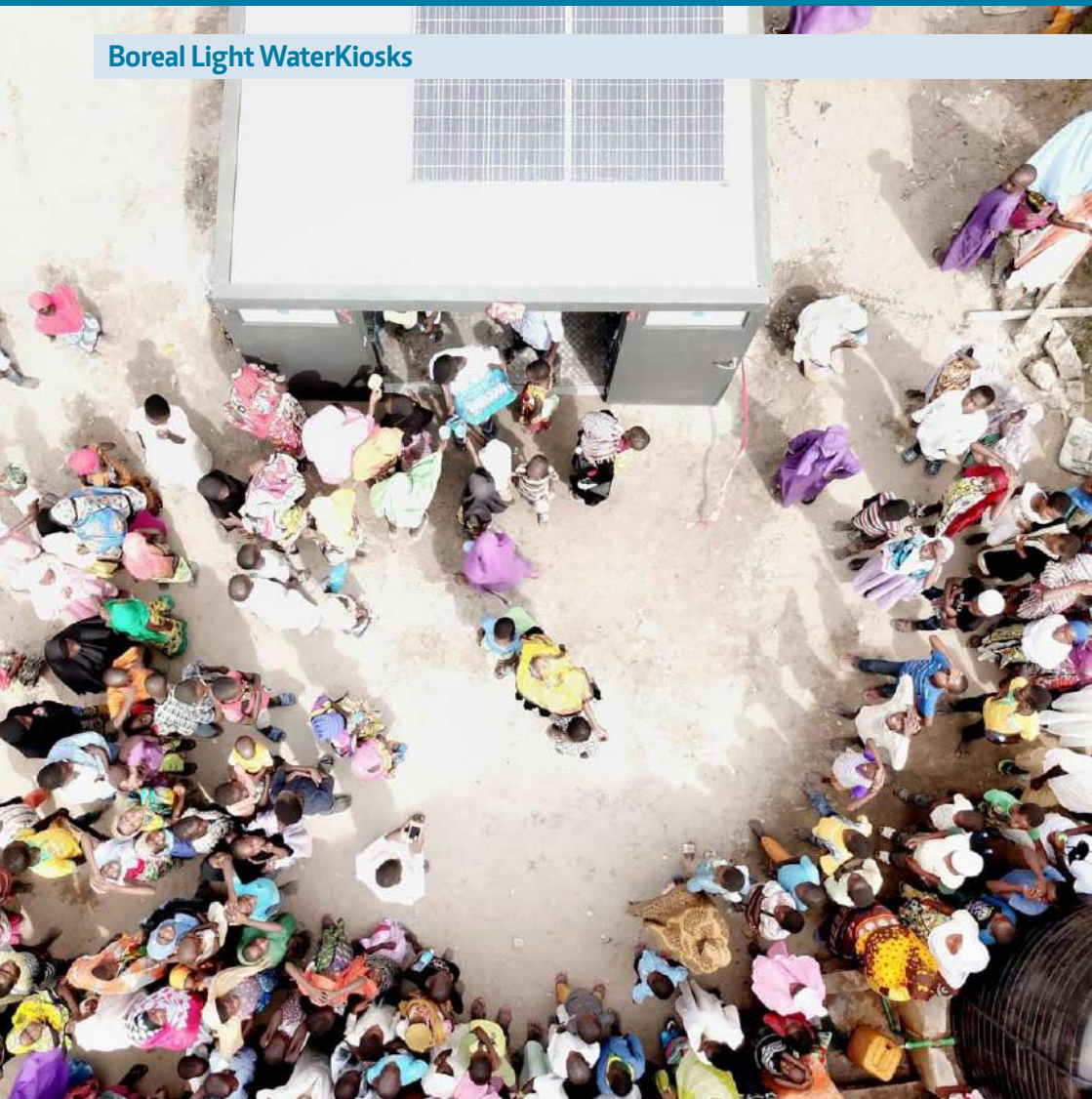
proximity to the **Jomo Kenyatta International Airport**. Here, in the beginning of 2017, the first **INTEWA** water purification system was installed. About 300 residents in 100 houses are served with drinking water quality according to German standards. The **INTEWA** system has a purification capacity of 24,000 liters per day. The operator of the system purifies water from the estate's borehole and delivers bottled drinking water to the households – fit for drinking and with significantly lower costs than purchased outside the estate.

