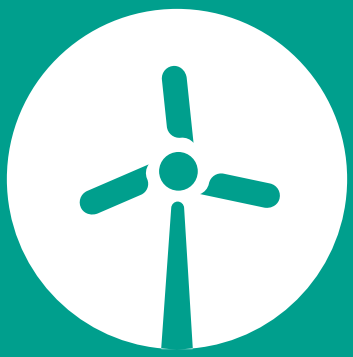

KENYA

ELECTRICITY AND HEATING

Kenya: innovation at the service of low-carbon electrification

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Kenya: innovation at the service of low-carbon electrification

Despite a low population density (42 million in habitants in a surface area of 580,000km²) and a human development index of 0.555, putting it in 152nd place in the world, over the last 10 years, Kenya has made rapid progress in electrification. Emissions from electricity generation have remained stable throughout that period. How has the country achieved these results? Can it be used as a model for low-carbon electrification?

Head editor • **THIBAULT LACONDE** • *Consultant, Energy & Development*

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1 • LOW EMISSIONS

In 2016. emissions related to electricity and heat production in Kenya stabilised at 1.1 CO_2 mteq. This level is comparable to that of 2015. the lowest since the mid-2000s. It represents a decrease of 55% compared to the 2013 record. No data are available for the year 2017.

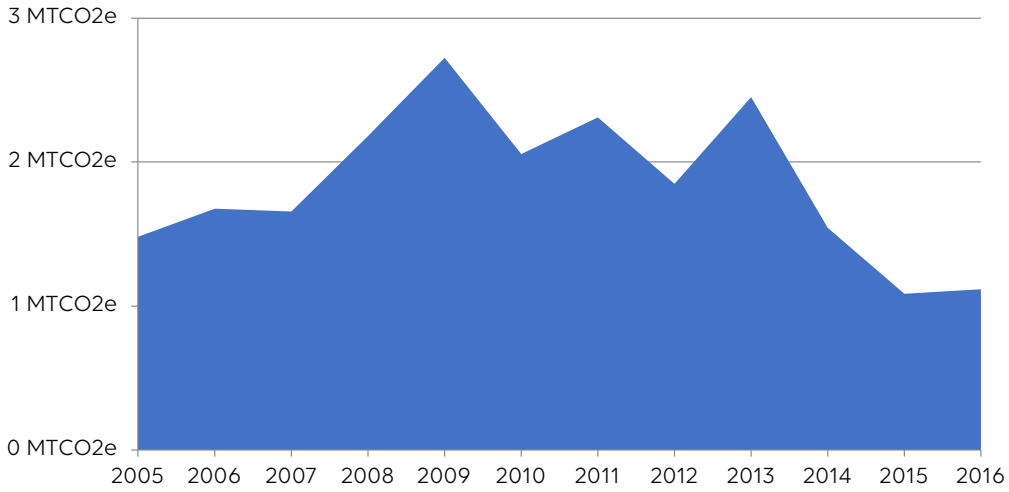

FIGURE 1. EMISSIONS FROM THE PRODUCTION OF ELECTRICITY AND HEAT

(Source: Enerdata)

• A LOW-CARBON ELECTRICITY MIX • Kenyan power sector emissions are particularly low: Spain. which has a similar population to Kenya. for example emits 67 $MtCO_2eq$ per year for its electricity and heat production. This cannot be explained solely by the country's level of development. In 2016. the carbon intensity of Kenyan electricity was 116 grams of CO_2 per kilowatt hour produced. So. to produce the same amount of electricity. Kenya emits. for example. six time fewer greenhouse gases than China or four times fewer than the United States (Ang. 2016).

This good performance can be explained by the composition of the electricity mix: Kenyan electricity generation is historically based on hydropower. with a share of geothermal energy that has grown strongly over the past decade. Fossil production. mostly based on liquid hydrocarbons. completes the mix and. during droughts. offsets the hydroelectric production deficit.

In 2016. despite relatively low hydropower generation. electricity production was 80% renewable. placing Kenya among the top 20 performers in the world for this indicator (IEA. 2018).

		2015		2016	
		Electricity production	Share of the mix	Electricity production	Share of the mix
Fossil fuels	Oil-based products	1,206GWh	12.5%	2,020GWh	20.7%
Renewables	Biomass	122GWh	1.3%	123GWh	1.3%
	Hydroelectricity	3,787GWh	39.2%	3,341GWh	34.3%
	Geothermal	4,479GWh	46.4%	4,204GWh	43.1%
	PV solar	1GWh	0.0%	1GWh	0.0%
	Wind	57GWh	0.6%	63GWh	0.6%

TABLE 1. KENYAN ELECTRICITY MIX

(Source: IEA. 2018)

• SIGNIFICANT USE OF TRADITIONAL ENERGIES • At the same time. emissions across the country are steadily increasing. Excluding emissions related to land use. changes in land-use and forestry (LULUCF). the country emitted 18.3 $MtCO_2eq$ in 2016. an increase of 116% since 2000 and 40% since 2010.

