Engineering in KENYA

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Energy

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Enhancing Professionalism

ENGINEERING PARTNERSHIPS CONVENTION | 2022

ENGINEERING PARTNERSHIPS CONVENTION 2022

"BUILDING BACK BETTER - EMERGING ISSUES IN ENGINEERING"

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2. Outcome Based Engineering Education
3. Aligning Engineering Practice to Meet COP26 Commitments and Climate Action Plans
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Call for Papers

Engineering in Kenya Magazine - Issue 008

The Institution of Engineers of Kenya (IEK) publishes Engineering in Kenya magazine, whose target audience includes engineering professionals, practitioners, policymakers, researchers, educators and other stakeholders in engineering and related fields. The publication is distributed to its target readers free of charge through hard and soft copies.

IEK hereby invites you to contribute articles for the next and future editions. The articles should reach the Editor not later than June 20, 2022, for our next issue whose theme shall be "Engineering Governance" and related sub-themes across all engineering disciplines. An Article can range from engineering projects to processes, machinery, management, innovation, news and academic research.

The articles must be well researched and written to appeal to our high-end audiences and to be informative to the public in Kenya and beyond. The magazine reserves the right to edit and publish articles in line with its editorial policy. The articles should be 500-1000 words, font type Times New Roman and font size 12.

Send your article today and get a chance to feature in the magazine!

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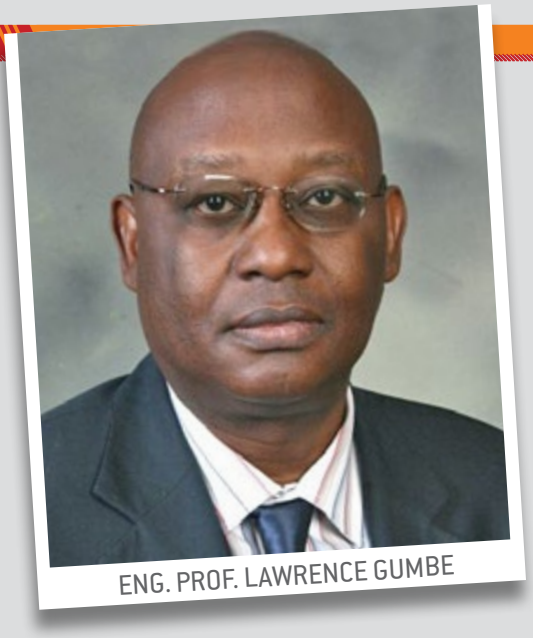
In this **Issue**

Cover photo: KenGen Engineers at Aluko- Langano Geothermal well where the company has recently completed a 3,000m geothermal well. PHOTO POOL



ENG. PROF. LAWRENCE GUMBE

Energy in Kenya

ELECTRIFYING KENYA IS CRUCIAL TO ITS TRANSFORMATION THROUGH INDUSTRIALISATION AND ECONOMIC DEVELOPMENT. IN THIS ENDEAVOUR, WE MUST FIRSTLY PRODUCE OR IMPORT THE ELECTRICITY.

ACCESS to reliable, sustainable and cost-effective energy sources is crucial for existence and development of modern societies. Kenya Vision 2030 is the long-term development blueprint for the country and is motivated by a collective aspiration for a better society by the year 2030.

The aim of Kenya's Vision 2030 is to create "a globally competitive and prosperous country with a high quality of life by 2030". It aims to transform Kenya into "a newly-industrialising, middle income country providing a high quality of life to all its citizens in a clean and secure environment". This vision is dependent on the availability of adequate energy resources.

Whether it is in the factory, farm, office, hospital or transport system, energy and especially electricity is necessary for operations.

An analysis of the national energy needs shows heavy dependency on petroleum (22%), electricity (9%), others (accounting for about 1%). Electricity access in Kenya is low despite the government's ambitious target to increase electricity connectivity to at least 65% by the end of the year 2022.

To achieve Vision 2030, the country's electricity generation, transmission and distribution needs to be developed in order to attain a consumption rate of 3,000 kWh/capita from the current level of about 164 kWh/capita.

The electricity sector in Kenya is highly capital intensive, has natural monopoly characteristic, particularly in the transmission and distribution segments and is poorly internationalized. Although there are increasing international connections in the transmission network, the exploration and importation of electricity remains very marginal in most countries and is only important in very specific cases. It has been estimated that African countries lose an estimated 4 percent of their annual GDP for lack of energy.

Grid electricity is the main source of electricity in Kenya. In 2021 the major sources of electricity being hydropower at 838 MW, Geothermal, 863 MW, thermal at 619.2 MW, wind, 437 MW, solar at 173 MW and cogeneration, 59.8 MW. The national electricity installed capacity was at 2,990MW as of November 2021 according to Kenya Electricity Generation Company, with a connection rate at 8.6 million people in an estimated population of 50 million.

In order to achieve middle income status, the electricity generation in Kenya needs to rise significantly. Estimates range from 20,000 MW to 60,000 MW installed generation capacity. In order to meet this projected demand, possible new

sources like coal with a projected potential of 1,920MW, liquid natural gas (LNP) at 1,050MW potential need to be explored. Other sources include Nuclear and other renewable sources.

Electricity generation in Kenya is largely the function of the Kenya Electricity Generating Company (Kengen) which is the leading company in the production of electricity in power stations, generating more than 60% of all the electricity consumed in the country. Other electricity producers include Geothermal Development Company (GDC) and Independent Power Producers (IPPs) which accounts for an estimated 39% of the installed capacity. Importation is also another source of electricity generation for the Country. However, to realize the Vision 2030 of consumption rate of 3,000 kWh/capita.

Most transmission of the power is carried out by Kenya Electricity Transmission Company (KETRACO) which handles high voltage lines of above 132 kV whose core mandate is to plan, design, build, operate and maintain new electricity transmission. The major challenge is the centralized system of transmission and for the country to meets its target, this may need to be decentralized.

The distribution and retail of electricity is the main function of Kenya Power and Lighting Company. Kenya Power (formerly KPLC) currently helps the Rural Electrification and Renewable Energy Corporation (REREC) in distribution in rural areas.

The main challenge in distribution is the monopoly exercised by Kenya Power. Is this monopoly constitutional?

The Fourth Schedule of the Constitution of Kenya has given the functions of "Energy policy including electricity and gas reticulation and energy regulation" to the National Government. The county governments have been given the functions of "Electricity and gas reticulation and energy regulation".

Electricity costs in Kenya are high when compared to Kenya's competitors in this sector. There is need to address this issue urgently.

Electricity sector in Kenya is currently governed by a number of legislation and acts. These are: Energy Act of 2019, which requires the regulator to ensure that the rates and tariffs established electricity sales contracts, transmission and distribution are just and reasonable, the national Energy policy, 2018, whose aim is to provide affordable quality energy for all Kenyans.

The recent shortage of petroleum products which led to long queues outside service stations has reminded the public that a decade ago the government reported the discovery of oil in Turkana.

Kenyans were hoping for good times in which there would be abundant cheap petrol and plenty of hard currency earned through oil exports. Efforts should be redoubled in mining and refining this oil as soon as possible.

The cost of off grid solar electricity systems has recently been declining leading to more connections of these systems in rural areas. This is an encouraging development.

Having wood fuel and other biomass accounting for 68% of the total energy consumption is disastrous to the environment, health and the economy.

The Ministry of Environment and Forestry estimates Kenya's forest cover at about 7.2%. Cutting trees and burning the same in open stoves as wood fuel leads to depletion of forest cover, increasing carbon and degrading our capacity to absorb the same, also inhalation of smoke from the stoves leads to respiratory diseases.

We must move away from wood fuel to better sources of domestic energy. Liquefied petroleum gas, LPG, has become a popular alternative to wood fuel.

The problem with LPG is that it is imported. This leads to the problem of finding the hard currency to buy the same.

Tanzania has found large deposits of gas in its territory. It wishes to develop an LPG industry at Likong'o village in Lindi town. Kenya has been in discussions with Tanzania on the possibilities of developing a gas pipeline to transport the product from Tanzania to Kenya within the auspices of East African Community. EAC, cooperation. This may be helpful in the long run.

Recent estimates have revealed that it may now be cheaper to cook with electricity than LPG in Kenya.

This is interesting because electricity is versatile and can be used for: Cooking in homes; powering machines and processes in industry; mass transport systems in urban areas; SGR railway transport; lighting and operations in offices and homes; and operations in agricultures such as pumping of irrigation water.

Electrifying Kenya is crucial to its transformation through industrialisation and economic development. In this endeavour, we must firstly produce or import the electricity.

In 2003 the installed capacity for Kenya was 1,207 MW. In 2021 the installed capacity in Kenya is 2,990MW. In 2003 the installed capacity for Ethiopia was estimated at just about 500 MW according to Ethiopia Country Report of 2015. Ethiopia has been more ambitious in developing its generation capacity. In 2021 the Installed capacity for Ethiopia is 4,967 MW, this figure will soon grow to more than 10,000 MW.

The Democratic Republic of Congo has recently joined the EAC. Congo has immense hydroelectricity generation potential. Some estimates put this potential at 200,000 MW. Through EAC cooperation Kenya may benefit from this potential.

We must be ambitious and innovative in developing our energy sector in Kenya. This sector is a necessary condition for our industrialisation, economic security and transformation.

The Institution of Engineers of Kenya had its elections in March 2022. We congratulate the new team led by President Eng Erick Ohaga. We are confident that under their guidance, the Institution of Engineers of Kenya will thrive!


ENG. ERIC OHAGA

Prioritize Role of Engineers to Stimulate Economic Development

IT gives me great pleasure to interact with readers of ***Engineering in Kenya*** magazine, having taken office and leadership mantle as President of the Institution of Engineers of Kenya in April this year. I take this early opportunity to thank IEK members, for entrusting me with leadership of the Institution for the term 2022/2024 and assure them of my commitment to advance the noble course of the institution.

Together with my newly elected Council colleagues, our mandate is clearly cut out from the onset: to forge a responsive and progressive Institution that will advocate for inclusion of professional engineers in every sector of our economy, and to promote fidelity to engineering standards and professionalism, so that engineering can effectively contribute to the pursuit of Kenya's national development agenda.

Indeed, the profession of engineering is central to Kenya's Vision 2030 and African Union Agenda 2063. Through infrastructure development, industrial engineering, research and academia, engineers in Kenya continue to contribute significantly to enhancing economic growth and improvement of quality of life in the country.

Over the last two years during the Covid-19 pandemic, many organizations conducted activities including work from home, as well as education on virtual platforms; which are essentially powered by engineering innovation. We engineers are proud to be associated with such innovations that have made living standards bearable. This is a testament of the significant role engineering plays in society.

As a professional society, we are determined to champion that laws, policies, governance structures and financial investment decisions being made at both the national government and county government levels in Kenya take into account and factor in full involvement of Engineers and the benefits Engineers bring to the society.

In this regard, my agenda as incoming President of the Institution of Engineers of Kenya will be to see to it that Engineers in Kenya receive priority consideration in the constitution of relevant decision-making organs in state agencies and corporate bodies. Engineers play critical roles and functions requiring engineering competency and accountability.

We will continue to work closely with partner organizations such as Federation of African Engineering Organizations (FAEO), the World Federation of Engineering Organizations (WFEO), development partners and our regulator Engineers Board of Kenya, alongside other stakeholders, to continue to develop systems that will strengthen further the capacity of IEK to play a leading role in Kenya's pursuit of Sustainable Development Goals, especially (SDG) number 9: ***Industry, Innovation and Infrastructure.*** We will push for increased investment in research and development critical to finding solutions for emerging world problems such as climate change in Kenya.

We thank our stakeholders for their continued support and collaboration in events and programs of the Institution of Engineers of Kenya. I also convey immense gratitude to my predecessor, the Immediate Past President of IEK Eng. Nathaniel Matalanga, together with his Council and IEK membership, for keeping IEK strong during the difficult period of the last two years in the face of the Covid-19 pandemic.

Their unrelenting hard work has ensured we take over leadership of our Institution anchored on a firm foundation, ready to soar higher. Strong institutional frameworks are key towards ensuring long-term sustainability and relevance. Working as one team, the new leadership will strive to sustain the momentum they built, and raise the bar even a notch higher. We can only become better.

Engineering in Kenya Magazine exemplifies our commitment as a professional society to continue ensuring knowledge sharing amongst IEK membership, and across entire society in Kenya, as well as in the global community. We thank the Editorial Board of the IEK for the good work they have done over the last one year and continue to do to keep our members and stakeholders fully informed every two months.

Finally, I thank all contributors and advertisers whose content keep our members fully informed. As an Institution, we shall remain committed to promoting development of science, scientific knowledge and engineering for sustainable economic development in Kenya. Enjoy your read.


ENG.SHAMMAH KITEME

Message from IEK Honorary Secretary

THIS seventh issue of Engineering in Kenya magazine is a testament of the capacity of our members to contribute great content that continues to inform, educate and empower through knowledge sharing.

This issue focuses on energy and it is a sector IEK members are playing a leading role in our economy.

IEK will continue to be the voice of Engineers in Kenya and the Engineering in Kenya magazine is a prized product that we will continue to support in this effort.

> ...ALL DEVELOPMENT MUST HAVE ENGINEERS AT THE FOREFRONT. THIS ALSO MEANS OUR COMPETITIVENESS AS WELL AS FAVORABLE POLICIES FOR LOCAL CONTENT ARE KEY. OUR FIRMS AND INDEED OUR MEMBERS HAVE EVERY RIGHT TO PARTICIPATE IN ALL DEVELOPMENT HAPPENING IN OUR COUNTRY.

As we enter the homestretch of heightened political activity leading to the general elections in August this year, IEK will engage in ensuring that the voice of Engineers is heard and that our agenda will find its way into the manifesto the political parties come up with.

We will engage so that the next government will take seriously the agenda of Engineers.

We know that all development must have Engineers at the forefront. This also means our competitiveness as well as favorable policies for local content are key. Our firms and indeed our members have every right to participate in all development happening in our country.

This is an area we will focus on as we ensure our relevance through capacity building that equips our members to compete not only locally but also regionally and globally.

Opportunities for our members as East African Community expands to the Democratic Republic of Congo and the African Continental free Trade Area mean we must focus to capitalize on the trade in services.

IEK through the secretariat and the council will ensure our members are informed of the opportunities available as well as advocate for the welfare of all our members. We're improving services in the secretariat which has now been expanded and resourced to effectively serve our members.

We will keep developing initiatives that ensure our members meet the CPD requirements for renewing their annual license.

Together with this publication, we will soon begin to release an easy-to-read newsletter that will be completely online. This will ensure members are kept informed as well as broaden the knowledge sharing platforms.

We're also creating an online resource center for Engineers to interact more on our website and make it more of their home than a site to visit once in a blue moon. Indeed, 50 years after IEK was established, we have to take our services to the next level. We must perform at the best level and give value to our membership.

This is our commitment and duty to our membership.

I now invite all our members, partners and indeed all our readers to interact with this 7th issue which is rich in great content.

I invite all the readers to give us feedback through our email, phone and social media as this helps us keep improving.


ENG. ERASTUS K. MWONGERA

Looking Forward to the Engineering Partnerships Convention 2022

Eng. Erastus K. Mwongera, CBS, CE, FIEK, , Chairman, Engineers Board of Kenya

THE Engineers Board of Kenya will convene the much-awaited ***Engineering Partnerships Convention (EPC) 2022 on*** 15th -17th June 2022. The EPC whose theme is ***Building Back Better, Emerging Issues in Engineering*** will bring together policymakers, industry experts, academicians, researchers, trade-in services experts, and Kenyan engineers to create dialogue, reflection, and partnerships that will strengthen Kenya's engineering education, training, and practice.

The Board regulates the entire engineering value chain. Global engineering education, training and practice undergoes daily transformations due to the dynamic nature of engineering. Kenya is required to align itself to both current and emerging global trends.

EPC 2022 will be premised on four pillars focusing on championing the shift to outcomes-based engineering education in Kenya, opportunities for growth in the liberalization of professional engineering services at the regional, continental, and global levels, Kenya's commitments at COP26 and aligning the engineering practice to mitigating climate change and safeguarding Public Safety and Welfare in Engineering Services.

The EPC 2022 Pillars is perfectly aligned with the EBK's commitments to Sustainable Development Goals (SDGs): SDG 4 on Quality Education; SDG 8 on Decent Work and Economic Growth; SDG 9 on Industry, Innovation, and Infrastructure; SDG 13 on Climate Action and SDG 17 on Partnerships Creation.

The Convention further dovetails very well with first Aspiration of the African Unions Agenda 2063 of a Prosperous Africa based on inclusive growth and sustainable development. We therefore welcome you all to participate in the EPC 2022.

The Engineers Board of Kenya is continuously strengthening Compliance and Enforcement Activities. The Board has completed the Countrywide Structural Assessment of ongoing Buildings. This will lead to policy development to minimize the increased cases of building collapse. The Board is scheduled to undertake disciplinary hearings from May for all cases referred by National Construction Authority (NCA) and those that have been received by the public. The Board has also launched the Engineers Stamp and we urge all members to register and collect them together with the Engineers Identification (ID). The Board has further developed a collaborative framework with the Board of Registration of Architects and Quantity Surveyors (BORAQS) and the National Construction Authority (NCA) in consultations with the Office of Attorney General.

The Board in its aspiration to register 10,000 engineers by 2027 has recruited the 3rd Cohort of Graduate Engineers in January 2022. Secondly, the Board has developed Agency Based Structured Graduate Engineer training with Isuzu, Kenya Bureau of Standards (KEBS), Kenya Electricity Transmission Company (KETRACO), and Schneider Electric.

The Board continuously undertakes quarterly Pre-Submission Conferences and encourage all Graduate Engineers, who are qualified for registration as Professional Engineers, to participate by booking the next conference on our website.

The Board is currently participating in Trade Talks at the East African Community (EAC) and African Union (AU) levels for liberalized engineering services, formulating a country position in consultation with industry in this regard. The Board participation will ensure the country stand and interest of the local engineers are safeguarded.

The Board has carried out extensive consultation with Ministry of Education, Universities, Commission for University Education (CUE) to develop Accreditation Framework for Engineering programs and expects matter to be resolved. Starting this May 2022, the Board will undertake independent review of 26No. pending engineering programs in various universities. The reviews will go a long way in supporting EBK's bid to accede to the Washington Accord under International Engineering Alliance so that our engineering programs are recognized internationally, thus enhancing global mobility of our engineers.