With safe drinking water as a selling point, the estate's flats have been occupied by new residents in record-time.

germanwatertechnologies.com



Boreal Light WaterKiosks



At Kenya's Coast, water seems abundant at first sight. But the available water usually contains too much salt to be consumed directly, causing water scarcity for many of the Coast's residents. Boreal Light is a German based start-up that designs and develops low-cost Solar water desalination systems used in remote areas off the electricity grid.

In March 2018, the initiative launched its first WaterKiosk Project on Wasini Island. The solar-powered water-desalination system provides the island with clean and hygienic desalinated water and prevents it from relying on rainwater and supply from the mainland.



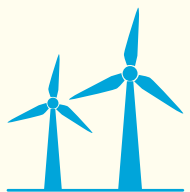
With advanced and yet simple to maintain technology behind it, the WaterKiosks treat water from both brackish and salty seawater sources. More than 8 WaterKiosks are already set up along the coastal areas in Kenya, together delivering more than 125,000 liters of drinking water per day. This number increases rapidly with the ongoing opening of more WaterKiosks.

For example, the WaterKiosk in Miamba, Kwale County, was inaugurated in December 2018 and provides up to 10,000 liters of water per day. Other kiosks, like the one Ukunda, can even deliver twice the amount of that.

Designed as a commercial and cultural hub the WaterKiosks Solar PV system can provide electricity, WIFI and other services thus boosting the village's economy.

boreallight.com





Wind is an abundant renewable resource that can be used to create clean energy. It was one of the first energy sources to be exploited by mankind – in ancient times mainly

for flour mills or water pumping. Since then it has evolved up to industrial scales and is mainly used for electricity generation.

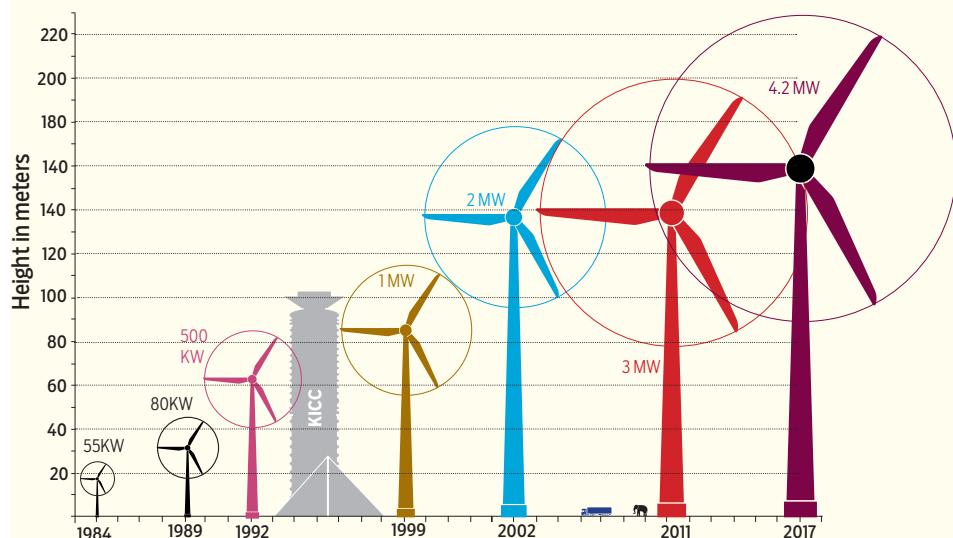
Next to hydro, wind energy is nowadays the biggest contributor of renewable energy in the world. In all regions of the world, advanced wind turbines are being set up. The current rate of newly installed capacity of around 60 GW per year is expected to grow to around 100 GW per year by 2028 – equivalent by then to around one hundred big coal or nuclear power stations.