When the LULUCF sector is included. emissions were 73 $MtCO_2eq$ in 2010. i.e. three quarters of the country's emissions. According to Kenya's second official communiqué on its emissions. with increasing fossil fuel demand. this sector is the main contributor to the increase in emissions between 1995 and 2010 (Government of Kenya. 2015).

This finding offsets the good performance of the electricity sector which can be partly explained by a shift of certain emissions linked to energy consumption towards the LULUCF category: in the absence of access to energy such as electricity or natural gas. wood is used to meet heat and lighting needs. Currently. electricity still accounts for only 4% of Kenya's final energy consumption compared to 68% for biomass.

2 • KENYA'S STRATEGY FOR LOW CARBON ELECTRIFICATION

Like many African countries. Kenya faces a challenge: in expanding access to electricity while controlling emissions from the electricity sector.

• SITUATION OF THE KENYAN ELECTRICITY SECTOR • Despite the progress in electrification. demand for electricity remains constrained by insufficient supply and consumption per customer is decreasing.

Kenya's electricity sector is facing several problems. The share of hydroelectricity. whose production depends on weather conditions. makes production difficult to predict. Power cuts are frequent: around six 5-hour breaks per month in urban areas (GOGLA. 2018). Electricity is expensive. about $0.15/ kWh compared to $0.04/ kWh in South Africa. and this burden is poorly distributed. with rates favouring large consumers to the detriment of individuals and small businesses (Institute of Economics Affairs. 2015).

Organisation of the Kenyan electricity sector

At the end of the 1990s. the Kenyan government decided to separate electricity generation. transmission and distribution activities (so-called unbundling policies). The Kenyan power sector is organised around the three major public companies resulting from this split: Kenya Electricity Generating Company (KenGen) for production. Kenya Electricity Transmission Company (KETRACO) for transmission and Kenya Power for distribution and sale.

KenGen produces three quarters of Kenyan electricity. 30% of the company's share capital was offered for sale in 2006 and it is now listed on the Nairobi Stock Exchange. as is Kenya Power. Most of Kenya's electrical installations are owned by KenGen (69%). with a fraction also owned by the rural electrification agency (1%).

Kenya licensed another three companies (Aggreko. Cummins and Deutz) to produce and sell their electricity during the 2000 drought in order to make up for the sharp fall in hydroelectric production. A dozen independent producers (IPP) have since set up in the country: in 2008. they owned 11% of the Kenyan electricity system and by 2017 their share had reached 30%. The production of IPPs is predominantly fossil-based. mainly diesel. The additional cost related to the purchase of fuel is transferred to consumers through a levy on their bills - the IPPs are therefore accused of increasing electricity prices. The government frequently threatens not to renew their 20-year licenses.

An independent Energy Regulatory Commission. the Electricity Regulatory Board. was created in 1998. An Energy Tribunal was established in 2006. primarily to function as body to hear appeals against ERB decisions.

Sources: Kengen annual report. Daily nation

TEXT BOX 1

In Vision 2030. its development programme adopted in 2008. the Kenyan government recognises the difficulties of the electricity sector. The programme prioritises increased production and efficiency gains. To achieve this. it plans to continue energy sector reforms with the creation of a robust regulatory framework and incentives for private investors. It also envisages the creation of interconnections with neighbouring countries with surpluses and the development of new energy resources. including geothermal energy and renewable energies. as well as coal. There has been a major delay in this area: while the plan provided for a capacity of 5.5 MW in 2017 (Government of Kenya. 2013). it has not even reached half of this target with 2.4 MW (KenGen. 2017).

• GOVERNMENT STRATEGY AND ACTION • The 2017-2022 development plan drafted by the Kenyan Energy Regulatory Agency is a continuation of Vision 2030. Between 2018 and 2024. it plans the to build 1277 MW in geothermal power plants. 841 MW wind power. 703 MW solar but also three coal-powered plants of 327 MW.

Kenya is also planning to acquire a nuclear power plant with a target of 1.000 MW in 2027 and 4.000 MW in 2033. The country has signed cooperation agreements in this area with China. Russia. Slovakia and South Korea. Under this latest agreement. signed in September 2016. 16 Kenyan students were sent to Korea to obtain a master's degree in nuclear engineering.