These milestones have all been made possible by the immense support of all our stakeholders including our staff and Board members, the Government of Kenya through the Ministry and Cabinet Secretary Transport, Infrastructure, Housing, Urban Development and Public Works, James Macharia, as well as the PS Infrastructure, Arch. Prof. Paul Maringa.

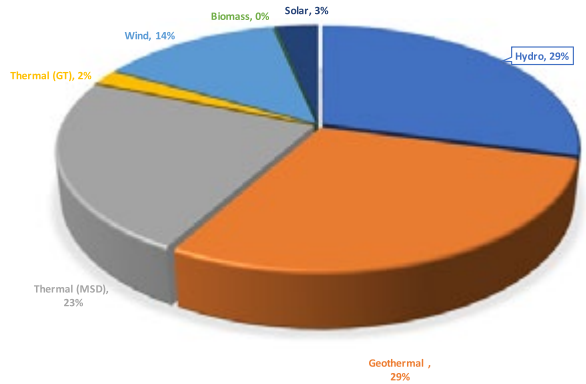
I congratulate the new leadership of the Institution of Engineers of Kenya (IEK), led by President Eng. Erick Eng Ohaga and hereby offer our commitment and assurance as EBK Board of our support in advancing development of engineers and the Engineering profession.

In the same vein, we celebrate the outgoing 2020/2022 IEK Council, led by Immediate Past President Eng. Nathaniel Matalanga for their dedication and notable contributions that raised visibility of the profession in Kenya and abroad and for their unrelenting advocacy for best engineering practices.

Renewable Energy as Source of Power in Kenya Today and Beyond

By Eng. Mwamzali Shiribwa

SHARE OF ELECTRICITY GENERATION IN KENYA 2020



RENEWABLE energy means all non-fossil energy sources including, biomass, geothermal, small hydro-power, solar, wind, sewage treatment and plant gas.

Thanks to the current geopolitical ramifications in the world today, renewable energy generation will be the growth outperformer in the Kenyan power sector over the next 10-year and beyond. Various sectors are at the heart of this great development.

For the promotion and development of Renewable Energy in Kenya, the Ministry of Energy established the Rural Electrification and Renewable Energy Corporation. The renewable energy technologies, include but not limited to geothermal, biomass, biodiesel, bio-ethanol, charcoal, fuel wood, solar, wind, tidal waves, hydropower, biogas and municipal waste.

Due to various challenges experienced by the only On-grid distributor of electricity in Kenya, many people are shifting to renewable energy supply. It is notable that the Transport sector has not been left behind in this journey to make Kenya a renewable energy pace setter on the continent.

Commercial enterprises and industry in Kenya require reliable, affordable, and environmentally friendly energy to cover their demand for electricity, heat and cooling. Renewable energies can make a sustainable contribution to cover this demand.

Geothermal

Geothermal resources are located within the Rift Valley with an estimated potential of between 7 to 10 GW spread over 14 prospective and identified sites. Currently, the country produces 29% (EPRA, 2021) of its electricity from geothermal source. Over 3GW of geothermal power projects are in planning stages. It is estimated that when Olkaria VI is completed, it will be the largest single geothermal plant in the world

Geothermal power has the potential to provide reliable, cost-competitive, base-load power while reducing vulnerability to climate. Besides being used to generate electricity, geothermal energy is also used in heating greenhouses for better crop yields. For example, Oserian Flower farm that is located in Naivasha is one of the leading flower exporters in Kenya. This flower farm relies on geothermal energy to heat greenhouses and sells 380 million flower stems each year. In addition, the company can grow new rose varieties with a 24-hour heating supply

Wind Power

Kenya has progressed on wind power generation. It now has a number of wind farms such as, Ngong Hills Wind Farm, located in Ngong, Kajiado County. This farm that produces 5.1 MW of electricity is owned by KenGen. The Kipeto Wind Power Station, also in Kajiado, is an 100MW wind-power electricity station. The third is the 310 MW Lake Turkana Wind Power (LTWP) Station located in Marsabit County. The LTWP is the largest of its kind on the continent with 365 wind turbines each with a capacity of 850k. Wind power sector received a massive boost in 2017 with the completion of the Lake Turkana wind farm.

Initially, wind power in Kenya contributed only a relatively small amount of the country's electrical power. However, its share in energy production is increasing. Kenya has projected to generate 2 GW of wind power, or 9% of the country's total capacities, by 2030 if the national grid can quickly be upgraded withstand it.

Solar

Solar capacity was at increased by 3.0% (EPRA,2021) The Government has played a significant role to advance the use of solar energy. Some measures include removal of import duty and zero-rated Value Added Tax (VAT) for renewable energy equipment and accessories. More Kenyans are now turning to solar power every year instead of seeking for connections to the national grid. A number of challenges that many face when seeking for connection to the national grid are the initial costs of setup and the high cost of power from Kenya Power and Lighting Company.
As part of protection measures, the government in 2012 enacted the Energy (Solar Photovoltaic Systems) Regulations and The Energy (Solar Water Heating) Regulations, 2012 (the "Regulations") by the Energy Regulatory Commission ("ERC"). These regulations were to ensure that good quality solar products as well as properly trained or qualified technicians are the only ones to operate

in the market. The Regulations require that all persons designing and installing solar PV, all manufacturers, vendors, distributors and contractors of solar PV systems shall be licensed by the ERC.

The private sector has come up with a number of innovative products. For example, M-KOPA project to enables more people embrace solar energy. Its basic model is to make solar power products affordable to low income households through a 'pay-per-use' installment.

The latest development is in the use of solar panels on rooftops of parking lots in malls, commercial buildings, hospitals and schools. These covered rooftops are designed to supply malls with electricity and supplement the grid power. Some Kenya Tea Development Authority factories have also embarked on using solar power and phase out grid power.

> The estimated solar potential in Kenya is almost 15GW. The largest installation is Garissa Solar plant with installed capacity of 55MW. Other notable solar power generators are Strathmore University with 0.6MW. The government projects the sector to produce 600 MW by 2030. As part of these efforts, the following projects are lined up; Samburu Solar Project (40MW), Kopere Solar Park in Kisumu (22,7MW), Witu Solar Project (40MW), Isiolo County Solar Project (40 MW) and Nakuru Solar Project (25MW

Solar Water Heating

The Solar Water Heating regulations covered both the direct and indirect solar water heating systems. "Direct solar water-heating system" means a solar water heating system in which water is heated directly in the collector. "Indirect solar water-heating system" means a solar water heating system in which a heat transfer fluid in the collector transfers heat to the water through a heat exchanger.

This regulation requires that all premises (whether newly built or under renovation) within the jurisdiction of a local authority with hot water requirements of a capacity exceeding one hundred litres per day shall install and use solar heating systems.

This regulation was to enable Kenya meet a part of its carbon emission reduction targets under the Kyoto Protocol under the Clean Development Mechanism. A mechanism that allows emission-reduction projects in developing countries to earn certified emission reduction (CER) credits each equivalent to one tonne of carbon dioxide, which can be traded or sold, or used by industrialized countries to a meet a part of their emission reduction targets.

Biomass

Over 75% of bioenergy in Kenya is generated from 'traditional biomass' such as charcoal, agricultural waste and firewood. Up to 80% of Kenyan households are dependent on firewood for cooking and heating. Instead of burning this biomass directly, they can be converted to renewable liquid and gaseous fuels through various processes

The Government has identified the existence of a substantial potential for power generation using forestry and agro-industry residues including bagasse. The total potential for cogeneration using sugarcane bagasse is 193MW. Mumias Sugar Company (Independent Power Producer) used to generate 35MW out of which 26MW was dispatched to the grid. However, opportunities within other sugar factories estimated to be up to 300 MW have not been fully exploited.

Biogas

Biogas in Kenya it is estimated that there are over 8000 biogas plants utilizing various raw materials e.g agricultural wastes, slaughterhouse waste, municipal wastes etc. However, there is no consolidated data on biogas production making it a challenge in determining the country's overall capacity.

Biogas potential in Kenya has been identified in Municipal waste, sisal and coffee production. The total installed electric capacity potential of all sources ranges from 29-131MW, which is about 3.2 to 16.4% of the total electricity production.

Tidal Wave Energy

This is the only technology that draws on energy inherent in the orbital characteristics of the Earth–Moon system, and to a lesser extent in the Earth–Sun system. It has a lot of potential but not been fully exploited.

Small Hydropower

Small Hydropower has historically been used primarily by the private sector, such as communities, mission hospitals, individuals and tea factories for grinding of grains and production of electricity. The first reported small hydropower was built in 1925 at Ndula on Thika river. The interest in small hydropower in Kenya was re-ignited in the 1990s due to power rationing.

Several KTDA tea factories have installed small hydropower plants to reduce the cost of power from the national grid. Investigations have identified 14 potential sites in Western Kenya for development of small hydro power stations.

Energy Conservation and Efficiency

Energy efficiency means using less energy to get the same job done – and in the process, cutting energy bills and reducing pollution. Many products, homes, and buildings use more energy than they actually need, through inefficiencies and energy waste. For example, energy-

efficient LED light bulbs are able to produce the same amount of light as incandescent light bulbs by using 75 to 80 percent less electricity.

Energy conservation is the decision and practice of using less energy. Turning off the light when you leave the room, unplugging appliances when they are not in use and walking instead of driving are all examples of energy conservation. The two main reasons people conserve energy are to gain more control over their energy bill and reduce the demand on the earth's natural resources.

Grid Upgrade

Kenya is investing on grid upgrades to reduce losses. In 2020, a total of 2,790.7 GWh were lost through transmission and distribution, which is about 24.3 % of total electricity supply. The reason why aging grid systems have to be upgraded and new ones developed

Work has commenced on a KES6.42bn (USD63.46mn) power transmission project for rural areas targeting Nyanza-Western, North Rift, South Rift, Mount Kenya, Upper and Lower Eastern, and Coast, with contractors appointed for each region.

A total of 16 counties with 591 public facilities and 35,460 households will be connected to power under the plan.

Eng. Mwamzali Shiribwa is former Honorary Secretary of the Institution of Engineers of Kenya and Director of Renewable Energy at the Ministry of Energy.

KenGen Completes Drilling of 7th Geothermal Well in Ethiopia

By IEK Correspondent

KENYA Electricity Generating Company PLC (KenGen) has completed drilling of the seventh geothermal well in Ethiopia, bolstering the company's renewable energy footprint in the Horn of Africa region.

This latest announcement is from the Aluto-Langano geothermal site where KenGen is implementing a drilling consultancy project for the state-owned Ethiopian Electric Power (EEP) company. The drilling of the seventh well was completed on schedule at a depth of 3,000 meters.

"This is the second 3,000 meters well we have drilled in Ethiopia so far, and I must commend our teams on the ground for successfully delivering to expectations despite the threats of COVID-19 and security situation in Ethiopia at the time of project implementation," said KenGen Managing Director and CEO, Rebecca Miano.

The milestone reaffirms the NSE-listed company's expertise in geothermal development in Africa, having earlier drilled the deepest geothermal well in the Horn of Africa also at a depth of 3,000 meters as announced by KenGen on November 11, 2021.

Commenting on the project timelines, Miano said: "We have now embarked on drilling of the fifth geothermal well under the EEP project in Aluto-Langano and we expect to complete the work in a fortnight's time."

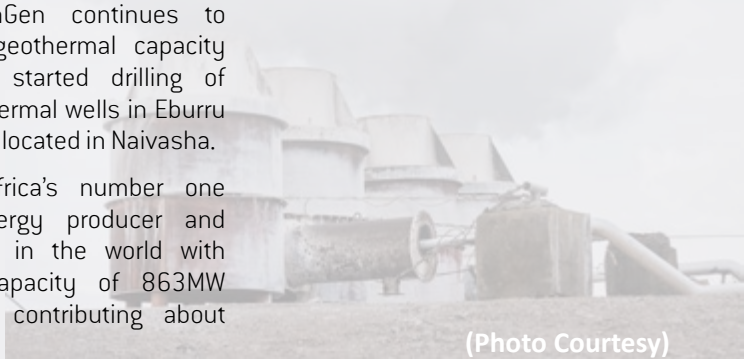
The Ethiopian and Djiboutian ventures are part of KenGen's ambitious diversification strategy, in which the company is seeking to acquire new revenue streams by offering commercial drilling services, geothermal consulting and other related services across Africa.

In November last year, KenGen announced that it had started work to deliver three geothermal wells in Djibouti setting in motion a Ksh.0.7 billion contract.

Locally, KenGen continues to grow Kenya's geothermal capacity and has now started drilling of additional geothermal wells in Eburru geothermal field located in Naivasha.

Kenya is Africa's number one geothermal energy producer and among top 10 in the world with an installed capacity of 863MW with KenGen contributing about 713MW. The country has an estimated geothermal potential of 10,000MW spread along its part of the Rift Valley circuit.

KenGen remains the leading electricity generation company in Eastern Africa region with an installed generation capacity market share of more than 60%. The company's primary business says its focus is on provision of safe, reliable, and competitively priced electric energy for the country, in an environmentally friendly and sustainable manner, while creating value for its stakeholders. KenGen PLC presently has an installed generation capacity of 1,818MW, of which over 86% is drawn from green sources namely: Hydro (826MW), Geothermal (713MW), Thermal (253MW), and Wind (25.5MW).



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Geosynthetics: Opportunities for Kenya in New Construction Engineering Technology

By Eng. Anthony Kimotho

There are eight main categories of geo-synthetics, namely geotextiles, geogrids, geonets, geomembranes, geosynthetic clay liners, geofoam, geocells and geocomposites. Eng. Anthony Kimotho delves deeper into their viability for application in Kenya and the region.

Infrastructure development in Kenya has seen tremendous growth in the last two decades. This has come with its fair share of challenges. Engineers have to come up with innovative ways to counter this which challenges include ; lack of adequate financial resources, time constraints, environmental degradation challenges,challenging terrain, availability of construction materials to mention but a few.

One of the most viable and proven solutions is use of geosynthetics in the construction of horizontal infrastructure. There are various base materials used in manufacturing geosynthetics such as fiber glass, HDPE, PP, PET etc. The most efficient reinforcing material is PET (polyester). The following are some solutions that have been effectively used all over the world for the last half century and present very innovative remedies to the challenges facing Kenyan civil engineers.

Geogrids: These are used for reinforcement and containment. Geogrids can be used to build roads in areas that were previously considered difficult or almost impossible to build infra such as roads, airport runways and railway lines. Examples areas with very cohesive soils, fine sands, swamps, marshland and subgrades that have a CBR lower than 1 to 2%.

Geogrids can also be used in construction of mechanically stabilized earth (MSE) structures as a perfect replacement to concrete retaining structures and abutments in bridges at a fraction of the cost. Geogrids are also used to reclaim land on very steep slopes. The biggest advantage in the use of geogrids is that it can stabilize MSE structures at angles greater than 90 degrees vertical.

Figure 1: MSE structure with geogrid reinforcement, Lekki Expressway, Lagos, Nigeria

Another very useful application of geogrids is reinforcement of asphalt. Over the years engineers in Kenya have always faced a very huge challenge on how to deal with reflective cracks. There are myraid of reasons as to why reflective cracks appear during construction of new roads and during rehabilitation of existing roads. While laying a new asphalt layer over an existing one that has cracks,the biggest challenge is on how to prevent the existing cracks from appearing on the surface of the new layers. Treatment of cracks and filling of potholes before laying the new asphalt has proven to be very ineffective. By laying an asphalt reinforcing grid in between the existing asphalt and the new asphalt layer, reflective cracks can be completely eliminated. The new alsphalt is reinforced such that factors that lead to development of cracks (e.g. potholes and bleeding on the wheel truck channels created by repetitive loading and brittleness of the primer by changes in temperature from hot to cold) can be completely eliminated. Use of PET geogrids with bituminous coating will increase the service life of the asphalt pavement by up to 4 times. This frees more resources to build new infrastructure. Geogrids are easy to install and will rarely require specialized equipment. Introduction of tensile strength characteristics in asphalt pavements will increase the life span of a road by a factor of 4.

Figure 2: Asphalt reinforcement in Ghana

Geogrids can also be used as basal reinforcement. This is an alternative to soil replacement. It means that regardless of the existing ground conditions, one is only required to strip 200mm of organic or other soft soil material, lay the geogrid and build the road embankment as illustrated below. The required strength for the geogrid follows from a stability analysis, which can be performed by specialised companies like Admir Kenya.

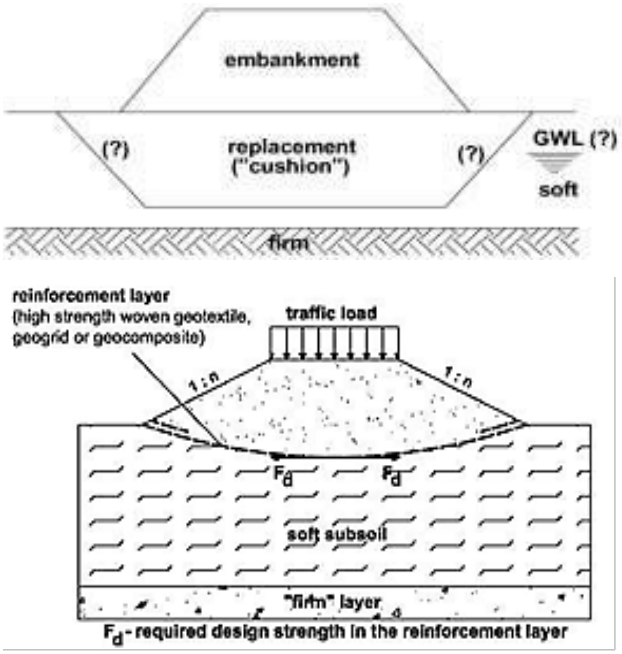

Figure 3: Basal reinforcement under embankment on soft sub-grade

Neoloy geocells: These are used for base reinforcement, containment

Neoloy geocells are another very innovative,speedy and cost efficient way of strengthening the sub base and sub grade layers in the construction of pavements. Due to the existence of passive resistance in between individual cells that contain the fill material as illustrated below, engineers are able to utilize soils previously considered poor quality e.g gap graded and uniformly graded soils. It also presents an opportunity to use waste materials such as quarry waste and recycled road and building aggregates. In return, this reduces the carbon footprint of the road. Use of poor quality soils found near the pavement construction site also greatly reduces the cost of haulage as well as emissions by the trucks that would be used for haulage. Another great advantage of using geocells is that borrow pits do not have to be established in areas with soils that could be useful for other uses e.g. farming . It also enables engineers to counter the challenge of environmental degradation in areas with delicate ecosystems e.g. forests.