Latest designs of turbines have higher capacities and therefore higher electricity

yield. The energy content of wind varies with the cube of the average wind speed, that means if the wind speed is twice as high it contains eight times as much energy. Wind speeds significantly increase with distance from the surface and the wind also blows much more stable in bigger heights. Therefore, the bigger the wind turbine the more efficient the electricity production.

Currently, the limits of wind turbine sizes are mainly set by the structural characteristics of the tower. Latest turbines have capacities of around 3 to 4 MW for onshore and up to 9 MW for offshore applications. German wind turbine technology is world leading. Four out of six globally active manufacturers are based in Germany.

Wind is a domestic energy resource that – after the construction phase – is independent from any imports. And it creates around four times more employment than comparable capacities of fossil power plants would.

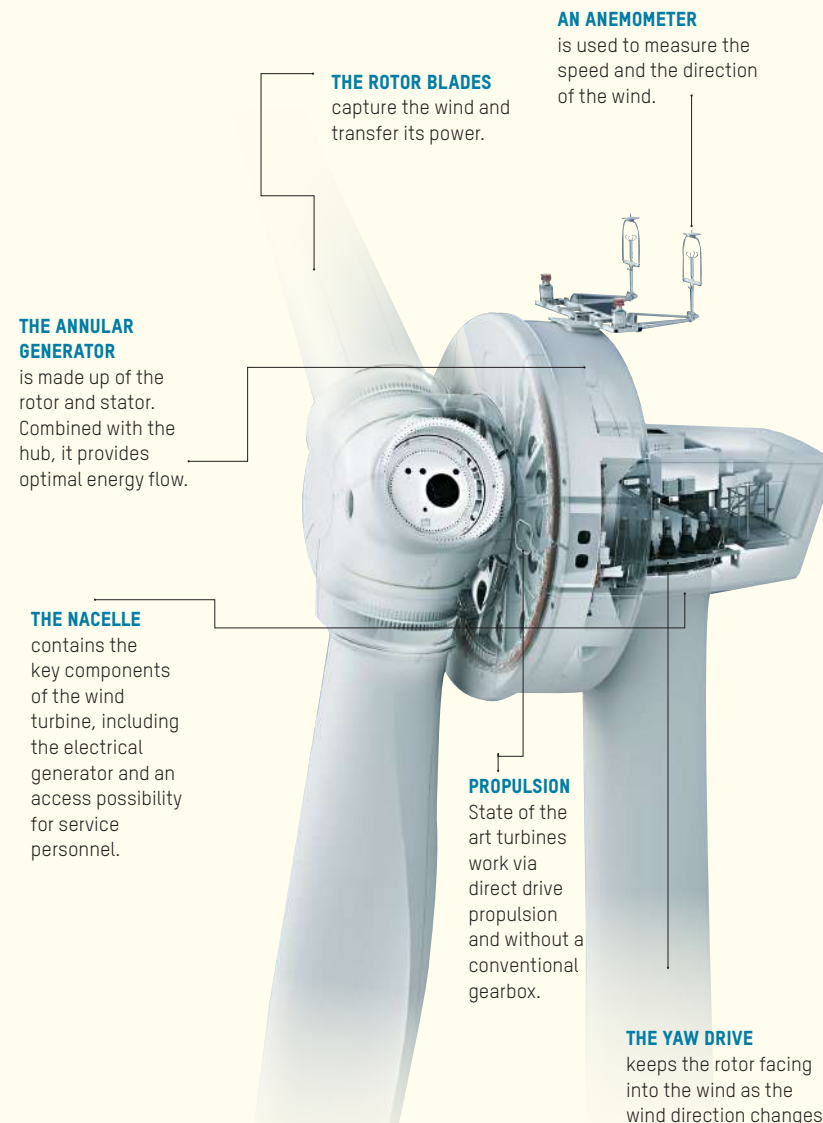


How it works:

As soon as wind blows over the blades, it causes them to revolve around the rotor. The rotor is connected to the main shaft which spins the generator thus creating electric power.