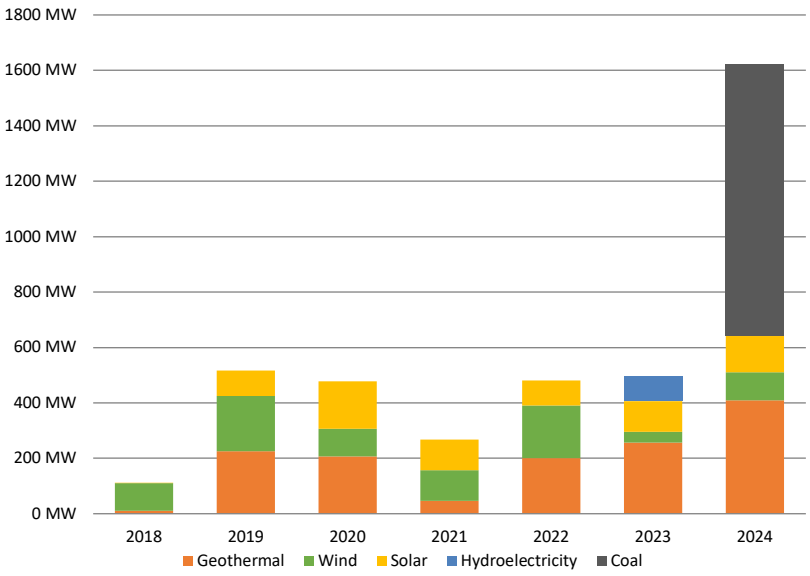

FIGURE 2. NEW COMMISSIONING PLANNED BETWEEN 2018 AND 2024

(Source: Kenya Energy Regulation Commission)

To develop its electricity production. in 2008 Kenya introduced guaranteed feed-in tariffs for electricity. These tariffs. which have been updated since then. provide investors with income for 20 years. In spring 2018. the Kenyan government announced its intention to replace this mechanism with a bidding system in the hope that competition will bring down the price of electricity.

Control of energy demand is also an important factor. Indeed. geothermal installations. which can operate continuously. provide almost half of the electricity and while it is not stored. a significant share of the production is lost during the night and off-peak consumption periods. To encourage companies to shift their consumption. in December 2017 the government created a reduced tariff of 50% for electricity consumed between 10.00 PM and 6.00 AM («time-of-use plan»). By mid-2018. 800 companies had subscribed to this tariff.

Finally. the rural electrification plan seeks to increase the electrification rate from 22% to 65% between 2013 and 2022 and. reaching 100% in 2030. This is the remit of a rural electrification agency created in 2006. In 2016. the electrification rate was 56% (World Bank).

3 • MOBILISATION OF ECONOMIC STAKEHOLDERS OF ALL SIZES

Kenya's electricity policy assigns an important role to the private sector. both in project development and public policy design. For example. the Kenyan government consulted extensively with the business community before launching the Kenya Off-Grid Solar Access Project for Underserved Counties (K-OSAP) to help companies investing in disadvantaged areas (GOGLA. 2018).

• A STRATEGY OF LARGE PROJECTS • The development of Kenyan power generation involves a policy of large projects. often unique on a continental or even global scale. In 2016. the country inaugurated the largest geothermal power plant in the world: Olkaria (280 MW). In 2017. the Lake Turkana wind farm (310 MW) was commissioned - the largest wind farm in Africa and the largest private investment in Kenya's history (REN21. 2017).

These projects are generally part of a broader development policy. The construction of the Lake Turkana wind farm. for example. was accompanied by the creation of road access. fibre optic links and local electrification projects.

Due to their size. these large projects are reserved for large multinationals or the KenGen public electricity company. The Canadian company SkyPower. for example. signed a $2.2 billion deal in

2015 for the development of 1.000 MW of solar power. while the American company GE is building the Kipeto wind farm as part of a 15-year construction and service. Similarly. KenGen produces 100% of the geothermal electricity (Government of Kenya. 2015) and for the time being is the only player capable of supporting the initial investment required for this production.

Innovation in Kenyan geothermal energy

Kenya. home to the Great Rift Valley in the west of the country. benefits from an ideal geological environment that provides it with an estimated geothermal potential of 10.000 MW. The country is concentrating these efforts on this energy to counterbalance the hazards of hydroelectric production: in terms of installed capacity. it is the 9th country. ahead of Japan. In 2016. Kenya installed 6% of new world capacity. although no new installations were established in 2017 (REN21. 2018).