Used together with geofabrics and geogrids, a composite pavement structure of geocells will greatly reduce the layer thickness of pavement that are subjected to heavy loading like Class A highways, airport taxiways and port side roads etc. CFS stations and containers terminals will also find this very efficient and cost effective. Geocells have over the years been used to create permanent roads that are unpaved while reducing the cost, construction time and need for regular maintainance.

Figure 4: Neoloy geocells installed at Hoima Road, Uganda

Geofabrics: These are used for separation, reinforcement, drainage, filtration Geofabrics are commonly used but majorly for filtration and separation purposes. However over the years engineers have been able to apply this material to solve very complex construction challenges. Please see below a few illustrations of how geofabrics have been used for filtration separation reinforcement and drainage.

Figure 5: Nonwoven geotextile used as filtration/separation fabric

The above are just but a few illustrations on how engineers can very cost efficiently build, rehabilitate and maintain horizontal infrastructure at lower budgets, reduced project timelines and at the same time offer higher quality infrastructure by applying geosynthetics.

Eng. Anthony Kimotho is the Country Manager for Admire Africa Kenya.

IEK Engineers Chaltu Marta, Mathew Arthur Scoop 2022 Grand Master Awards

By IEK Correspondent

GE Ms. Chaltu Marta (Second Right) receives her winner's certificate during the Kenya Solar Week Awards 2022. She won in the "Women Leader of the Year" Category. (right) Eng. Mathew Arthur's Winners' Certificate.

IEK Engineers Chaltu Marta and Mathew Arthur have won 2022 Grand Master Awards organized by solar energy sector players dubbed Kenya Solar Week Awards. The Kenya Solar Week Awards are organized to celebrate players in the renewable energy sector.

Eng. Arthur Mathew is a Professional Engineer currently working as a Design and Maintenance Engineer at Geothermal Development Company (GDC) and was awarded in "Excellence in Engineering Project" Category.

Youthful Engineer Chaltu Marta on the other hand received "Women Leader of the Year Award". She currently works as Regional Lead in West Kenya & Uganda Region for W Giertsen Energy Solutions (WGES), part of the W Giertsen Group, a family-owned Norwegian Company founded in 1875.

In her current role, she supports the company with Tea Industry Solarization. The team provides reliable and quality solutions both for the Grid Tie Solar System and developing state of the art Boiler Solarization to reduce firewood by about 50%. "This will impact the environment and the industry by supporting several SDGs including SDG13, SDG7, SDG8, and SDG12. By providing affordable & reliable energy that ensures responsible consumption of firewood, we are creating a more descent work and climatic environment," she told *Engineering in Kenya* magazine.

Hailing from a marginalized community in Kenya, the award-winning Eng. Chaltu Marta has also made it her mission to mentor & empower other young women in her community.

She is currently Vice Chair of Institution of Engineers of Kenya North Eastern Branch, Marsabit County, Vice Chair of IEEE Women in Engineering Kenya, Publicity Lead for IEEE Young Professionals Kenya, Chair of IEEE Power & Energy Society Kenya and STEM Wahandisi La Femme Publicity Co-coordinator.

Eng. Chaltu has been part of numerous mentorship programs and a speaker in both local and international Webinars. Her passion is sharing of knowledge in the Renewable Energy Sector. "Through tremendous support from my employer W Giertsen Energy Solutions, these mentorship programs have been able to support thousands of young people," she told *Engineering in Kenya* magazine. Eng. Chaltu Marta has also previously received accolades from engineering bodies such as Federation of African Engineering Organizations, ranking top 5 in the Female Engineer in Africa category, for her dedication and commitment to the course of engineering excellence.

The Journey of Electrifying Kenya - History and Milestones of Kenya Electricity Sector

By EiK Correspondent

1875

Seyyied Bargash, the Sultan of Zanzibar, acquires a generator to light his palace and nearby streets.

1908

Harrali Esmailjee Jeevanjee, a wealthy merchant in Mombasa, acquires the generator and transfers it to the Mombasa Electric Power and Lighting Company.

1908

Around the same time, an Engineer, Mr Clement Hertzel, is granted the exclusive right to supply electricity to the then district and town of Nairobi. This leads to the formation of the Nairobi Power and Lighting Syndicate.

1922

The two utilities in Nairobi and Mombasa are merged under a new company incorporated as the East African Power and Lighting Company (EAP&L).

1932

EAP&L acquires a controlling interest in the Tanganyika Electricity Supply Company Limited (TANESCO).

1936

EAP&L obtains generating and distribution licenses for Uganda, thereby entrenching its presence in the East African region.

1948

The Uganda Electricity Board (UEB) is established by the Ugandan Government to take over distribution of electricity in the country.

1954

The Kenya Power Company (KPC) is created - to be managed by EAP&L - for the purpose of transmitting power from Uganda through the Tororo-Juja line.

1964

EAP&L sells its majority stockholding in TANESCO to the Government of Tanzania.

1983

With its operations confined only to Kenya, EAP&L is renamed The Kenya Power and Lighting Company Limited (KPLC).

1997

The functions of generation are split from transmission and distribution. The Kenya Power Company, which has been under the management of KPLC since 1954, becomes a separate entity responsible for public-funded power generation projects. 1998: The Kenya Power Company is re-launched as the Kenya Electricity Generating Company (KenGen).

2004

The Energy Sector Recovery Project (ESRP) is started to rehabilitate and reinforce the transmission and distribution network in order to improve the quality and reliability of supply, reduce system losses and increase access to electricity.

2007

Rural Electrification Authority (REA) is established to speed up the implementation pace of the rural electrification programme.

2008

Kenya Electricity Transmission Company (KETRACO) is incorporated by the government to accelerate transmission infrastructure development.

2008

The government incorporates the Geothermal Development Company tasked with developing steam fields to reduce upstream power development risks so as to promote rapid development of geothermal electric power.

2008

Kenya Electricity Transmission Company (KETRACO) is incorporated and registered under the Companies Act, Cap 486 pursuant to Sessional Paper No. 4 of 2004 on Energy to provide reliable, efficient and effective electricity transmission and promote power trade for sustainable socio-economic development.

2008

Geothermal Development Company (GDC) is formed as a Special Purpose Vehicle (SPV) to accelerate the development of geothermal resources in Kenya. GDC is tasked with developing steam fields and selling geothermal steam for electricity generation to Kenya Electricity Generating Company PLC (KenGen) and to private investors.

2010

Nuclear Electricity Project Committee is formed.

2011

The Kenya Power and Lighting Company rebrands to Kenya Power.

2012

Nuclear Electricity Project Committee transformed into a parastatal under the State Corporations Act, as the Kenya Nuclear Electricity Board in November.

2019

Following the enactment of Energy Act 2019, Kenya Nuclear Electricity Board (KNEB) changed its name to Nuclear Power and Energy Ageny (NuPEA). The legislation conferred an expanded mandate to the organization involving carrying out research for development and dissemination of energy technologies as well as capacity building for the entire energy sector. This is in addiction to development of the Nuclear Power Programme for electricity generation in Kenya.

2019

Rural Electrification Authority (REA) rebrands to Rural Electrification and Renewable Energy Agency, expanding the mandate to spearhead Kenya's green energy drive.

Renewable Energy || The Future of Geothermal Energy in Kenya

By Jackson M. Kioko

RENEWABLE energy is a major focus for national governments and big businesses alike, especially amidst an increasing emphasis on combating global climate change. There are five (5) major types or sources of renewable energy. These include, the solar energy from the sun; geothermal energy from heat inside the earth; wind energy; biomass from plants and hydropower from flowing water.

Geothermal energy

This is the natural heat from the earth's interior stored in rocks and water within the earth's crust. The main source of this energy is the constant flow of heat from the earth's interior to the surface. This heat creates the molten rock, or magma, beneath the surface crust. Volcanoes, geysers and fumaroles are the visible evidence of the great reservoir of heat, which lies within and beneath the earth's crust. The magma heats the surrounding rock structures and when underground water comes into contact with this heat, geothermal fluid is formed. This energy can be extracted by drilling wells to tap concentrations of steam at high pressures and at depths shallow enough to be economically justifiable.

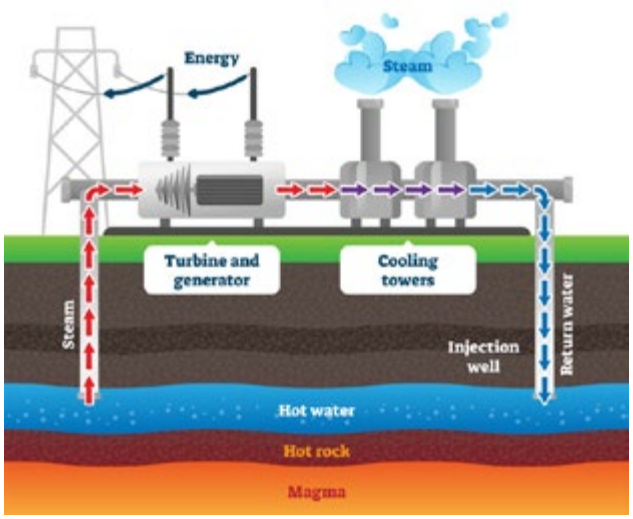

Figure 1: schematic diagram of geothermal energy production.

Overview of geothermal energy in Kenya

Geothermal resources in Kenya are located within the Rift Valley with an estimated potential of between 7,000 MW to 10,000 MW spread over 14 prospective sites. Accelerating the development of Kenya's geothermal power capacity is a vital enabling action for meeting Kenya's development ambitions to become a newly industrializing, middle-income country by 2030. Geothermal energy has been identified as the single most promising technology to keep the power sector on a low-carbon development pathway, and is a priority mitigation action in the Kenyan National Climate Change Action Plan (NCCAP).

Figure 2: The burgeoning Olkaria geothermal plant, Kenya.

Harvesting geothermal energy in Kenya provides environmental solutions, and it also stimulates economic growth. As geothermal plants create jobs and power Kenyan businesses, these operations can wield a direct influence on the fight against poverty. With a fast-growing economy, Kenya is already moving toward industrialization and modernization. The nation hopes to be an upper-middle-income country within the next decade. Officials remain optimistic that geothermal energy can power burgeoning industries throughout the country.

Geothermal compared to solar and wind energy

Geothermal provides a consistent energy source once the infrastructure to produce it is put into place. Unlike solar and wind energy, geothermal remains pretty even for 365 days a year. The amount of energy one generator can produce each day doesn't change all that much, either. In this way, it is extremely reliable. Geothermal power exploitation has other numerous advantages over solar and wind energy sources. It is not affected by drought and climatic variability; it's a green energy with no adverse effects on the environment and is absolutely indigenous. Compared to fossil fuels and even other renewable energy sources, geothermal is extremely inexpensive.

Generally, the little space required for geothermal power development compared to other energy sources such as coal fired plants is very minimal. Geothermal power plants require approximately 11% of the total land used by coal fired plants and 12-30% of land occupied by other renewable technologies.

The future of renewables

On a global scale, renewables are taking a larger and larger share of energy produced and consumed. In Paraguay for instance, 100% of all the electricity generated is from hydropower. Spain is in its efforts to reduce reliance on fossils in energy production and has some of the largest solar and wind power projects in the world. Germany exports wind power energy to the European Union. Morocco, Egypt and our country Kenya have large wind power plants which are helping them keep up with the growing energy consumption demands. The USA, Indonesia, Iceland and Kenya are making strides in developing geothermal energy. Unfortunately, several developing countries like Nigeria, Jordan and Ghana are making plans to build nuclear power plants thus in future most nuclear power plants may be located in developing countries in future.

Setbacks on geothermal energy

Unlike other power options, geothermal energy requires highly skilled technicians. In a developing country such as Kenya, geothermal training programs are hard to come by. Fortunately, the United Nations identified this problem decade ago and established the first Geothermal Training Programme in Iceland where Kenya's Electricity Generating Company has highly benefited through sending its personnel for training.

While geothermal energy does have its advantages, there are some downsides. Using geothermal energy causes a small amount of greenhouse gases to escape, such as carbon dioxide. These gases are usually trapped in the ground, but this pumping method can make them escape. Furthermore, groundwater can be affected by pumping geothermal energy, as it relies on water deep within the earth's surface (which would sometimes rise and join the groundwater otherwise). Other times, trace amounts of toxins can enter the groundwater due to pumping activities.

The future of geothermal Energy

Geothermal energy in Kenya is a promising alternative power source. Kenya has the geothermal potential to turn its energy crisis around. A report by the Geothermal Energy Association noted Kenya as "one of the fasted growing geothermal markets in the world." It predicted that "Kenya will lead the world with substantial additions to their geothermal infrastructure over the next decade and become a center of geothermal technology on the African continent." The long-term outlook of the renewables adaptation in Kenya remains bright.

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(Photo Courtesy)

A Systematic Approach to Siting of Energy projects: A Case study of Nuclear Power Plant Siting in Kenya

By Nduma Ruwah, Eng. Erick Ohaga, Kenneth Anakoli & Emmanuel Mulehane

Introduction

SITING is the process of selecting a suitable location for a facility, including appropriate assessment and derivation of the related design bases. Siting process involves two basic stages – site survey and site selection. Activities during site survey stage involve identification of prospective locations, collection of information/ data related to factors affecting site selection and conducting preliminary investigations. Site evaluation, in general, involves: a) Demonstration of acceptability of the site using the related information/data and satisfying established criteria for selection of NPP sites and b) Derivation of site related design basis.

Site evaluation continues till the end of operating life of the plant to ensure safety against hazards associated with external events. This is important due to changing perception of the hazard from external events as well as the changing natural and/or manmade environment in the site region over time.

This paper illustrates the approach followed in siting Kenya's first nuclear power plant with the aim of replicating the process for other energy projects in the country.

Methodology

The siting process began with a reconnaissance visit to the regions of interest and collecting GPS and generic site data. Then the siting criteria was developed using IAEA guidelines. Regional analysis was performed to establish the regions of interest and later potential sites were identified within the regions of interest. The identified sites were evaluated against the requirements and ranked to identify the preferred and alternate sites.

Once identified, the land acquisition process was commenced after which preliminary and detailed site characterization should be conducted, sites licensed and construction of the nuclear power plant started.

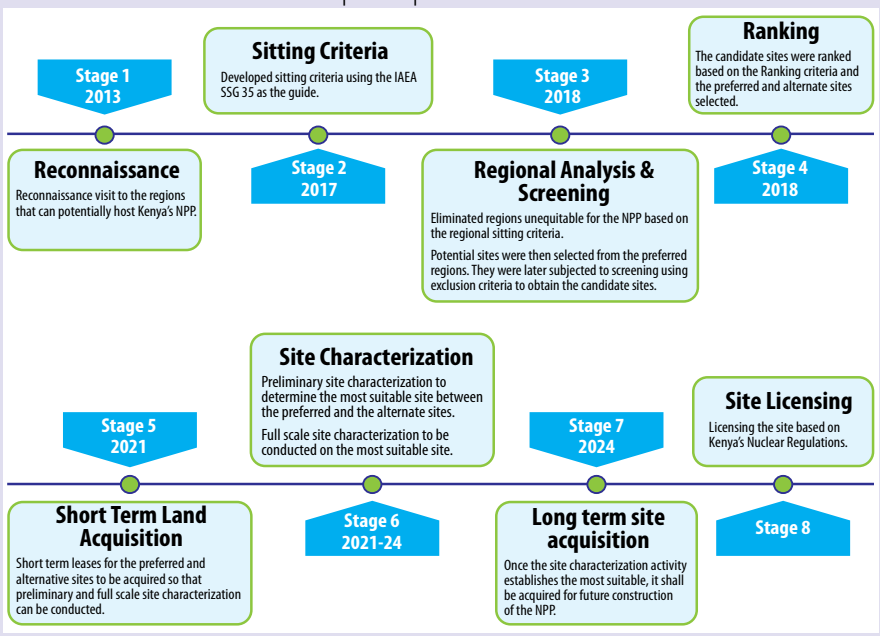


Figure 1 : Site selection roadmap

The "Criteria for Siting of Nuclear Power Plants in Kenya" was developed to govern the siting of nuclear power plants in Kenya and a Siting Guideline document containing the topics for field investigations. Subsequently, fieldwork activities along the Kenyan Coast and Lake Victoria region were conducted.

Later, ranking of the candidate sites was done. To achieve this, a multi-criteria decision-making technique using the Analytical Hierarchy Process (AHP) was used. AHP uses a multi-level hierarchical structure of objectives, criteria, sub criteria, and alternatives, to arrive at the most optimal site available. A total of eight (8) sites along the Kenyan Coast and sixteen (16) sites in the Lake Victoria region were ranked.

On preliminary selection of potential sites, the activities carried out included a detailed literature review, desktop research, reconnaissance visit and formation of the site selection team.

Data was collected from existing resources that include population, drainage, geology, seismology and tectonics, faults, environment, transport infrastructure. It was then collated and analyzed using a GIS platform. ArcGIS 10.6 and Google Earth were effective tools for viewing the characteristic factors of geomorphology, environment, and terrain of the areas of interest. In addition, satellite imagery was also used for interpretation and for navigation. The other tool used included Population Explorer Beta for population approximations. Broadly, three regions were identified namely the Coastal, Lake Victoria and Lake Turkana regions from which tentative potential sites were selected.

In evaluating the potential sites, the main tasks were identification of key parameters for an NPP used for the development of site selection criteria, fieldwork, data compilation, analysis and evaluation.

The factors considered were: (a) The man-made or natural factors occurring

outside the geographical region of the site under consideration with the potential to impact the nuclear power plant (b) Environmental and features (characteristics) with the potential to influence the transfer of radioactive material to the environment and human beings and (c) Population parameters, either demography or distribution, and any other factors that could impact the implementation of emergency measures to both individuals and population in its entirety.

The potential sites in Kenya were subsequently subjected to further screening using exclusionary criteria like capable faults, volcanic hazards and feasibility of implementation of an emergency plan.