There are two types of wind energy technologies: onshore – wind turbines installed on land – and offshore – installed in large water bodies. As much as offshore wind generally generates a higher capacity, the installation of an offshore wind farm is technically more demanding and more cost-intensive than an onshore plant.

After around 6 months' operation period, modern wind turbines will have produced more energy than their manufacturing, transport and construction processes have consumed.

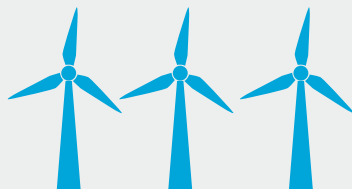


WIND PROJECTS IN KENYA

Until today, the immense wind resources in Kenya remain – despite a handful of projects – mainly untapped. The wind resources in the densely populated Kenyan Highlands are relatively weak. However, towards the North and the East, favorable wind conditions enable efficient use of wind energy. Here, sparsely inhabited areas allow the erection of wind turbines without blocking fertile soils. Some locations at the southern shores of Lake Turkana are even among the highest yielding in the world.

To successfully develop wind energy in Kenya, it is important to ensure public acceptance of wind farms. Participation models such as citizens' wind farms can be beneficial and are common in countries like Germany or Denmark.

DID YOU KNOW



One modern wind turbine of 3 MW can power more than 2,000 households in Germany.

Mainly due to different climate conditions in Kenya, consumption patterns are different – meaning an even higher number of households in Kenya.

Ngong Hills Wind Farm - 25.5 MW

Ngong Hills overlook the leafy Karen district in Nairobi and mark the border between the hustle of the country's capital and the serene Maasai plains of Kajiado. Since the year 2009, a weekend excursion to Ngong Hills – popular among Nairobians – features a new attraction; a wind farm with an initial capacity of 5.1 MW, expanded to 25.5 MW in the year 2015. The wind farm is operated by Kenya's biggest electricity producer **KenGen** who currently plans an extension by another 10 MW with five state-of-the-art turbines.

kenген.co.ke

Lake Turkana Wind Project - 310 MW

Lake Turkana Wind Power Project is the biggest Wind Farm in Africa being commissioned in 2018. It is located in Marsabit at around 600 kilometers from the capital. It has been generating and supplying electricity into the Kenyan national grid since late 2018.

The area has unique geographical conditions. Daily temperature fluctuations generate strong predictable wind streams between Lake Turkana with relatively constant temperatures on the one side, and the desert hinterland with steep temperature fluctuations on the other side. The valley between Mount Kulal and Mount Nyiro effectively acts as a funnel in which the wind streams are accelerated to high speeds.

itwp.co.ke

Nestled into the slopes bordering the South East of Lake Turkana, a total number of 365 turbines with a capacity of 0,9 MW each adds up to a total capacity of 310 MW – close to 15% of the country's installed energy generation capacity.

Other Wind Energy Developments

A few more wind parks in Kenya are in different stages of development. In some remote locations – for example in two of Kenya Power's mini grids – also small wind turbines are in use.

Upcoming large scale wind projects include Kajiado's Kipeto with 100 MW targeted capacity projects, as well as Meru Wind Project with 400 MW, Kinangop with 60.8 MW and one in viewing distance from Lamu Archipelago with 90 MW. All these upcoming projects are onshore.

PHOTO: Amazing view of the Lake Turkana Wind Project





To reach the targets of combating climate change, globally and also in Kenya, the transport sector has to contribute through burning less fossil fuels like Petrol or Diesel. With Kenya's electricity supply almost entirely sourced from renewable energies, the transport sector is now the biggest contributor to greenhouse gas emissions in Kenya.