KenGen does restrict itself to implementing existing technologies - the company innovates to accelerate the deployment of new productions. It has therefore developed a technology know as wellhead (because the turbines are installed close to boreholes without the requirement for the creation of a heating system).

The technology was trialled in the Olkaria region from 2012. It involves installing small turbines (2 to 5 MW) as soon as the drilling is completed so that production can start without waiting for the construction of a permanent power station. These turbines can be containerised or assembled on trailers and their installation requires little civil engineering work. They can therefore be moved easily to new projects when the permanent installations are completed.

The wellhead system enables geothermal electricity production to start in a few months. compared to 2 to 3 years for a conventional power plant. Moreover. this system can facilitate the development of geothermal energy by lowering the initial investment and providing the operator with income earlier in the project cycle.

Finally. wellhead type turbines could be used permanently to supply electricity to an isolated grid for which investment in a conventional geothermal power plant would not be justified.

Source: Saitet. 2015

TEXT BOX 2

A difficulty encountered by these major projects comes from the separation between generation and transmission activities that makes coordination more difficult. For example. the power line to convey production from the Lake Turkana wind farm is still being constructed (Daily Nation. 3 May 2018).

• SOLAR KITS. MINI-GRIDS. PAY-AS-YOU-GO... • The *Last-Mile Connectivity* project. funded by the African Development Bank. plans to connect 314.200 households located within 600 meters of a transformer to the grid. For the other non-connected households. the costs of extension of the grid. which are too high compared to the potential demand for electricity. encourage the use of decentralised electrical systems. This off-grid electrification is accessible to companies of modest size and is producing a proliferation of initiatives.

In 2016 and 2017. Kenya was the world's second largest market for solar kits behind India: 1.2 million systems were sold in 2016 and 900.000 in 2017. due to the drought that limited Kenyan revenues (GOGLA. 2018). The distribution of these systems involved a dense network of retailers and enabled revenues to be generated locally. Now more than a third of homes not connected to the electricity grid have a solar system that can meet basic needs such as lighting and phone charging (REN21. 2017). This market is of interest to foreign companies: BBOXX (Great Britain) and Mobisol (Germany). companies specialising in the production of solar kits. raised $20 million in 2017 to expand operations in Kenya. Rwanda and Tanzania.

Access to these systems may involve new business models. such as «pay-as-you-go». which has been developed in several African countries. including Kenya. This business model involves leasing a solar kit to households. The kit includes a battery. a charge controller. a solar panel. LED bulbs and a telephone charger. or even a television. Consumers pay on a daily. weekly or monthly basis which limits recovery costs for the business and avoids the use of a household loan. The payment is made by telephone. and if the payment is not registered. an integrated system interrupts the operation of the kit and the supply of electricity. These PAYG companies have electrified about 500.000 homes in Kenya and Tanzania. but are mostly financed by foreign investors. Local commercial banks are still very reluctant to finance these projects. which are deemed too risky. thus depriving local investors of capital (Sanyal. 2017).

Rural electrification also involves creating micro-grids. The creation of a local-scale grid not connected to the national power grid makes it possible to supply it with limited investments. In the past. however. this alternative was unattractive because the use of generator sets. with high fuel and maintenance costs. made electricity expensive. The lower cost of renewables is changing this situation. enabling the development of mini-grids in non-electrified areas. The Kenyan government recently obtained €33 million from the French government for the installation of 23 mini solar power plants in the north of the country. aiming for a production of 9.6 MW. Private companies are also involved in this field: PowerGen Renewable Energy. a Kenyan company specialising in the implementation of small power grids. raised $4.5 million in 2016 to invest in Kenya and Tanzania.

Micro-grids in Kenya

The public operator Kenya Power manages about twenty micro-grids powered by generators mainly in the north of the country. These facilities will soon have to be upgraded to integrate a share of solar production.

Private companies are also allowed to produce and distribute off-grid electricity. Payment by mobile phone. promoted by companies such as M-Pesa. Airtel Money or Orange Money. have played a crucial role in the development of these services.

In 2017. 40% of existing commercial micro-grids in sub-Saharan Africa were in Kenya (65 out of 150). The country will host at least a third of the new micro-grids built in Africa by 2021. Thanks to the fall in the price of photovoltaic modules. these projects should mainly be powered by solar energy. Small hydropower systems will also be developed.

Source: GORDON. 2018

TEXT BOX 3

At the end of 2016. Kenya joined Lighting Global. the programme set up by the World Bank to test and ensure the quality of off-grid solar systems.