The sites were then ranked using the Analytical Hierarchy Process (AHP) to obtain the Preferred and Alternate Candidate Site for each of the three regions based on a set of key parameters. These are: faulting, human induced events, electric grid accessibility, population characteristics, environmental issues, flooding, transport infrastructure and nuclear security.

Results

Sites at the coast and L. Victoria region were ranked and preferred and alternate sites from the regions selected.

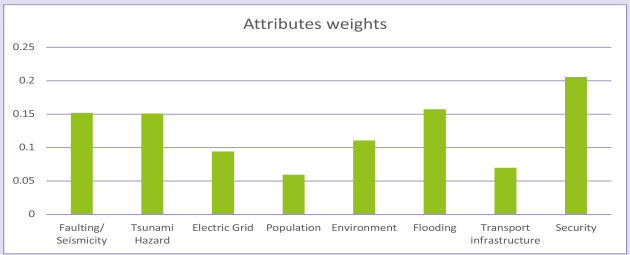


Fig. 2. Weights of the siting attributes.

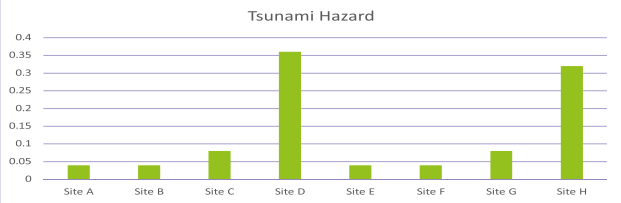


Fig. 3. Coast site rankings based on their susceptibility to tsunamis.

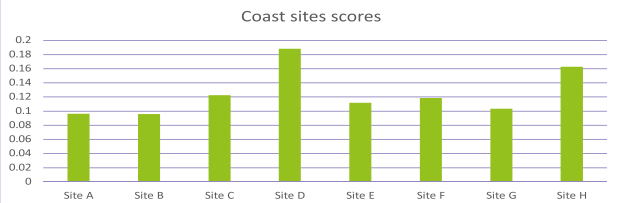


Fig. 4. Overall Coast site rankings.

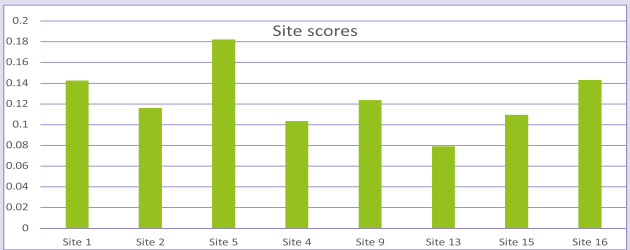


Fig. 5. Overall L. Victoria site rankings.

Discussion

The analysis was based on four critical factors: risk to safety in case of an event, cost of mitigation, cost of remediation, and socioeconomic impact. In order to evaluate these critical factors, a number of parameters were identified and prioritized based on their impact on the four critical factors.

> The parameters used for ranking were: faulting/ seismicity, tsunami hazard, electric grid, population density, environment, flooding, transport infrastructure and security. Out of these eight parameters, four were observed to be the key attributes because they were assigned a greater weight: security (20.55%), flooding (15.73%) seismicity/faulting (15.21%) and tsunami hazard (15.07%).

In the Coast region of Kenya, Site D had the highest score mainly attributed to its excellent performance with regards to tsunami hazard, flooding, electric grid and transport infrastructure. Site H emerged second because of its excellent performance with regards to seismicity/ faulting and transport infrastructure.

In the Lake Victoria region, Site 5 had the highest score attributed mainly to its excellent performance with regards to tsunami hazard, population and seismicity/faulting. Site 16 emerged second due to its high score in environment, security and flooding

Conclusions

The analysis of potential sites for nuclear power plants in Kenya was based on four principles: risk to safety in case of an event, cost of mitigation, cost of remediation and socio-economic impact.

Adopting such a process in selecting suitable sites for energy projects (power plants, substations, transmission lines et cetera) will ensure: -

1. Safe commissioning, operation and decommissioning of the energy installations,
2. Minimize conflict and improve project acceptance by the stakeholders and more specifically the project affected persons (PAPs),
3. Guarantee project affordability by ensuring money that could be invested in paying and/or relocating PAPs and cater for engineering solutions can be saved.

This project was executed by a team of Electrical, Civil and Mechanical engineers, geologists, hydrologists, environmental scientists and anthropologists and based on its success; engineers should develop synergies with other professionals for the global good.

Eng. Nduma Ruwah is an Electrical Engineer at NuPEA, Eng. Erick Ohaga is an Electrical Engineer and President of the Institution of Engineers of Kenya (IEK). He is the Director of Nuclear Infrastructure at Nuclear Power and Energy Agency. Geologists Kenneth Anakoli and Emmanuel Mulehane work at Nuclear Power and Energy Agency. jnduma@nuclear.co.ke

Atlas Copco

8 Benefits of Going Green

In a world that is increasingly environmentally conscious, consumers want to spend their hard-earned money on products that will not harm the planet and are made by companies that are doing their part.

However, not all businesses are ready to embrace the need for "going green." One reason is that many executives still believe that green investments are prohibitively expensive. Nothing could be further from reality.

In many cases, the return on investment of environment-friendly technology is excellent. While the initial purchase price may be higher, this equipment will quickly pay for itself through energy savings, visible on the electricity bill. On a very small scale, think of traditional lightbulbs and the more expensive LED lights. Sure, the latter is more expensive but they outlast their predecessors by years and consume much less energy.

The same is true for many other green investments – on a much larger scale.

But going green has many benefits apart from the return on investment (ROI). Here are just a few.

1. Energy savings are a major economic benefit.

In the case of an air compressor, for example, electricity costs make up 80% of the total cost of ownership. As a result, an energy-efficient model will quickly pay for itself.

2. Tax credits and other benefits.

Many governments now offer tax credits and other benefits for purchasing environment-friendly technology, which speeds up ROI even more. This is especially true now that many countries have committed to meeting ambitious emissions goals in the near future.

And because the industrial sector greatly contributes to an economy's total energy consumption, offering these tax credits to manufacturers makes a lot of sense. But Governments not only try to meet their emissions targets through incentives but also through more stringent regulations.

3. Tighter government emission standards.

Hoping to meet their climate change goals, governments are increasingly putting in place regulations to reduce pollution and promote efficiency. As a result, companies purchasing outdated equipment now may soon find themselves on the wrong side of tighter emission standards. Only investments in cutting-edge, green technology can ensure that machinery will be in compliance with new environmental rules for a long time to come.

4. Going green is the right thing to do.

The overwhelming majority of scientists, and study after study, tell us that the planet is warming at a rate that will radically change how humans live on it. In fact, natural disasters like droughts, wildfires, floods, and storms are already gaining in strength. That's why it is easy to see why people want the companies they buy from to be part of the solution and not part of the problem. Green investments are one way to show consumers that your business shares their values and is determined to play its part in preserving habitable earth. That does not just help the planet.

5. Attracting customers and building brand loyalty.

Research and polling have shown that customers increasingly value companies that help protect the environment. In the age of social media, this is especially important. Businesses do not want to be branded as polluters or as dragging their feet on switching to green technologies. Always keep in mind that nobody has been boycotted yet for consuming too little energy or being too green.

6. Becoming an attractive employer.

Your green investments could also end up being an investment in the next generation of skilled employees. Young people are especially concerned about the environment. That makes sense because, unless drastic actions are taken, they will feel the negative consequences that will be the result of a changing climate. If you were a bright, well-educated, and/or well-trained person looking to enter the workforce or taking the next step on the career ladder, wouldn't you prefer to work for a company that is seen as an industry leader when it comes to being environment-friendly?

7. Increasing job satisfaction.

Your commitment to "going green" – from using recycled products to planting trees, from subsidizing public transportation to making green investments – will increase the job satisfaction of environment-conscious employees and help you retain your best workers.

8. Going green means improved occupational safety and health, for example by providing cleaner air at work. That, in turn, means fewer sick days and a healthier, more energetic staff. As you can see, from direct financial benefits to marketing considerations and staff recruitment and retention, green investment is not just a smart investment in the present but also in the future

Opportunities Available in Liquified Natural Gas Clean Energy

By Eng. Roselane Jilo & Eng. Gilbert Nduguyu

1. Assessment of Fossil Energy

FOSSIL energy sources are defined as hydrocarbon deposits formed in the geological past from the remains of living organisms.

Heavy fuel oil (HFO) or residual oil is a fraction at the lower end of the fractioning column obtained during the distillation process in the crude oil refinery. As a residual product, it is of low quality compared to most petroleum products. High viscosities require pre-heating for transport. HFO also includes a high share of impurities, such as water, soil and sulphur depending on the crude oil. It is mostly used as a relatively cheap but still liquid fuel for power generation and shipping. Its use causes higher environmental pollution compared to other fuels. For every fraction, various kinds of HFO exist distinguished by their viscosity and net calorific value. HFO is mainly used in diesel power plants at the Coast and Nairobi while the remaining proportion is used for industrial production. At present all HFO is imported through Mombasa port and thereafter transported by road to the power plant locations. It is currently not recommended as suitable fuel option due to its negative environmental impact.

Gasoil and kerosene are fractions at the middle of the fractioning column of the distillation process. Various kinds of gasoil are also distinguished by their viscosity and net calorific value. Gasoil and kerosene are at the upper end of the cost range of generation fuels. Kerosene is used in households (e.g. for lighting and generators), it powers jet engines of aircrafts, but also gas turbines in power stations. The transport sector accounts for the largest share of the total gasoil consumption in Kenya. The remaining share of gasoil consumption is typically used for power generation in large isolated grids. For power generation in Kenya, kerosene is used in gas turbines such as for the thermal Muhoroni power plant. Gasoil and kerosene are recommended fuel options for backup and peaking capacity plants.

Natural gas is a gaseous fossil fuel consisting of a mixture of hydrocarbons, primarily methane found in and extracted from geological formations beneath the earth's surface. It can be distinguished by its composition and by the extraction technology required by the geological formation. Beside the natural gas extracted from gas fields, there is also associated gas or flare gas. This gas is produced during the crude oil extraction process and is often flared. It generally shows a different composition than free gas. As relatively new gas types, unconventional gas resources are currently being developed such as shale gas or coal-bed methane trapped within shale and coal formations. Natural gas has been the third important energy source in the world measured by energy content, behind crude oil and coal2. Its share has continuously been increasing.

2. Energy Use in Kenya

The energy sector in Kenya is largely dominated by petroleum and electricity (mainly produced from fossil fuels and hydro), with wood fuel supplying the basic energy needs of the rural communities, the urban poor, and the informal sector: wood fuel and other biomass account for 68% of the total energy consumption , petroleum 22%, electricity 9%)(about a third based on the fossil fuels heavy fuel oil (HFO) and gasoil products, the remaining based on renewable energy sources), others 1%.

The sectors that consume energy are households, industry, public facilities, and transport. The energy sector is a substantial part of Kenyan society. The sector provides direct and indirect employment to an estimated 16,000 people. The total population of Kenya was estimated to be 47.6 million people in 2019 (National Council of population and development), of which the rural population was about 75%. `

3. Liquified Natural Gas

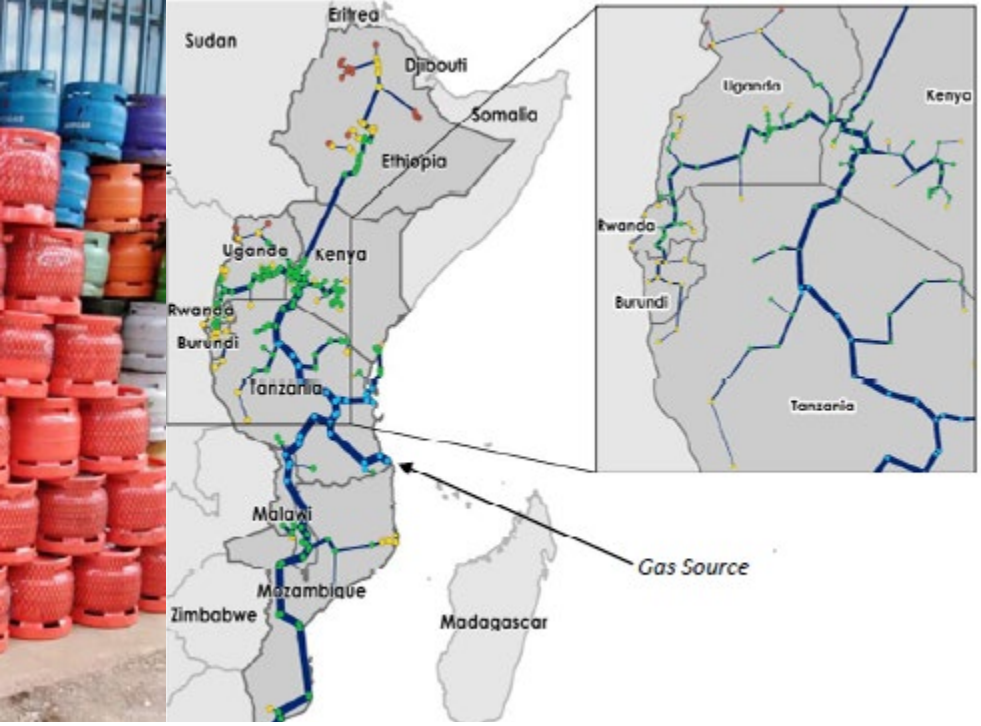
Liquified natural gas value chain comprises (1) Exploration and Production, (2) Liquefaction, (3) Shipping, and (4) Storage and Regasification. The natural gas is liquefied at the country of origin, transported by special LNG ships to the port of destination, re-gasified in LNG terminals and then transported to consumers through pipelines. Supply of natural gas is limited by the available transport infrastructure. The use of liquefied natural gas (LNG) is a relatively new option for large-scale power generation. The logistics facilities make up a considerable part of the overall LNG costs.

Due to the vast resources of natural gas worldwide, the potential for LNG is large in theory. It is restricted by required liquefaction and regasification facilities as well as competing demand on the world market. For Kenya, the prospects of discovering natural gas deposits has encouraged the government to explore opportunities for developing the domestic resource instead of importing. LNG is recommended as an alternative fuel option to allow for the diversification of fuels used in power generation and its environmental advantage compared to more harmful fossil fuels. The use of LNG would also provide economic benefits for other consumers, such as industries, households and transport sector.

4. Kenyas Opportunities for LNG Investments

4.1 LNG Gas Transmission Pipeline to Kenya

According to potential for regional use of East Africa's natural gas by sustainable development solution network, a global initiative of the United nations, trunk gas pipeline network originating in Tanzania and Mozambique and spanning from Ethiopia to South Africa could become a backbone of a regional clean energy



system. Discoveries of Natural gas have been made in Mozambique and Tanzania (Ledesma 2013). Baseline Modelling of transmission pipeline was done for LNG gas supply to eight African countries as per fig 1 below.

Fig. 1. Proposed LNG transmission pipeline to serve eight African Countries (Sustainable Development Solutions Network, 2014)

During the East African Petroleum Conference in May 2019 held in Mombasa Kenya, the Tanzanian Ambassador to Kenya invited Kenya for provision of technical expertise in the exploration and installation of LNG Infrastructure. Kenya's experience in operation of oil and gas infrastructure was a preferred country due the local content factor, mutual agreements and East Africa economic block.

In March 2020, the Kenya and Tanzania government agreed to construct a 600 KM Pipeline from Songo Songo Island in Dares-salaam to Mombasa at a cost of $1.1bn.

4.2 Floating Storage and Regasification Unit (FSRU)

In line with the Kenyan Government's environmental ambition, M/s Great Lakes Energy Africa Ltd proposes to introduce LNG into Kenya by using an FSRU (Floating Storage and Regasification Unit) at the Port of Mombasa for storage and regasification of the LNG (Highlights 61/2015). The proposed FSRU will be located within the Port of Mombasa, the largest port in Kenya and a regional hub for international trade. The Port of Mombasa serves East and Central Africa with imports and exports.

The proposed FSRU is a conversion of a standard LNG Carrier and is of standard size: it has a tank storage capacity of about 160,000m^3. The FSRU is equipped with regasification and can therefore supply either LNG or natural gas to shore. Regasification is the process of converting LNG gas from its liquid state to a gaseous state. Seawater is generally used for the regasification process, as would be the case in Mombasa. LNG or gas would be supplied from the FSRU either by pipeline or truck. Fig 2 below is schematic of the LNG transfer from a ship vessel to FSRU

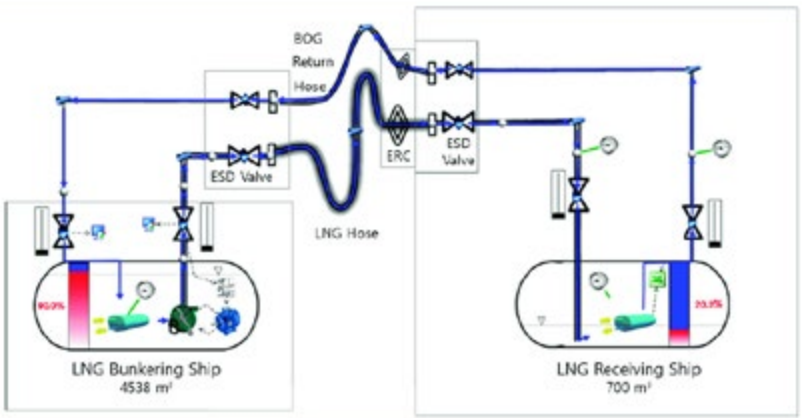


Fig. 2 schematic of the LNG transfer from a ship vessel to FSRU

(Sustainable Development Solutions Network, 2014)

4.3 Power plants

The national ambition of increasing electrification in Kenya includes plans to build a large number of additional power plants during the next 10-15 years. These power plants, in addition to existing plants, may well run on LNG if this is introduced into the country. For the power plants that are located a long distance from the port of Mombasa, and from the FSRU, for example in the Nairobi area, fuel will be delivered to the power plant by truck. The fuel will be LNG, in order to minimise the volumes transported. These power plants will therefore need to develop storage tanks for LNG. Only the power plants in the port area, the existing Kipevu power plants or future newly built plants will allow delivery of fuel via a pipeline. The delivery will consist of natural gas, and storage of LNG is therefore not needed for the power plants in the port.