This causes not only environmental damage, but also dependence from fossil fuel imports. For Kenyans, every kilometer driven in a conventional vehicle equates to money that is sent offshore. By electrifying the transport sector - that means replacing the current technologies of cars, trucks, buses and trains powered by internal combustion engines - Kenya increases its environmental performance and boosts its domestic economy.

All over the world, electric mobility is rapidly maturing. One would think that Kenya would trail in adopting electric mobility, i.e. after other markets have fully embraced it. But amazingly, Kenyan entrepreneurs and consumers have proven otherwise. With the rapidly expanding electricity grid, an almost entire green power supply cupped with innovative mindsets; Kenya is quickly becoming a pioneer in electric mobility.

The Future of Mobility in Kenya with Drive Electric



It's cheaper, cleaner & quieter – and it is already here. For the longest time, people have been talking about the future of mobility being electric, a subject that the **Drive Electric** team has been passionate about for years. With studies, field tests and ambition, the **Drive Electric** team has proven viability of electric vehicles in Kenya. The vast range of electric vehicles already available fit most

of the city's residents' needs and more are to come. **Drive Electric** installs, operates and maintains charging stations and monitors their energy flow to analyze the vehicle's power consumption. As electric mobility comes with its own unique environment, Drive Electric's dedicated team guides its customers and provides holistic solutions best suited for every individual need.



Driveelectric can install charging stations in homes, offices and also set up in places accessible to the public like shopping malls or airports.

Derived from years of testing and tens of thousands of driven kilometers, 70% savings on fuel consumption is possible, in addition to eliminating emissions and noise.

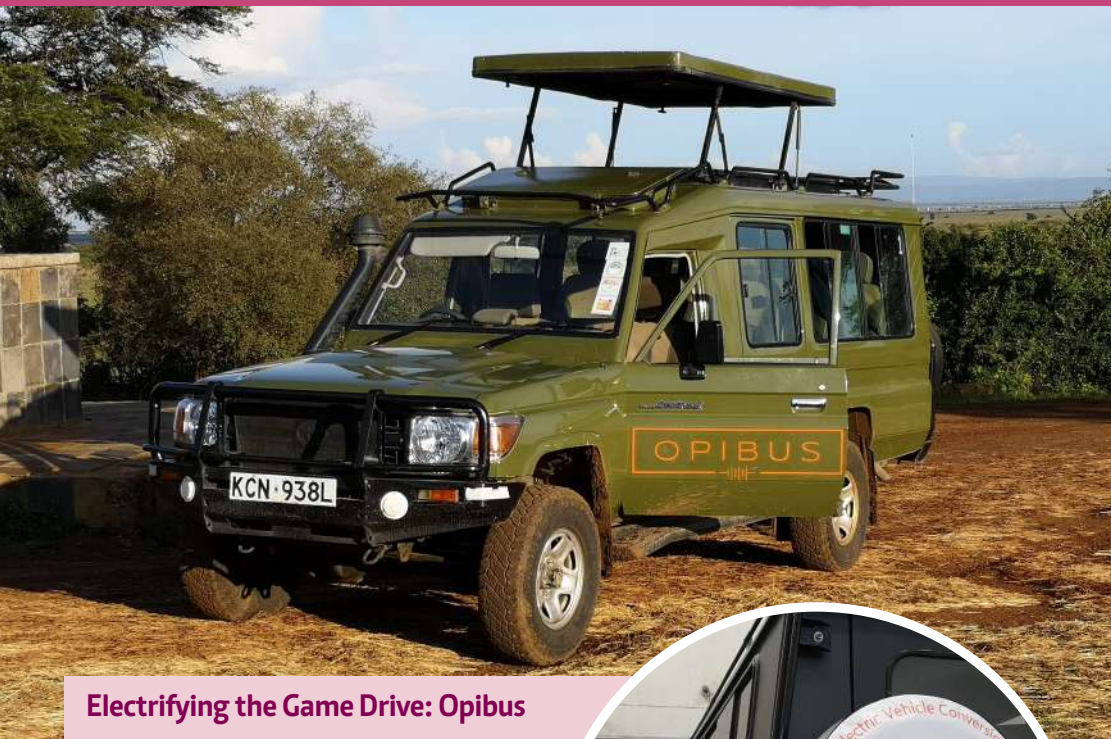
Through their Eco Hub concept, **Drive Electric** also proves that owners of electric vehicles can charge their cars using solar energy, further lowering operation costs.