4 • CIVIL SOCIETY: VIGILANT AND INNOVATIVE

Electrification and the development of Kenyan electricity generation respond to significant social demand. Civil society actors. however. remain sensitive to the impact of projects on living conditions and can also play an active role in finding new solutions.

• PERCEPTION OF PROJECTS BY CIVIL SOCIETY • Public opposition is often an obstacle to the development of new energy projects. In Kenya. as elsewhere. debate on these projects is divisive and polarised between the positions of developers and those of opposition groups. Access to land is one of the recurrent points of conflict. especially when projects have little local economic benefit. Communities sometimes express suspicion towards projects: risk of corruption. hazards and pollution (risk of electrocution. noise. etc.). impact on the environment and tourism. etc. These fears often reflect insufficient stakeholder commitment in the upstream phases (Johnson. 2017).

Mobilisation against the Lamu Coal Plant Project

Kenya plans to install its first coal-fired power plant on Lamu Island in the Indian Ocean. The plant is to be built under a partnership between Kenya and China. supplied with South African coal.

Those living in the vicinity of the future plant are worried about the consequences of the project on the environment and the local economy. especially fishing and tourism: the island. whose old town Lamu is a World Heritage Site. attracts many visitors. They also feared that the benefits of the project would not be distributed fairly. They gained the support of several local and international NGOS (Greenpeace Africa. 350 Kenya. Kenya National Commission on Human Rights. etc.) and personalities including Nobel Prize winner Joseph Stiglitz.

Kenyan activist Okiya Omtatah Okoiti fought against the project in the Kenyan courts. in particular by denouncing the consultation carried out by the Energy Regulatory Commission and the impact study conducted by the Kenya National Environmental Management Authority. His appeal was dismissed in February 2018.

On 5 June. World Environment Day. a charity event was held in Nairobi - a first in the history of Kenya. The demonstrators protested against the Lamu project and the coal mines in Kitui County in the middle of the country.

Source: Daily nation. Decoalonize

TEXT BOX 4

• THE ROLE OF CIVIL SOCIETY IN INNOVATION • Non-state actors. including non-profit organisations. play an important role in technical and economic innovation for the diffusion of new sources of energy. These innovations often arise at community level - a group of young people or women facing the same problems come together to try to devise a solution together. These groups can then be assisted by external actors. most often NGOs. who will advise or fund them (Muok. 2015).

The use of solar lanterns. for example. was initiated in the mid-2000s by Evans Wadongo. a student at the Jomo Kenyatta University of Agriculture and Technology. aged 18 at the time. Inspired by his childhood in a non-electrified region in the west of the country. he designed a solar lantern that was simple and suitable for the needs of Kenyan families. The lamp is made locally from recycled materials. In an example of economic innovation. communities have organised themselves into village banks to grant microloans for poor families to acquire equipment such as improved

stoves or solar kits.

Microcredit and access to energy

The use of renewable energies. especially solar. for basic needs such as lighting. is generally less expensive than the use of a generator or kerosene lamps that require the purchase of fuel. However. it requires an initial investment which is an insurmountable obstacle for households which do not have any savings or the guarantees and documents needed to obtain credit. Microcredits make it possible to get around these difficulties.

In 2013. Equity Bank. a leading Kenyan bank with 10 million customers. teamed up with the US company MicroEnergy Credits to create EcoMoto. a lending solution specifically designed to enable the distribution of energy products. These credits are used to purchase solar kits (solar lanterns or solar home systems) from Greenlight Planet. d.light. Fenix and Orb brands as well as improved cookstoves.

Loans range from $10 to $600 over a period of up to 12 months with an interest rate of 14%. The repayment rate is calculated to be less than the fuel price that would have been required without the purchased system. Savings over six months are usually sufficient to repay the loan.

In its initial version. the loan could be obtained in 24 hours with a one-page form. A mobile phone accessible version was launched last year in partnership with the operator Equitel. and funds are now released in minutes.

This project is supported by the US Development Agency. USAID. and the NGO Winrock International.

Source: Winrock International. 2017

TEXT BOX 5

CONCLUSION

Kenya's electrification is progressing rapidly without an increase in emissions from power generation. This success is explained by the importance of renewable resources and by the government's favourable policy. but also by the mobilisation of non-state actors. Large and small companies. local communities. NGOs. etc. are all contributing to the proliferation of projects that are making Kenya one of the most dynamic and innovative countries in terms of access to energy. Nevertheless. the possibility of the significant use of coal from 2024 could undermine this virtuous circle. The project. financed in this case by China. also highlights all the inconsistencies of international climate policies. especially on funding.

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