5. Conclusion

The primary objective of the introduction of LNG into Kenya is to use it as fuel for producing electricity. Other uses include as a fuel for cooking, as a fuel for transport industry and fertilizer production, However, the environmental benefits of LNG are notable. LNG used as a fuel for industrial use has the same environmental benefits as with electricity production. The targeted sectors are those with significant levels of energy consumption, mainly tea production, or as fuel for maritime transports.

Shift to use of LNG in place of other fossil fuels like HFO and diesel Kenya will be aligning to climate change initiatives

6. Recommendations

Kenya should take advantage of large deposits of LNG in the neighboring Tanzania, make use of the Pipeline expertise and put up a pipeline from Songo Songo Island approximately 600 KM to Mombasa. With this move, there will be a process to reduce reliance on diesel and HFO power plants to LNG plants considering that by the year 2040, the technologies supporting use of these fossil fuels will be phased out by first world countries

Once sufficient, LNG is piped into the country the government should enforce the use of LNG in the place of HFO in heavy industrial plants among others. Future consideration for use of LNG to include domestic use, fertilizer production in readiness for automobile industry.

Development, Maintenance and Management of Water Works Critical for Economic Growth

Fredrick Tito Mwamati (P.Eng.Tech) Chief Executive Officer, Tanathi Water Works Development Agency.

Tanathi Water Works Development Agency (TAWWDA) is one of the Nine (9) Water Works Development Agencies in Kenya. The Agency serves Kitui, Makueni, Machakos and Kajiado Counties.

TAWWDA is mandated to undertake the development, maintenance and management of national public water works within the area of jurisdiction.

The Agency is also mandated to operate the water works and provide water services as a water provider, until such a time as a responsibility for the operation and management of the water works are handed over to a County Government, Joint Committee, Authority of County Government or water services provider within whose area of jurisdiction or supply the water works is located.

TAWWDA also provides reserve capacity for purposes of providing water services where pursuant to section 103 of the Water Act 2016, the Regulatory Board orders the transfer of water services functions from a defaulting water services provider to another licensee; provide technical services and capacity building to such County Governments and water services providers within its areas as may be requested, and provide to the Cabinet Secretary with technical support in the discharge of his or her functions under the Constitution of Kenya and the Water Act 2016.

Some of the milestones and accomplishments over time that remains vital to us include the design of Thwake Multi-Purpose Dam, Construction of Masinga-Kitui Water Supply and Sanitation Project, Rehabilitation of Yatta Canal and over 200 community water schemes including schools and health centres. One capital project recently completed by the Agency is Mavoko Water Supply Project.

We also recognize the foresight shown by HE President Uhuru Kenyatta's national government led efforts through the Ministry of Water, Sanitation and Irrigation in providing for the resources we have to serve our customers today.

Currently, there are a number of challenges facing the Agency. These include meeting increasingly strict water quality regulations, meeting water demands of a growing community, finding ways to make better use of existing water resources through storage and water conservation, exploring new water resources, maintaining a skilled and motivated staff, determining groundwater use in the counties within our area of jurisdiction, maintenance of high standards of waste water collection and disposal and maintaining a healthy and flexible organization to meet future challenges. The Board of Directors, management, and staff have developed a Strategic Plan to provide a roadmap for meeting these challenges.

Water remains an important resource to our dear country. As an Agency, we are taking every step to ensure we develop projects that resonate with the challenges facing our nation. Resolving challenges facing this sector will help to prepare adequately while anticipating problems that are likely to occur in the future.

Finally, I take this opportunity to immensely thank the Institution of Engineers of Kenya and other stakeholders for their support in knowledge sharing and capacity building. We celebrate the good industrial working relationships within the professional engineering fraternity.

Thank you.

Mavoko Drinking Water Supply Project

Mavoko water supply project is located at Mavoko Municipality in Machakos County and is expected to expand and increase water services in Mlolongo, Syokimau, Athi River towns and adjacent areas. Mavoko area has the highest industrialization potential in the country especially in Athi River due to vast land currently under ranches which is gradually changing use to industrial and commercial. The population has also increased tremendously due to massive investment in residential developments.

The project (EPC) was funded by the Government of Kenya and the Belfius Bank of Belgium through the Ministry of Water, Sanitation and Irrigation at a total cost of Kshs 2.5 billion. ASPAC Intl (sprl) was awarded the Contract for the Design and Construction works and completed the project in March 2021.

The major project Components is as follows:

- Construction of 12,000m^3 water treatment plant
- Desilting of KMCC Dam and construction of new intake to produce 8,000m^3/day of water
- Desilting of EAPCC Dam and construction of new intake to produce 3,000m^3/day of water
- Installation of 1No pump and rehabilitation of 1No pump at Salama Pump station to produce 1,000m^3/day of water from Nolturesh
- Construction of 13km Nairobi pipeline to supply 5000m^3/day of water from Nairobi City Water and Sewerage Company (NCWSC)
- Construction of 4500m^3 reservoir tank at Syokimau
- Rehabilitation of 3500m^3 Lukenya RC Tank
- Capacity Building for Mavoko Water and Sewerage Company (Mavwasco)

The project main achievement is the increase of service delivery from 3hours to 24 hours by increasing the treated water supply from 3,000m^3/day to 12,000m^3/day. The existing connections are 9,500. The project targets 500,000 people which is a mix of Domestic, Commercial, Institutional and Industrial. Several upcoming housing projects and the Kenya Meat Commission have already been connected. The Agency intends to extend pipelines to also serve Kinanie Leather Industrial Park with a supply of atleast 2000m^3/day.

Project site visit by the former CS Sicily Kariuki and Water secretary Eng S.O Alima

Intake works (3000m^3/day) at Mbagathi River (EAPCC Dam)

Sludge drying bed at the Water Treatment Plant

Flocculation basin and sedimentation tanks of the 12,000m³/day WTP

12,000m³/ day Water Treatment Plant

Backwash Pump House

2500m³ RC Clear Water Tank

Chemical Building

4500m³ RC tank and 300m³ Steel elevated tank at Syokimau. Pump House (2No 200m³/hr pumps)

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Oppo Redefines Phone Technology Experience With The New Reno 7 Series

FOR the first time in Africa, OPPO unveils the newest addition to its Reno series; OPPO Reno7 Series in Nairobi, Kenya. The Reno 7 is powered by the world's first ultra-sensing selfie IMX709 sensor manufactured by Sony and designed by OPPO. This guarantees sharper clearer and brighter unlimited selfie portrait images. The rear triple camera set up provides a 64MP AI triple camera, a 2MP Depth Camera and a 2MP Micro lens with 15x to 30x magnification.

Leveraging this flagship-level hardware, The Reno7 comes packed with impressive imaging features including Bokeh Flare Portrait, Selfie HDR, AI Portrait Enhancement, and many others so that users can capture the world in stunning, professional-quality portraits.

To create the colour and texture of the **Sunset Orange** Reno 7, OPPO makes use of its own Fiberglass-Leather design, bringing an entirely new tactile sensation to the Reno series in the process. This texture is combined with a bright orange colour tone to make Sunset Orange a sophisticated choice in style. Lively, bright, and extravagant, and at the same time suitable for both men and women, the passionate Sunset Orange makes the phone instantly recognizable while creating a premium feel with its leather texture.

The Reno 7's other eye-catching colour finish; **Cosmic Black**, makes use of the iconic OPPO Glow effect to create a back cover that is glossy in appearance with a fingerprint-resistant matte texture. The classic Cosmic Black model presents an immersive pondering black that is simple and pure in its design to which creates a mesmerizing appearance as vast as the universe. Also on the phone's back cover, the spliced design of the camera module uplifts the premium appearance of entire device, drawing eyes towards the high-tech camera module.

The inclusion of the Micro lens on the OPPO Reno7 involves more than simply making room for an additional lens on the phone. At the structural level, OPPO has made the decision to install the Micro lens module on the back cover of the phone, rather than directly mounting it on the motherboard. As the short focal length of the Micro lens requires the phone to be placed very close to the objects being photographed, OPPO has also added a new Orbit Light underneath the Micro lens to provide additional illumination while the Micro lens is enabled.

Reno7 5G has been created by the innovative use of Laser Direct Imaging (LDI) manufacturing process on the exterior of a smartphone. The use of LDI technology is the first time LDI has ever been applied to the exterior design of a mobile device. It is also the first time that OPPO itself has used laser engraving technology to perform additional precision processing on top of the OPPO Glow layer. OPPO has applied LDI processing to draw 1.2 million micro-rasters, and each raster has been created with a precision of just 20 microns. This creates a visual and textural illusion of shooting stars streaming across the device that shine and fade into the black galaxy as the phone is held in the hand.

OPPO will be announcing the specs, and other details about the features of the upcoming phone in its much-anticipated virtual launch. In the launch OPPO will be unveiling the Reno 7 with well-known celebrities; Bahati, Diana Marua and Wabosha Maxine to showcase its vast features and extensive capabilities.

The OPPO Reno 7 will be available in Kenya in Sunset Orange and Cosmic Black in all OPPO and Safaricom stores in Kenya. It will also be available for online purchase through Jumia, Kilimall and SkyGarden. Available versions will include the 6GB RAM + 128 GB ROM, the 8GB RAM+128GB ROM at and lastly, the 8GB RAM + 256GB ROM (available in 4G and 5G versions) will be priced at KSH 42,999 (4G) and KSH 59,999 (5G). Pre-orders for the OPPO Reno 7 will start on 25th April 2021 as the first official sales will start on May 5th.

Oppo is a leading global smart device brand. Since the launch of its first mobile phone 'smiley face' in 2008, OPPO has been in relentless pursuit of the perfect synergy of aesthetic satisfaction and innovative technology. Today, OPPO provides a wide range of smart devices spearheaded by the find X and Reno series. Beyond devices, OPPO also provides its users with ColorOS operating system and internet services such as OPPO Cloud and OPPO+. OPPO has footprints in more than 50 countries and regions, with more than 40,000 employees dedicated to creating a better life for customers around the world. For more information, please visit OPPO Official Site; ***https://www.oppo.com/en/.***

Evaluation of the Effectiveness of Power Plans in Kenya

By James Mutinda Peter, Eng. Erick Ohaga, Joseph Nduma Ruwah & John Mwangi Muigai

Introduction

ENERGY planning is the projection of how the power system should grow over a specific period of time, given certain assumptions and loads projection and the investment in generating capacity additions and transmission facilities expansion and reinforcements. Energy planning seeks to address the energy trilemma i.e. supply power balancing on energy security, economic competitiveness and environmental considerations. However, the plans can become technically and economically obsolete due to new inventions in electrical utilization equipment or unforeseen industrial, commercial, or residential projects.

In this regard, a key focus is necessary for the development of the integrated energy plan to ensure that it's realistic, accurate, and implementable for the provision of least-cost power for the country. Additionally, a precise implementation of these energy plans will be consequential in the achievement of the country's development goals. Kenya is considering the introduction of nuclear power in the energy mix which requires a proper electrical grid system planning to avoid events that might challenge the safety of the plant, hence the need to get it right the first time. Therefore, it is paramount to ensure that our energy plans are foolproof, realistic, and implementable. The figure below illustrates the power planning process used to generate the country's power plans.

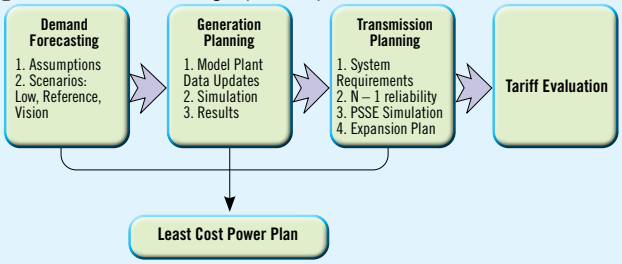

Figure 1 : Power Planning Process

Methodology

The study process involved the collection of data on generation planning projections for the years 2011, 2013, 2015,2017, and 2020. The data obtained was then analyzed to check the accuracy of the power plans. After graphing of the data obtained, the trends were observed to compare with the actual installed generation capacities. Afterwards, conclusions and recommendations were drawn from the results.

Results

3.1 Generation Plans

Power plans obtained (for the years 2011, 2013, 2015, 2017 and 2020) were tabulated below for comparisons. These trends are also depicted in the graphs. From the data obtained the generation capacity is expected to increase over the planning periods for the different plans.

Table 1 : Power Plans (Source LCPDP Reports)

	Total Installed Capacity (MW)				
Year	2011 Power Plan	2013 Power Plan	2015 Power Plan	2017 Power Plan	2020 Power Plan
2011	**1,363**				
2012	1503				
2013	1,532	**1,805**			
2014	2,000	2,228			
2015	2,888	2,528	2213		
2016	3,168	2,493	2,205		
2017	3,868	3,844	2,332	**2,235**	
2018	4,373	4,304	2,496	2,381	
2019	5,113	4,488	3,446	3,237	**2,694**
2020	5,611	5,008	3,570	3,744	2,869
2021	6,451	5,608	3,983	3,848	3,315
2022	7,237	6,548	4,333	4,421	3,856
2023	8,237	7,468	4,622	4,457	4,696
2024	8,857	8,388	4,597	4,537	5,094
2025	9,977	9,428	4,846	4,794	5,793
2026	11,118	10,588	5,168	5,337	6,277
2027	13,138	11,656	5,475	5,584	7,465
2028	13,758	13,266	6,028	6,137	7,491
2029	15,410	15,241	6,303	6,876	7,422
2030	17,220	17,261	6,840	7,368	7,366
2031	19,220	19,561	7,277	7,878	7,255
2032	21,620	22,086	7,764	8,280	7,287
2033		24,673	8,301	8,900	7,319
2034			8,882	9,073	7,131
2035			9,521	9,644	7,005
2036				10,043	7,037
2037				10,490	7,069
2038					6,751
2039					6,441
2040					8186

Table 2 : Comparison of Power Plans to Actual Installed Capacity.

	Total Installed Capacity (MW)				
Year	2011 Power Plan	2013 Power Plan	2015 Power Plan	2017 Power Plan	2020 Power Plan
2011	**1,363**				
2012	1,503				
2013	1,532	**1,805**			
2014	2,000	2,228			
2015	2,888	2,528	**2213**		
2016	3,168	2,493	2,205		
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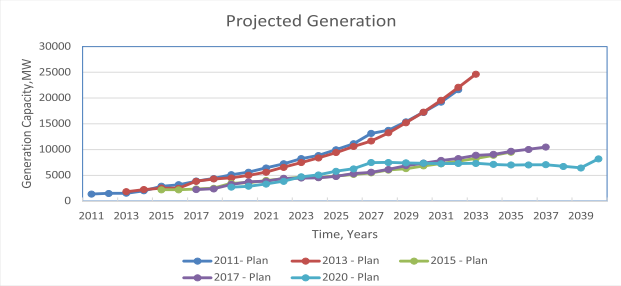

Figure 3 : Projected Installed Capacity

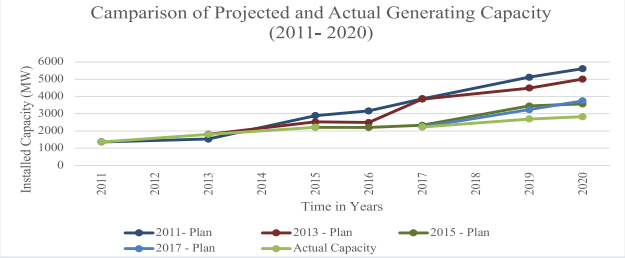

Figure 4 : Comparison of Generations Plans to Actual Capacity, 2011-2020

Discussion

An analysis of the planned generation capacity increase shows that there was a consistency of 2011 and 2013 least-cost power development plans. According to these plans, a high increase in generation capacity was projected. The 2011 and 2013 LCPDP plans were very optimistic with projections of a large increases in the total generation capacity. On the contrary, the 2015 and 2017 generation plans were pessimistic as the planned increase in generating capacity is minimal over the planning periods.

According to the 2020 least-cost power development plans, the total installed generation capacity is expected to increase moderately up to the year 2027, with a decrease for the remaining years of the 2020- 2040 planning period. The 2011 and 2013 LCPDP plans appear to be consistent with each other, but detailed scrutiny shows that these plans contradict each other in some years. For example, for the years 2020-2028 in these energy plans, a mismatch of between 500 - 1000MW exists. Such a mismatch is huge as is equivalent to 20-30% of the grid capacity. From the 2015 and 2017 energy plans, consistency in trend is noticed but with a great mismatch in installed capacity for a number of years. For instance, the mismatch between the years 2028-2033 ranges from 500-600MW which is large compared to the installed generation capacity.

A comparison of the actual installed generating capacity and each individual power plan equally shows recognizable inconsistencies as shown in fig 4. The actual installed capacity is below all the plans for most years of the planning periods. The 2011 and 2013 power plans are off by approximately 2000-3000MW. The mismatch for the years 2017-2020 ranges from 2000 - 3000MW signaling errors in either the planning process or project implementation. For the 2015 and 2017 LCPDP plans, the projection is closer to the actual installed capacities but off by at least 500MW. Compared to the size of the Kenyan grid, this difference is equally high as it accounts for approximately 15 - 20% of the grid capacity. In conclusion, the plans for 2011, 2013, 2015, and 2017 predict higher installed capacities than the actual generation. This clear contradiction of the energy plans for the planning periods warrants an explanation as the plans generated are expected to be accurate and consistent.

Conclusions

The analysis of 2011, 2013, 2015, 2017, and the 2020 LCPDP, shows that the output of the planners was not consistent. These inconsistencies can be attributed to either a poor planning process, a delayed implementation of power projects, or delayed implementation of flagship projects.

From an analysis of the planning process, the projection in demand growth is optimistic as the GDP growth rate used is above the historical averages. For all the power plans in consideration, the GDP growth rate is higher than the historical average of 5.3% for the years 2010 - 2019. It's worth noting that these optimistic demand projections were carried over to the generation and transmission expansion plans. To be precise, the low scenario projection is realistic as it uses a GDP growth rate close to the actual growth rate. However, the delayed implementation of vision 2030 flagship projects such as the electrification of standard gauge railway, smart cities, etc. could also be the reason for these inconsistencies.