The next step for **Drive Electric** is building partnerships to deliver electric mobility to public transport users. At a time when Nairobi is setting up its first mass transit systems, negotiations with the Ministry of Transport to leapfrog Diesel buses and directly drive electric are underway.

If ever there was a good time to switch to an electric vehicle, now is the time.

 driveelectric.co.ke





Electrifying the Game Drive: Opibus

The electric motor is superior to the combustion engine when it comes to torque and power. Almost instantaneously peak torque is achieved from stationary with a continuous powerful acceleration. Through flexible and innovative design, any vehicle can be modified to run on electric propulsion. This results in immense fuel savings and removes emissions completely.

The entrepreneurs behind Kenyan **Opibus** combine the demands of Kenya's tourism industry with their perspective on sustainable, cost efficient mobility. With a newly established workshop in Nairobi, **Opibus** reduces the tourism industry's environmental footprint while at the same time creating quality employment. Safari cars' conventional drivetrains are replaced with electrical components – customized as per the requirements of every single car. Coupled with more and more renewable energies utilized in Kenya's lodges, **Opibus** efforts to electrify the

fleet of Safari vehicles in Kenya are resolutely shifting this crucial part of the economy towards more sustainable business practices. And the next goal is only an eyesight away, with the immense fleet of so called Matatus, public service vehicles, still to electrify in the coming years.

opibus.se

Strathmore's Electric Cycle



The **Strathmore Energy Research Center (SERC)** also holds a stake in progressing electric mobility in Kenya, coupled with Solar energy supply. SERC's electric tricycle targets to tackle the transportation needs of merchants and in the rural areas.

A solar roof not only provides shade for the cyclist but also provides enough electricity to

run the bike with an included battery pack also during nighttime. The electric cycle already made it from Nairobi to Mombasa. The next journey is scheduled to even cross half the continent, with Cape Town as a final destination.

solar-e-cycles.com

More Initiatives for Electrifying Kenya's Transport Sector

More and more companies and institutions acknowledge the trend towards electric mobility and Kenyans increasingly face the choice of shifting their mobility from the old-fashioned way of fossil fueled vehicles towards electric transportation. This includes up-market resorts like the **Panari** in Nyahururu where electric golf carts are used to carry guests to their rooms. Also within enclosed industrial facilities, Diesel driven forklifts have been thrown out a long time ago – in favour of electric ones. At one of the most admired real estate development sites in the country, **Two Rivers Mall** now offers a charging station to motorists, partnering with private venture **Noparide** that has invented the idea of carsharing to Kenyan shoppers – to just highlight a few of the many developments in Kenya's e-Mobility space.

ACRONYMS

AC	Alternating current
DC	Direct current
EnDev	Energising Development Partnership
ERC	Energy Regulatory Commission
GESIP	The Green Economy Strategy and Implementation Plan
GHP	Geothermal heat pumps
IPP	Independent Power Producer
KenGen	Kenya Electricity Generating Company Ltd.
KETRACO	Kenya Electricity Transmission Company Ltd.
KICC	Kenyatta International Convention Center
km	Kilometer
KPLC	Kenya Power and Lighting Company Ltd./ Kenya Power
KTDA	Kenya Tea Development Agency
kV	Kilovolt
kW	Kilowatt
LTWP	Lake Turkana Wind Power
MoEP	Ministry of Energy and Petroleum
MW	Megawatt
PPA	Power Purchase Agreement
PV	Photovoltaics
REA	Rural Electrification Authority
V	Volt

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kenia.ahk.de

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Water Resources Authority
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