Table 3 : Projected GDP Growth rates [2,3,4,5,6]

Energy Plan	Year	Reference Scenario	Historical Growth Rate
2011 - 2031	2010	4.50%	
	2011	5.20%	
	2012	5.90%	
	2013	6.60%	5.9%
	2014	7.30%	5.3%
	2015 Onwards	8.00%	5.7%
	2016		5.8%
	2017		4.9%
	2018		6.3%
	2019		5.4%
2013 - 2033		10%	
2015 - 2035	2015 - 2035	7.3%	
2017 - 2037	2017 - 2037	6.70%	
2020 - 2040	2020 - 2040	4.84%	

Figure 5: Comparison of LCPDP Growth rate to Historical Average

In the event that the power plans are implemented, with GDP growing at the normal rate, the generation will surpass the demand resulting to excess capacity, more capacity charges and higher power tariffs. A high cost of power would eventually slow down the country's economic growth.

From the findings of this paper, it's recommended that the energy planners should use GDP growth rates as realistic as possible, the Ministry of Industrialization Trade and Enterprise Development to revamp its efforts in fostering industrialization, for demand growth.

James Mutinda Peter, Eng. Erick Ohaga, Joseph Nduma Ruwah & John Mwangi Muigai Work at Nuclear Power and Energy Agency. Their contact is jmutinda@nuclear.co.ke.

WORLD ENGINEERING DAY FOR SUSTAINABLE DEVELOPMENT

4th March, 2022

IEK Celebrates 2022 World Engineering Day in Style

By EiK Correspondent

THE Institution of Engineers of Kenya recently joined the global community in marking a wonderful day, set aside annually, to celebrate Engineers, Engineering as a profession and the contribution of the science to development of humanity and mankind.

The United Nations Educational, Scientific, and Cultural Organization (UNESCO), which supports engineering through the Natural Science Division, acknowledges engineering as the most significant means of achieving sustainable development through the enhancement of capacity building, gender equality as well as safeguarding World Heritage.

It's Executive Board meeting held in April 2019 unanimously endorsed proclaiming the 4th day of March of every year as the World Engineering Day (WED) as recommended by the World Federation of Engineering Organizations (WFEO).

> This year's theme was "Build Back Wiser – Engineering the Future". The Institution of Engineers of Kenya in collaboration with the Engineers Board of Kenya annually holds celebrations to mark World Engineering Day in Kenya. This year, celebrations were held at the University of Nairobi Chandaria Hall, where over 437 Engineers attended physically and 1225 virtually.

The Cabinet Secretary Ministry of Transport, Infrastructure, Housing, Urban Development and Public Works, James Macharia, EGH was the Chief Guest. He was represented by Eng. James Kungu, the Chief Engineer Roads, State Department of Infrastructure.

He stated that the ministry was not indifferent to the problems of the profession and was aware of the urgent need to implement better schemes of service for engineers, and was pushing to have bigger budget allocations to infrastructure development and innovative financing models particularly in the area of housing, energy and water supply.

He further urged IEK and EBK to look into issues pertaining to the training and accreditation of Engineers. "We cannot continue to have a standoff on an issue that affects the future of our engineering students. It is like shooting ourselves in the foot. The Ministry of Education therefore needs to urgently work with us and the Commission of University Education on the modalities to resolve this impasse," he reiterated, in reference to accreditation of engineering courses in local universities.

Engineers Board of Kenya Chairman Eng. Erastus Mwongera in his address noted that while there have been challenges posed by the COVID-19 pandemic, there has been some great achievements on the engineering front.

"The construction industry grew by 16.2%, GDP from construction in Kenya is estimated to reach Kshs. 159,682 million in 2023. There has been an upward trajectory in infrastructure development with the construction of 10,500KM of tarmacked roads in the last 8 years," said Eng. Mwongera.

He noted that the installation of 2,600 Megawatts in the last 8 years to add to 1,300 Megawatts that existed before is a great step forward, and that the connection of an extra 6.3 million households to the National Grid from the 2.3 million households in 2013, ranking Kenya 1st in Africa, will go a long way towards supporting energy needs of the country.

Prof. Dr. Gong Ke, President WFEO who made a virtual address said "To build back wiser, the foremost consideration is to leverage science, technology and engineering in a more open, innovative and responsible way. For all engineering practitioners, it is required to better master the necessary knowledge and skills for promoting sustainable development, especially to make use of digital technologies such as Big Data, Artificial Intelligence and Internet of Things to meet the pressing global challenges," he reiterated.

The Institution of Engineers of Kenya also marked its 50th Anniversary of IEK and the day was commemorated alongside the WED Celebrations.

The IEK Editorial Board mandated to oversee the production of the Engineering in Kenya Magazine presented the magazine's annual report. The day also marked the magazine's 1st anniversary having been launched during the World Engineering Day celebrations in 2021.
The day culminated in the launch of the 2nd IEK Career week by Eng. Grace Muthoni Kagondu. Through the Capacity Building and Mentorship Committee, The Career Week holds forums for knowledge sharing that not only prepare students for transition into the Engineering workforce but also provide the necessary mentorship for career planning.

The five-day event was tailored to accommodate the different disciplines, bringing together over 1000 Engineering students from the University of Nairobi, Technical University of Mombasa, Kenyatta University, Jomo Kenyatta University of Agriculture and Technology, Moi University, Dedan Kimathi University of Technology, Technical university of Kenya, and Masinde Muliro University of Science and Technology.

Eng. James M. Kung'u (with shovel in hand) , the Chief Engineer Roads, State Department for Infrastructure, Ministry of Transport, Infrastructure, Housing, Urban Development and Public Works is joined by Eng. Erastus Mwongera (right), Chairman of Engineers Board of Kenya (EBK)

Immidiate Past President of IEK Eng. Nathaniel Matalanga (right) poses with President of Costa Rica Institution of Engineers Oscar Sanchez (left) and President India Institution of Engineers Eng. Navin Vasoya on the sidelines of 2022 World Engineering Summit in San Josè , Costa Rica in March 2022.

2022 World Engineering Summit Calls for Increased Engineering Collaboration

By EiK Correspondent

THE World Engineering Summit (WES) 2022 took place in March 2022 in San José, Costa Rica. WFEO members and partners came together to discuss global challenges, calling for close collaboration and cooperation in scientific, technological and engineering areas to accelerate action towards achieving the UN SDGs and build back better from the COVID-19 pandemic.

> The World Engineering Summit - WES 2022 "Innovation + Technology + Sustainability = Engineering 2050" was the forum where engineering professionals from around the world came together to discuss the impact that innovation, technology and sustainability have on the future practice of engineers worldwide.

WES 2022 provided a unique opportunity, at such a critical time, for people to explore how engineering can provide innovative solutions to finally win the fight against COVID-19 and achieve a transformative and resilient recovery from the COVID-19 pandemic.

"Engineers must think globally and act locally, engineers must think far and act now." - Prof Gong Ke, WFEO.

On March 4, World Engineering Day, UNESCO released its 2nd Engineering Report. This report identified the crucial role of engineering for achieving the UN SDGs by 2030.

"Engineering is to solve problems for human development, the foremost problem facing the world today is sustaining human development and preserving the planet, in which, engineering and engineers are shouldering great responsibility. Engineers must think globally and act locally, engineers must think far and act now," said the WFEO in a statement.

The aim of this World Engineering Summit - WES 2022 was to envision engineering in 2050 and how its actions, technology and innovative ideas will impact our planet, our people, but most importantly the role engineers play and will play towards a sustainable future.

To inspire all the participants in the summit, WFEO invited renowned and respected speakers to talk about global issues that require further discussion, such as the future of Engineering to 2050, challenges and opportunities for humanity towards 2050, technologies in terrestrial monitoring and their applications, and innovative solutions with technology at the service of sustainability.

The forum was an international space where engineers, politicians and decision-making leaders participated; where engineering solutions based on technological and innovative solutions were discussed as contributors to addressing challenges such as climate change, its mitigation and adaptation, environmental preservation and restoration, natural disasters among other needs.

It was the first time WFEO held its regular meetings in Costa Rica, home to almost 5 million people, a place between two seas, a land of innovations and a true paradise for visitors. In addition to its natural beauty, the country's its enormous commitment to the environment is noteworthy. For decades, it embarked on a quest for a sustainable development model that would help preserve the environment and achieve energy sovereignty through the implementation of standards, policies and instruments to produce greener energy. Despite its small size, Costa Rica is taking giant steps and moving towards a future where resources are 100% sustainable through various initiatives.

Kenyatta University

Transforming Higher Education...Enhancing Lives

SCHOOL OF ENGINEERING AND TECHNOLOGY

HISTORICAL BACKGROUND OF THE SCHOOL OF ENGINEERING AND TECHNOLOGY

The School of Engineering & Technology had a humble beginning as a Department of Appropriate Technology Centre which was mandated to demonstrate the application of physics in solving day-to-day problems in the rural and urban areas of Kenya using locally available resources. Later it was upgraded to Department of Appropriate Technology (DAT) between 1985-2002 which finally graduated to become the current School of Engineering and Technology in 2008.

We started by offering degree programs in the areas of Civil Engineering, Energy Technology, Computing and Information Technology, Mechanical Engineering and Electrical & Electronics Engineering.

The school has grown to the current seven Departments with the addition of Gas and Petroleum and Agricultural & Biosystems Engineering Departments.

Three programs are already partially recognized and accredited by the Engineering Board of Kenya (EBK). The other four undergraduate programs have already been submitted for considerations will be accredited soon.

Notable achievement of the school includes graduating a large number of engineers in the various degree programs, establishment of new programs, participation in several conferences, workshops and seminars, competitions in different fields, partnering with other schools, universities, government agencies, private agencies, industry partnerships and even international organizations in the area of education, research and innovations. These initiatives have seen the school attracting funding for several school projects, scholarships and establishment of post graduate programs which are already at advanced stages and have already attracted several Masters and PhD students. The school has grown to become a centre of excellence that it is today, impacting positively both locally, regionally and internationally.

The School has received great support accorded to it the by the university management and other cooperating schools and departments.

The greatest strength is in the commitment and determination of our staff and students.

We produce graduates who are knowledgeable and skilled in their disciplines.

Some of the challenges we have faced as we developed the school include limitation of resources, both human and infrastructural.

PARTNERSHIPS, COLLABORATIONS AND SCHOLARSHIPS

The School played host in May to GIZ and FH Aachen University of Applied Sciences who visited for preparations on implementation of MoU on Biomedical Engineering. They are supplying laboratory equipment and giving support to Biomedical Engineering programme worthy over 40 million shillings.

GIZ, which is supporting the programme in a number of African countries, has strongly supported the programme development in Kenyatta University and has signed a memorandum of understanding with the University.

Kenyatta University recently signed an MOU with Kenya Electricity Transmission Company (KETRACO) and presented a cheque for Kshs 1m being full scholarship for two lady students to study engineering at KU.

Kenyatta University held the 3rd Deep Learning Indaba from 25th to 30th August 2019. During the INDABA, participants were taught, learned and debated the state-of-the-art in Artificial Intelligence and machine learning.

The mission for the INDABA was to strengthen Artificial Intelligence in Africa. The Nairobi Indaba attracted approximately 1000 guests from across the world. The holding of the INDABA in KU was a great opportunity for the University to gain world recognition as a leading University in the region.

Kenyatta University reaped immensely from increased international research visibility, financial inflows from the Indaba revenue, solidifying her position as a regional leader in technology innovation.

Iowa State University (ISU) has collaboration with Kenyatta University that has taken three (3) students to pursue PhD degrees in Material Science and Civil Engineering.

Arizona State University (ASU) visited Kenyatta

University in May 2018 and entered general collaboration agreement. During the April 2019 visit, a colloquium was organized where we made presentations on topics of Kenyan interest. Our presentation was on *"Mobile Network Coverage with rapidly Expanding Suburbs".*

Staff and students in the Department of Gas and Petroleum have developed a project that allows for remote monitoring and control of wellheads from which a prototype has been developed. The project incorporates the latest technology such as machine learning for data analysis, embedded systems for data gathering and block chain technology for secure data transmission to the cloud. With this project, Kenya is leading in the current digital transformation in the oil and gas industry.

Staff in the department of Civil Engineering are collaborating with staff from Tartu University, Estonia, in implementing a project entitled "A carbon negative construction material – potential implementation in Africa" under the EU-Africa climate cooperation research grant.

Member of staff of the School from the Department of Gas and Petroleum Engineering was awarded scholarship for PhD programme under the World Bank African Center of Excellence in Oilfields Chemical Research (ACE-CEFOR) at Port Harcourt University.

Also a member of staff from the Department of Energy Technology in collaboration with one from Physics Department won a four-year collaborative Research Grant worth 12 Million Danish Kroner on Widespread use of Geothermal Energy in East Africa. This includes training of 2 Ph.D students in the Department.

The School of Engineering and Technology is reviewing its curricula for engineering programmes in collaboration with other universities and liaising with the industry players. We are also working on postgraduate Masters and PhD programmes where we recently held a stakeholders workshop to address concerns from different players in the engineering industry, academia as well as Government Institutions. The programmes will then be taken to the Senate for ratification and Commission for University Education (CUE) for approval

INNOVATIONS

1. TIBA Vent, a mechanical ventilator and a direct innovation of the School of Engineering and Technology, was recently approved by the Pharmacy and Poisons Board which makes it recognized nationally and internationally. The next step will be clinical trial after which mass production will begin. TIBA-VENT ventilator which has put Kenyatta University on a global map, has a team of 15 who have been honored by His Excellency, The President of Republic of Kenya with Head of State Commendation (HSC) medal. The team has also been recognized by United Nation as "UN Persons of the Year 2020" for the same invention and by IEEE KU Students Branch where they were awarded the IEEE Chapter of the Year Award.
2. Smart Detector Access Systems used for access control where it detects whether one has won a face mask and has the recommended temperature before being allowed entry into a building.
3. Ugali Maker for which the team won Kshs. 300,000/= from the Vice-Chancellor's Research Grant.
4. Solar Drier System under incubation at Chandaria.
5. KU CUBESat Project sponsored by Kenya Space Agency (KSA) for which the project won 1,000,000/=.
6. Smart Watch Project for detection of oxygen levels and temperate to combat COVID 19
7. Commenced a start up called AFEX which is an organization using engineering & technology to solve societal problems.
8. Hand wash machine which has helped immensely during the COVID 19 pandemic

CONFERENCES

1. We recently participated in KIPPRA conference held at the Bomas of Kenya to showcase our innovations.
2. IEEE power Africa Conference 2021 23rd to 27th August, 2021 sponsored by IEEE.
3. Kenya Space Agency capacity building workshop.
4. IEEE Globecom conference 2019 in Hawaii
5. IEEE ASYP (Africa students and yung professionals Congress) 2019
6. IEEE Power Africa Conference 2020
7. IEEE Engineering Festival 2020
8. IEEE Engineering Festival 2021
9. IEEE Global Deans Conference 2020

SCHOOL OF ENGINEERING & TECHNOLOGY PROGRAMMES

S/No	DEPARTMENT	PROGRAMME
1.	Mechanical Engineering	BSc(Mechanical Engineering)
		BSc(Aerospace Engineering)
2.	Civil Engineering	BSc(Civil Engineering)
3.	Agricultural Biosystems	BSc(Agricultural Biosystems)
4.	Electrical& Electronic Engineering	BSc(Electrical& Electronic Engineering)
		BSc(Biomedical Engineering)
5.	Gas& Petroleum	BSc(Gas& Petroleum)
6.	Energy Technology	BSc (Energy Technology)
		Msc(Renewable Energy Technology)
		PHD (Renewable Energy Technology)
7.	Computing Information Technology	BSc(Computing Science)
		Diploma in Information Technology
		Bachelor of Information Technology
		Bsc (Applied Computer Science)
		MSc (Computer Science)
		PHD (Computer Science)

The Energy Trilemma: A Delicate Balance of Conflicting Dimensions

By Eng. Dr. Roy Orenge

ENERGY is a very crucial component for economic development. Present day civilization has been built primarily by availability of energy in many forms. In modern times, availability of energy has resulted in shorter working days, higher agricultural and industrial production, improved transportation facilities among other benefits. Any form of development in the present time should however be achieved without compromising the ability of future generations to meet their own needs. This is to say there should be a sustainable approach to development and this also applies to provision of energy.

The World Energy Council's definition of energy sustainability is based on three core dimensions: Energy Security, Energy Equity and Environmental Sustainability of Energy Systems. Balancing these three goals constitutes the 'Energy Trilemma'.

Energy Security reflects a nation's capacity to meet current and future energy demand reliably, withstand and bounce back swiftly from system shocks with minimal disruption to supplies. A country should have in place mechanisms to shield itself even when there is a global crisis without grossly affecting the economy. There should be reduced reliance on net imports for total energy consumption and have diversity of suppliers. Of importance here is also the ability to meet demand for oil and gas considering infrastructure capabilities including storage and refining capacity. A good result here is that even with global fuel crisis, citizens should not reach to a point of queuing or scrambling for the commodity due to its shortage in local markets.

In the electricity sector, having generation that meets demand together with reserve capacity to respond to varying daily peak demand is one of the indicators of energy security. Another indicator is having a reliable and resilient electricity infrastructure. Having more transmission lines or increased redundancy in the network improves the system resiliency. This is due to availability of alternative routes to carry large quantities of power when a major line is lost due to a fault. This will significantly reduce instances where faults in one region cascade to other areas leading to widespread and national blackouts. An electrical system that is less prone to blackouts is generally regarded as more secure.

Energy Equity refers to a country's ability to not only provide universal access to the population, but also affordable and abundant energy for domestic and commercial use. For oil products, availability and price per litre is an equity indicator. The percentage of people in the population with electricity together with the applicable tariffs are used to assess equity for electricity. Global dynamics notwithstanding, energy should be made affordable to the population. Subsidies, tax exemption or reduction are measures that can be explored in trying to increase energy equity especially in developing nations. In Kenya, the last mile connectivity had a great impact in trying to bridge the electricity equity gap by connecting millions of people. This increased the country electricity connectivity from about 32 % in 2013 to over 75 % currently (data.worldbank). The effort was made possible by political goodwill with a lot of financial investment from the government.

Environmental Sustainability of energy means that a country should mitigate environmental degradation and climate change impacts in the course of energy generation, transmission and distribution. This dimension is measured by the percentage of electricity generation from renewable and other low-carbon sources and also the amount of CO_2 emissions from fuel combustion per capita.

The World Energy Council (WEC), has been preparing a World Energy Trilemma Index (WETI) annually. This index ranks 130 countries on their performance in meeting the demands of the energy trilemma and assesses how well countries are balancing the three dimensions.

In the latest 2021 publication, WEC ranked 127 countries into 101 places, as some have same scores. Kenya was ranked 80th in the World with an overall score of 50.7 which is a drop from 54.3 scored in the 2020 ranking. The country was also ranked 12th out of the 29 countries that were ranked in Africa. The 2021 score for different components of the trilemma is as shown in Figure 1.

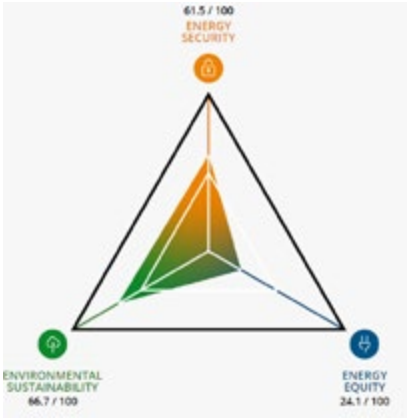

Figure 1: Kenya's Energy Trilemma in 2021 Source (WEC)

Kenya still has a long way to go in achieving energy equity despite recent efforts. This is however the dimension that has seen the highest improvement recently as seen in the progress of the three components since 2000 in Figure 2 below;

Figure 2. Evolution of the Energy trilemma in Kenya 2000–2021. Source (WEC)

The best ranked countries in the trilemma are those that have diversified their energy resources and actively managed demand for energy through well- established energy-efficiency programs. Some countries, especially those that are still climbing the economic ladder will find these dimensions conflicting. For instance, the UN sustainable development goal on affordable and Clean Energy (SDG 7), urges the change from current reliance on fossil fuels to more sustainable and less harmful sources of energy. This goal is commendable but faces practical complexities. Energy that is cheap such as coal may not be good for the environment, most clean sources of energy are intermittent, variable and insufficient to power industries and sustainable energy sources may not be locally available leading to continued use of fossil fuels to improve energy security. Different policies are required to improve each of the three components of the trilemma.

There is a broader definition being proposed that adds the fourth aspect which is the social dimension of energy. This focuses on people, their involvement and acceptance of decisions in the energy industry. Therefore, we are talking of a change from a trilemma to a "quadrilemma". The people factor is very important in energy projects. In Kenya, community engagement has been incorporated as a mandatory step before implementation of energy projects. Some projects have failed because of this fourth dimension to energy sustainability. In Kenya for example, the Kinangop's 60-megawatt (MW) project in Nyandarua County was opposed by the local community and leaders who claimed they had not been adequately consulted (africa-energy.com).

The energy trilemma or "quadrilemma" is therefore a challenge to many developing countries like Kenya. Instead of attempting to resolve it, a country should develop a framework to manage it by quantifying trade-offs among the conflicting goals. The policymakers could prioritize some goals at a given time frame. These priorities can be changed from time to time so as to achieve energy sustainability in the long run. Though the conflicts among the goals might not be completely resolved, a priority approach in policy making will show progress over time.

Dr. Roy Orenge holds a PhD in Electrical Engineering with a specialization in Sustainable Power Systems. He is an energy consultant with about 10 years' experience in academia and energy sector research. He is currently the head of electrical and electronic engineering department at JKUAT.

IEK President Eng.Erick Ohaga (fourth left) leads Council Members in hosting Emmanuel Mwachofi (fifth left) and his family at the IEK Secretariat. Emmanuel performed excellently in his KCPE examinations and aspires to be a civil Engineer in future.He will be supported by the Institution through the good will of members to enable him attain his goals.

Future Trends in Renewable Energy and Enabling Technologies in East Africa

By Eng. Samwel Kariuki

Energy demand in the world is growing further out of limits of installable generation capacity, going by what is currently happening in European nations due to Russia/ Ukraine war. Billionaire Elon Musk has even proposed revival of oil & gas plants to meet the needful demand. Future energy demands should be met and improved efficiently and securely, more so in Africa where there is need to prepare first before anything else.

New enabling technologies related to renewable energies will help to reduce environmental costs, and thus the energy systems will be operated as both securely and economically without environmental problems. New renewable energy markets are critically required in both the wholesale and retail spectrums.

The environment is increasingly being polluted because of rapid industrialization and human work. Sustainable development mainly covers the use of renewable energy, energy security, energy pricing, energy policy, renewable energy applications and smart grid technologies. Two trends are currently related to the consumption of fossil resources and the global climate change.

The data of parameters—such as economic, political, and partly environment and human life—are related to the present energy systems. According to most of the energy policies currently in use, the fundamental parameters are to save energy and use domestic energy sources. However, there will be a close relationship between the energy use and environment in the future. While planning and building all industrial plants, their effects on the environment should be taken into consideration for improving the economy, supporting ecology and saving energy. Energy investments related to environmental protection require large financial resources. The success of any new technology will be measured by parameters of cost-effectiveness that improves the environment.

A sustainable global energy system should optimize efficiency and limit emissions. The technology and the global economy must also develop in harmony with a sustainable and steady development. To obtain sustainable energy systems, vigorous action should be undertaken in the areas of energy diversity and efficiency, supply reliability, public trust, market-sensitive interventions, market-based climate change responses, cost reflective prices, technological innovation and development and regional integration of energy systems.

Government policies should be carefully planned for the production, replacement, transportation, distribution and usage of energy. Due to energy-related environmental problems and challenges, countries should aim to protect the climate systems, improve their policies and implement related preventions.

Thus, the standards on reducing local air pollution should be also strengthened and implemented effectively and efficiently. Dependence on conventional fossil resources, which is mostly produced in politically unstable countries, the current energy supply and use are highly unsustainable. To meet the present and future demands for improving conditions—such as human, economic, social and environmental—fundamental changes in technologies will be required everywhere. Some topics such as innovation, investment, work, organization and leadership should be taken into consideration.

In the long term, if investments in renewable technologies continue, renewable will have the potential to make significant contributions to energy needs of developing economies. Further, there are several technologies that include biofuels, and fuel cells also contributing to heat, transport and electricity markets.

By providing a balanced resource diversification of countries for the primary energy resources, the share of domestic and renewable energy resources in the generation system can be increased to the maximum extent.

In order to use less and cleaner energy in power plants, buildings, industrial facilities and transport systems, many energy-efficient enabling technologies are applied. These technologies could slash costs by up to 80 per cent, ensure energy savings by up to 30 per cent and help to slow global warming in the future. Thus, countries could stay cost-effective and make sustainable progress in terms of development.

Samwel Kariuki [P.Eng.Tech] [MIET] is a professional project engineer with a UK-based consultancy firm.

Boost Profitability and Operational Resilience with Unified Power Management and Process Automation

By Josiah Habwe, Process Automation Director, Schneider Electric East Africa

ENERGY-intensive industries, especially oil and gas and petrochemicals, have never been more pressured to meet sustainability targets, boost uptime, maximize throughput and reduce total expenditures (TotEx) by lowering the end-to-end lifecycle costs of their assets.

> One way owner/operators and engineering professionals can identify strategies to reach these goals is to ask themselves two straightforward questions:
>
> 1. Is there an overlooked source of value in our operations?
> 2. Can we take advantage of currently available technology to unlock it?

Thanks to advances in connectivity and digital analytics technology, the answer to both questions is an ***unequivocal yes.***

Until recently, industrial enterprises' power and process systems were designed and operated independently across a plant's lifecycle. However, evidence confirms that uniting these two domains and managing them holistically can offer dramatic resiliency and efficiency benefits for industrial operations.

Whether organizations integrate during a plant's design phase or unite existing power and process system management during a major infrastructure upgrade, the fusion of the two has real potential to accelerate business value and help build a long-term competitive advantage.

Traditionally, power management and process automation separation was primarily due to technical hurdles with separated engineering domains connected by hardwired signals and localized digital information. Even though more global digitization has largely removed those barriers, the prevailing opinion amongst select industry professionals is to resist merging the two engineering and operations silos. The situation is rapidly changing now as engineers realize the lifecycle benefits of coordinated systems within an operational and maintenance framework.

Conventional wisdom suggests that because classic systems, such as those in liquefied natural gas plants are joined only at the I/O level, unifying them at the information and analytic level increases potential risks. The thought is that separate networks keep issues isolated to one system rather than two.

However, there's ample evidence to suggest that companies require new data-driven insights to support better, faster decision-making to thrive in today's volatile economic environment.

They need to respond faster to critical conditions that threaten uptime and become more agile to make their operations more resilient, safe, and profitable, which is much easier to achieve with converged power and process systems.

Converged power and process solutions with predictive analytics, such as **Schneider Electric's EcoStruxure™ Process and Power,** are engineered to help boost profitability by:

- Improving operational efficiency and saving energy
- Increasing electro-dynamic protection for more uptime
- Enhancing asset reliability to prevent downtime

According to Craig Resnick, Vice President, ARC Advisory Group, "The fusion of power and automation is a catalyst for operational resilience and improved sustainability across the plant's lifecycle." In their examination of the benefits of power and automation Fusion, ARC concludes that:

- This integrated, digitalized approach can reduce electrical, instrumentation, and control CapEx reductions by up to 20%
- OpEx costs, including decreased downtime, can be reduced by up to 15%
- Bottom-line profitability can increase by up to 3%
- End users can see energy procurement cost reductions of up to 2-5% and carbon footprint reductions of up to 7-12%

Converged digitized systems offer additional benefits, including faster commissioning, less cabling, simpler maintenance, and a reduced footprint. With the outstanding potential to improve process and energy efficiency while lowering risks to operational continuity, digitized process and power control solutions make good business sense in an unpredictable business environment.

Would you like to explore more insights about the Schneider Electric EcoStruxure™ Power and Process for your organization? I invite you to talk to us today.

The writer of this article can be reached on Josiah.habwe@se.com

ATHI WATER WORKS DEVELOPMENT AGENCY

Developing and Maintaining Innovative Water and Sewerage Infrastructure

Eng. Michael M. Thuita
Chief Executive Officer, Athi Water Works Development Agency and President, Tunneling Association of Kenya (TAK)

Athi Water Works Development Agency: How we are developing, maintaining Water and Sewerage infrastructure for Nairobi, Kiambu and Murang'a counties.

Athi Water Works Development Agency (AWWDA) is one of the nine (9) Water Works Development Agencies (WWDA) established under the Ministry of Water, Sanitation & Irrigation. It was established under the Water Act 2016 vide Legal Notice No. 28 of 26th April 2019.

The Agency is responsible for the development, maintenance and management of water and sewerage infrastructure in the counties of Nairobi, Kiambu and Muranga Counties covering 5,800.4Km2 with a total population of 8,012,390 people. Currently, the Agency has a bulk water production capacity of 664,337m3/day and a wastewater treatment capacity of 210,500 m³/day.

The Chief Executive Officer Athi Water Works Development Agency, who is also President of the Tunneling Association of Kenya, Eng.Michael M. Thuita , spoke to ***Engineering in Kenya*** magazine.

What really is the core mandate of Athi Water Works Development Agency?

We are a State Corporation under the Ministry of Water, Sanitation and Irrigation. We work in very close collaboration with other water works development agencies to ensure that there is reliable water and sanitation services.

As an agency, we are mandated under the Water Act 2016 to develop, maintain and manage water and sewerage infrastructure in Nairobi, Kiambu and Murang'a Counties.

We are also mandated with the responsibility of providing technical services and capacity building for these counties and the water providers in the same counties.

Share with us some of the outstanding projects you have undertaken as a State Agency that you can quickly highlight on?

Since the establishment of the agency, we have implemented major water and sewerage projects, including rehabilitations, expansions and construction of new projects.

Athi Water has rehabilitated the Sasumua Dam located in Njabini, Aberdare. We have also rehabilitated and expanded the Dandora Waste Water Treatment Plant in Ruai, Nairobi County, and also rehabilitated the Kariobangi Waste Water Treatment Plant to restore its capacity.

We have constructed independent water supply systems in Nairobi satellite towns like Gatundu, Ruiru and Kiambu to serve these towns and relieve Nairobi City water supply systems of pressure.

Currently, we are also implementing mega water and sanitation projects to accelerate access to water and sanitation through projects such as the Karimenu II Dam, Ruiru II Dam, and we just completed the Northern Water Collector Tunnel and Kigoro Water Treatment Plant.

Your notable milestones?

In the last one year, we have been able to move from rented offices to our own government-owned offices on Kiambu Road

In terms of service provision, over the last five years, we have been able to develop additional water sources that produce an additional of 300,000m3 of water per day.We have also been able to develop water treatement plants for Nairobi and satellite towns to produce 196,000m3 of water per day.

We have been able to establish automated systems for project management that have enabled us to track project issues, enhance efficiency and resolve problems early.

What challenges exist in implementing water infrastructure projects?

Some of the challenges we continue facing include litigation issues like in the recently completed Northern Water Collector Tunnel involving land ownership and need for necessity consultations with project affected persons. Also, in the built-up areas faced with way-leave encroachment issues, people have built high-rise buildings along the way-leaves and developed on way-leaves for sewer lines.

Urbanization and rapid population growth exacts additional pressure on existing water supplies infrastructure and sewerage systems. Resources in terms of adequate funding to implement expansion in the face of swelling populations are also scarce.

What solutions would you recommend for these challenges?

In mitigation, we continue to engage in coordinated planning and development, and continuous review of our planning policies so as to take care of compliance challenges arising.

We equally continue to consult widely and dialogue where possible so that development projects in the common good are not derailed.

As a State Agency with a technical mandate, how much are Engineers involved in your core decisions-making processes?

Internally at AWWDA, engineers play a vital role in planning, implementation, procurement, and all stages of our infrastructure development. We have worked and will keep working closely with the Engineers Board of Kenya and the Institution of Engineers of Kenya for training and capacity building of students in our water projects like Karimenu II Dam, The Northern Water Collector Tunnel.

We have also formed the Tunneling Association of Kenya where I am the President to promote engineering knowledge transfer because of the technical capacity and technical dynamics of the main projects .

On the subject matter of climate change, what are some of the precautions AWWDA is putting in place to mitigate climate change?

We are highly affected by climate change in terms of changes in river flows as well as changes in rainfall patterns. To mitigate these, our projects have adopted green energy. For instance,we recently completed the Oloitoktok Water Supply Project where we have installed a solar firm of 1.5MW which is the largest solar firm in the water sector so far.

We are moving from waste to resource by engaging in waste water re-use activities. Our agency is working closely with KFS, resource water management and NEMA in environmental degradation

What is the current carrying capacity of the biggest dams run by Athi Water Works Development Agency?

Our biggest water supply dam is Ndakaini dam , which can store 70,000,000 cubic metres at full capacity. It is 2,041 metres above the sea level and is 65 metres deep. The dam in Murang'a county is the main supplier of water to Nairobi, which has a population of 4,397,073 people, according to the last census.

We rehabilitated Sasumua Dam that was built in 1968 with a storage capacity of 16 million litres, about 42 metres high.

Ruiru (I) Dam is a medium-sized dam with a storage capacity of 2.9 million cubic metres and stores raw water with yield of 21,600 cubic metres per day .

The Agency is currently implementing Karimenu II Dam which is 90% complete and Ruiru II Dam which is at 10% completion. Karimenu II Dam will benefit 1 million residents of Juja, Gatundu and Nairobi, supplying 70 million Litres of clean water per day.

What are the benefits of these dams to the country?

These dams help in sufficient storage of water that can be used for water supply during drought seasons. They are critical in our management of floods during the rainy season and enable mitigation of effects during hydro-logical changes in the availability of water.

Integrated resource use. Give remarks.

In terms of integrated resource use, the country should be moving gradually towards coordinated planning and development. Water is a scarce resource, which can easily cause conflict in the future generation if not properly coordinated and integrated by the water, energy and irrigation sectors in terms of planning and development.

The Ministry of Water,Sanitation and Irrigation has actually taken this forward and is presently implementing Thwake Dam which is a multipurpose dam for energy,irrigation and water supply.

Existing Solar panels Technologies and the Case for Nuclear Fission Energy Generation in Kenya

By Eng. Benedict Mutunga PE, MIEK, Meng

1.0 Introduction

IN 1831 it was discovered that when you spin a magnet inside a coil of wire an electric current was generated, ever since mankind has been burning stuff to generate heat that drive the turbines which turn the magnets inside coils or vice versa to generate electricity. Solar panels on the other hand generates electricity by converting photon energy into electrical energy with no moving part. It is estimated that by the end of 2025 the cost of delivering 1 (one) kWh of solar energy will be less than one dollar. This is an encouraging state of affairs in tackling the challenge of adverse climate change. Solar and wind means of generating electric energy have been advanced as the practical solution to the eradication of greenhouse gases that result from burning of fossil fuels, hence their reference as green energy sources. The challenge with these two electric energy generation forms is their intermittence nature. This can be addressed with application energy storage systems such as batteries, pumped hydro and inertia wheels. The cost of this storage solutions is still high making the capital expenditure on these forms of energy generation still expensive. In Kenya, solar energy is a promising method of energy generation. Kenya falls within the tropics where solar insolation is quite good throughout the year. This brings the notion that we just need solar panels, cables, junction boxes, inverters and batteries for storage then we are good to go. Currently there is no available study that has been conducted on the suitability the solar panels in the Kenyan market. Most of the solar systems designs in the country are based on manufacturer's data which was mostly biased toward temperate climate. Solar panels require high insolation and low temperatures for maximum conversion efficiency. In the tropics a high insolation is good enough for electricity generation but the high temperatures lower the conversion efficiency. Most commercial solar panels have efficiencies ranging between 10% and 30% [6]. Despite the challenges of ionizing radiation and loose nukes problem, nuclear electric energy generated through fission remain the most practical green energy source. Despite progress in the design of the tokamak devices for electricity generation by fusion is still within the laboratory scale and it will take a while to be commercialized. Wind energy has the challenge of intermittency and high cost of operation and maintenance due to periodic replacement gear boxes. The materials solution to this, is to use neodymium (Nd) permanent magnets that will reduce the cost of generating wind electric power though the capital expenditure might be higher due to supply chain constraints of lanthanides, Nd being one of them. Wind turbines are a danger to bird and having wind farms in birds' habitats affect their ecosystem which might result to extinction of some species. This article will elucidate the existing solar panel technologies and advance the case for Kenya to embrace nuclear fission technology for electricity generation.

2.0 Solar cell

The silicon ***p-n*** junction solar cell was developed by Chapin et al. in 1954[1]. Solar cells are classified together with other photonic devices such as light emitting diodes (LED), lasers ***(light amplification by stimulated emission)*** and photodetectors. The basic light particle i.e. the photon plays a major role in photonic devices. Their operation is based on the interaction between an electron and a photon [1]. Radiative energy of the sun derives from nuclear fusion in which about kg of hydrogen (H) is converted to helium (He) with a net mass loss of kg in every second[1]. Mass loss is converted through Einstein relation () to Joules[1], where $\mathcal{E}$ denotes energy, ***m*** denotes mass and ***c*** denotes speed of light in a vacuum ≡ ~3 x $10^8 ms^{-1}$.

This energy is emitted primarily as electromagnetic radiation in the ultraviolet and the infrared region (0.2μm to 3μm in λ) [2].

2.1 p-n Junction Solar Cell

Consist of a p-n junction formed on a surface, a front ohmic contact strip and fingers, a back ohmic contact that cover the back surface and an antireflection coating on the front surface [1]. Reflection on surface of incident light from air ($\dot{n}$ =1) into semiconductor silicon ($\dot{n}$=3.5) is about 0.31, implying that 31% of incident radiation is reflected and is not available for conversion to electrical energy in silicon solar cells [2]. On exposing a p-n junction solar cell to solar spectrum, photons with less energy than the materials bandgap E_g, makes no contribution to the cell output [3]. A photon with energy greater than material bandgap contributes energy E_g to the cell output with excess being dissipated as heat [3]. When electron- hole pairs are formed in the depletion layer of the p-n junction they are separated by build in electric field. Hence potential difference is limited by build in voltage which in turn is determined by the energy gap E_g [2]. Only photon with energies larger than band gap are absorbed in a semiconductor, and hence light generated current decrease with increasing energy gap due to the limited solar spectrum [2]. This explain why silicon is best suited for p-n solar cell material as in its intrinsic form it has a band gap of 1.12eV (electron volt), electron mobility (μ_e) of 1450 $cm^2V^{-1}s^{-1}$ and hole mobility (μ_p) of 505 $cm^2 V^{-1}s^{-1}$[1]. Visible light has photon energy in the range 1.63 eV and 3.26 eV [4]. This implies that only semiconductor materials with band gap between 1 eV and 2 eV can be considered for solar cell manufacture using the p-n junction technology [1].

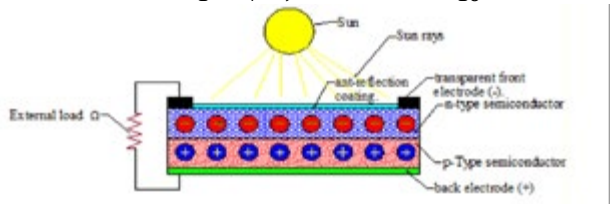

Fig. 1. Schematic diagram of a p-n junction solar cell

Figure 1 above show a schematic diagram of a p-n junction solar cell which work by absorbing light photons that dislodge electrons from the n-type semiconductor creating an electron hole pair that jump out of the depletion zone. If a circuit is connected between the cathode (- electrode) and anode (+ electrode) via an external load, elections flow from the cathode through this external circuit to the anode where the combine with

the holes and alienate maintaining electrical neutrality. The flow of electrons creates a current that is used to power the external load [5]. Currently the market offers two types of wafer based silicon solar panels the monocrystalline and the polycrystalline [4]. The industry standard is to have monocrystalline panels to have diamond shape at the joints between four cells which is distinct from polycrystalline that have square shape at joints of four cells [1,2,3,4,5,6] (see fig. 2. a and b). For monocrystalline panels, the cells are in the form of passivated emitter and rear locally-diffused (PERL)[1]. The PERL is achieved through anisotropic etching which exposes the slowly etching (111) crystallographic planes resulting into cells with inverted pyramids on the top [1]. The pyramids reduce reflections of incident photon on the surface of the panels [1]. Monocrystalline silicon solar cells have no grain boundaries that are associated with phonon scattering of electrons which is a function of temperature in an inverse proportion [3]. This make the monocrystalline solar panels the most suited for use in the tropical regions where temperatures are on average high, bringing into question why the Garissa solar power project was done with the polycrystalline solar panel given the project budget of Ksh. 13.7 billion. The project was carried out in a semi-arid hot area where monocrystalline panel were appropriate and funds were not a constrain. On the other hand, polycrystalline panels have grain boundaries with a lower production cost and lower conversion efficiency in comparison to monocrystalline panels and more appropriate for use in temperate regions especially in winter [6]. They are the widely used panel owing to the low cost as far as wafer-based panels are concerned.

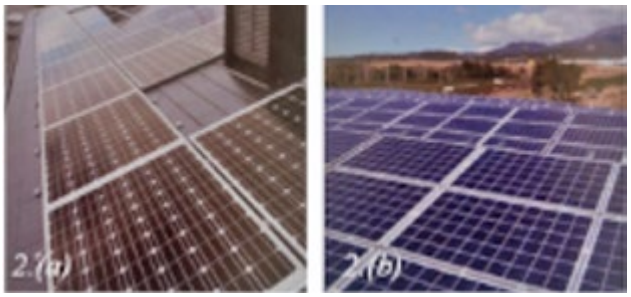

Fig. 2. (a) Show monocrystalline SW275 solar panels on a roof top system 16.225 kW installed at Hyogo Japan, while fig. 2. (b) Show SW250 polycrystalline panels in a 600kWsolar power plant installed at Shizuoka Japan. Photos courtesy of Europe Solar Innovation Co., Ltd –Japan to which Europe Solar Innovation (EA) Co., Ltd-Kenya is affiliated.

2.2. Thin-Film Solar cells

The challenge with Silicon solar cells is cost. A relatively thick layer of single crystalline is required in order to have reasonable photon capture rate, such crystalline Silicon is an expensive commodity. Thin-film technology provides a cheaper alternative approach in lowering cost.

2.2.1 Amorphous Silicon (Si) Solar Cell

Amorphous silicon (***a***-Si) thin-film is usually is deposited on a low cost large area substrate. In amorphous silicon distribution of bond lengths and bond angles disturb the long range order of the crystalline silicon lattice which changes the optical and electronic properties. Optical energy bandgap increase from 1.12eV in crystalline silicon to 1.7eV in ***a***-Si. The basic for a series connected ***a***-Si solar cell is shown in Fig. 3. A layer of SiO_2 followed by transparent conducting layer of a large band gap, degenerate semiconductor such as SnO_2 are deposited on glass substrate and patterned using a laser [1]. A coating of ***p-i-n*** junction stack of amorphous silicon is then deposited by decomposition of saline in radio-frequency plasma discharge systems and after deposition the ***a***-Si layers are patterned by laser [1]. A layer aluminium is sputtered on to the rest of the silicon and this layer is patterned by laser forming a series of interconnected cells as shown in Fig. 3. The cell has the least manufacturing cost with a modest efficiency of 6% [1]. ***a***-Si obtained by this process is incorporated with a fairly large concentration of hydrogen [1]. Hydrogen atoms tie up dangling silicon bonds, thus decreasing of localised states in the energy gap [1]. The localised states play a dominant role in determining the carrier transport properties of ***a***-Si [1]. A typical process temperature for the fabrication of ***a***-Si cell is usually below 573.15K, otherwise no hydrogen is incorporated in the film [3]. In outdoor power modules such as solar street lighting the beneficial effect of hydrogen upon the ***a***-Si propertied deteriorate under illumination. Illumination by light with photon energies larger than the energy gap leads to new light induced defects states referred to as "Staebler-Wronski" degradation which explains why most solar street lights installed in most of Kenyan towns fail within a short period after commissioning [1].

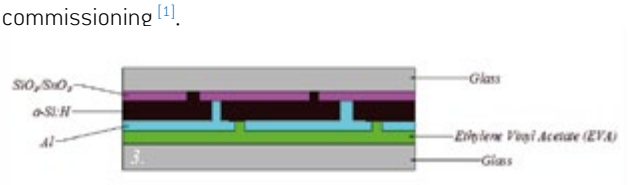

Fig. 3 show series interconnected a-Si solar cells deposited on a glass substrate with a rear glass cover bonded using ethylene vinyl acetate (EVA)

2.2.2 CIGS Solar cell

First copper indium diselenide ($CuInSe_2$) was reported by Bell Telephone Laboratories in 1974 with a conversion efficiency of 6% [1]. In 1982 CdSr/$CuInSe_2$ solar cell with conversion efficiency of 10% was developed [1]. With partial replacement of indium with gallium (Ga) the conversion efficiency was raised to 15% in 1993. By 2008 this cell had been developed to a conversion efficiency of 19.9% [2]. The CIS is a direct band gap semiconductor material with an absorption coefficient higher over a broader wavelength range than other semiconductor materials. Bandgap of CIGS vary continuously from 1.0 eV (for $CuInSe_2$) to 1.7 eV (for $CuGaSe_2$) [1]. Fig. 4 show a typical CIGS solar cell structure.

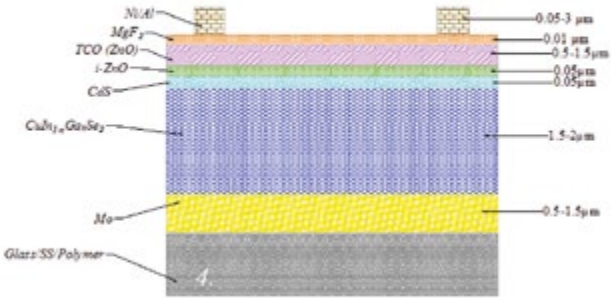

Fig. 4. A typical structure of CIGS Solar cell.

2.3 Third Generation Solar Cells

Research and development is being conducted on various novel technologies of converting photon energy into electrical energy in various laboratories across the world. The promising technologies that are nearing commercialization include: -

2.3.1 Dye-sensitized solar cell (Gratzel cell)

The biggest challenge to commercialization of this type of solar cell is the sensitizing dye stability. Most available dyes degrade within a period of five years implying, no stable conversion efficiency of the cell for economical commercialization. The cell consists of a transparent conductive oxide layer (TCO) (usually

fluorine doped tin oxide (SnO_2: F)) deposited on a glass and used as an anode [1]. The conductive plate is a layer of titanium dioxide (TiO_2) formed into highly porous 3-D structure with an extensively high service area for holding large numbers of dye molecules [1]. The plate is then immersed in a mixture of photosensitive ruthenium-polypyridine dye solution with molecules in nanoscale size. To capture reasonable amount of photon, the dye molecules are covalently bonded to the porous TiO_2 3-D nano structure [1]. A separate backing is made with a thin layer iodide/iodine electrolyte spread over a conductive platinum sheet. The semiconductor TiO_2 is solely used for charge transport; the photo electrons are provided from a separate photo sensitive dye [1]. At the surface between the dye, semiconductor and electrolyte charge separation occurs [1]. If this cell would have gone to commercial stage it would be an opportunity for value addition for the titanium being mined at the Kenyan coast.

2.3.2 Organic Solar Cell

The current laboratory reported conversion efficiency of organic solar cell is 5.7% [1]. This cell attracts a high interest due to large area and low cost potential. Carrier mobility in organic cells are very low as their transport process is dominated by carrier hopping in organic semiconductor [1]. The thickness of organic active layer in organic solar cell is thus limited to few hundreds of nanometres for low series resistance [1]. Organic semiconductors show strong absorption of UV and visible photon with a penetration depth of 80-200 nm [1].

2.3.3 Quantum Dot Solar Cells

A different approach of increasing the conversion efficiency is utilizing hot carriers before they relax to the band edge via phonon emission [1]. Carriers can be extracted hot and cool down to enhance photo voltage or utilization of hot carriers' energies to produce secondary EHPs (electron hole pairs) through impact ionization to enhance photo current [2]. The crucial point is to retard the relaxation of photo generated carries [1]. Hot carriers loose energy by multi-phonon processes and heat dissipation in the semiconductor. Carries in the semiconductor confined by a potential barrier in regions that are smaller than or comparable to their deBroglie wavelength or to the Bohr radius of excitation in the semiconductor bulk i.e. in the semiconductor quantum wells, quantum wires and especially quantum dots (QD) [1]. In conventional bulk semiconductor a single EHP is generated per absorbed photon. This implies that both high and low energy photon give only a single pair of charge carriers (electrons and holes). Extra energy of the of near UV photons is not fully utilized using the bulk semiconductor films [1]. In QDs high energy photon can produce multiple charge carriers by impact ionization process, setting the stage for achieving photon conversion efficiencies greater than 100% [1].

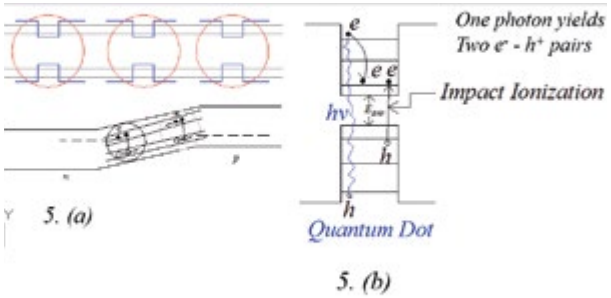

Fig 5. (a) shows hot carrier transport through the mini-band of the QD array, resulting in a higher photo-potential, while 5. (b) show how enhanced efficiency can be achieved through impact ionization [1].

However as shown in fig 5. (b) hot electrons transport/collection and impact ionization are mutually exclusive and only one of these processes can be present in a given system [1]. The QD solar cells promises high power conversion efficiencies and offers special tenability owing to the fact that absorption properties of semiconductor quantum dots are size dependant [3]. QD solar cells have the potential to increase the maximum conversion efficiency up to 66% once the technology moves from laboratory stage to commercialization stage [6].

3.0 Discussion

From the description of the commercially available solar panel technologies it is clear that the most suitable solar panels for tropical environmental conditions, within which Kenya and Sub-Saharan Africa lie is the Si monocrystalline type. The capital expenditure on Si monocrystalline panel is relatively higher compared to other types of solar panel but on comparison to amount of electricity they can generate they are never the less more economical. Their service life is much longer than all other commercially available technologies. From the above elucidation of solar panels technologies, there is need for regulation of this industry to guaranteed quality and beneficial technology transfer to our country and robust solar energy projects that give value for money to Kenyans. The intermittent nature of renewables (solar and wind) and high cost of electric power storage technologies, makes it necessary for a developing country like Kenya to think seriously on investing in nuclear fission technology in electricity generation. For electric energy security, Kenya need to develop an energy mix that will ensure the least cost to the electric power to consumer. The set up cost of a fission nuclear power plant is usually high but once in operation the cost of power generation is the lowest compared to other modes of generation. Nuclear Power and Energy Agency (NuPEA) - Kenya had already done due diligence on concerns that were raised in an article that was carried on Kenya Engineer Magazine Volume 40 No. 5 Sep/Oct issue of 2019 on "A pedestrian approach to nuclear energy and safety implications to Kenya". Kenya needs political good will and allocation of more resources to NuPEA to have nuclear energy technology included in our electric energy mix. To combat adverse effect of CO_2 emission the world is embracing e-mobility and transportation and all major manufactures of automobiles planning closure in the use of internal combustion engines. Our country needs to adequately plan for the increase in demand for electric power. NuPEA needs to sensitize the general public of their activities in an approach that is understandable to a lay person. We need to completely remove CO_2 emitting technologies from our energy mix and at the same time ensure a competitive electric energy cost that can spur economic growth and at the same time ensure good quality life of all Kenyans on matters electric energy. In fact, our emery mix should solely be made of nuclear fission electricity and renewables.

4.0 Conclusion

Kenya needs sustainable development backed by reliable and competitively priced power supply. There is need to regulate the renewable (wind and solar) energy industry to ensure quality and value for money in all projects as well as adoption of appropriate technologies by our country. For energy security, competitive energy pricing that can spur economic growth and ensure environmental protection our energy mix should include nuclear fission technology

Eng. Benedict Mutunga PE, MIEK, Meng (Materials Science and Engineering), Mechanical Engineer, Ministry of Transport, Infrastructure, Housing, Urban Development and Public Works.

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Kenya Institute of Highways and Building Technology (KIHBT) is a training Division of the State Department for Infrastructure in the Ministry of Transport, Infrastructure, Housing and Urban Development and Public Works. The mandate of KIHBT is development of Human Resource capacity in the infrastructure sector, especially the Roads Sub-sector, and plays a key role in the implementation of the National Agenda as stipulated in Vision 2030.

The Institute offers diverse training courses in the infrastructure sector in the fields of: Building Technology; Architecture; Civil Engineering; Mechanical Engineering; ICT and Highway Engineering. KIHBT, in partnership with various Governmental and development organisations such as: Kenya National Highways Authority (KeNHA); African Development Bank (AfDB); International Finance Corporation (IFC); and International Labour Organization (ILO), is running various training programmes targeted at the youth, women and road contractors.

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  - Construction Plant (Higher Diploma, Diploma)
  - Industrial Plant
- Transport Management (Diploma, Craft)
- Welding and Fabrication (Craft)
- Automotive Technology (Craft)
- Welding and Fabrication (Craft)
- Auto Electrician (Proficiency)
- Refrigeration and Air Conditioning (Proficiency, Grade)
- Construction Plant Mechanics (Proficiency, Grade)
- Motor Vehicle Mechanic (Grade)

Civil Engineering Department

- Structural Engineering (Higher Diploma)
- Civil Engineering (Diploma)
- Land Surveying (Diploma)

Highways Engineering Department

- Highway Engineering (Higher Diploma, Diploma)
- Roads Construction (Craft Certificate)

Building Technology Department

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  - Instrumentation option (Diploma)
- Electrical Installation (Craft, Grade)

Information Communication Technology

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EAST AFRICA SKILLS FOR TRANSFORMATION AND REGIONAL INTEGRATION PROJECT (EASTRIP)

KIHBT is in the process of being upgraded a Regional Flagship TVET Institute (RFTI) and Centre of Excellence in Roads and Highways Training; under the funding of East Africa Skills for Transformation and Regional Integration Project (EASTRIP), a World Bank funded project. EASTRIP development objectives are to increase the access and improve the quality of TVET programs in selected Regional Flagship TVET Institutes and to support regional integration in East Africa. The project objectives are to be met through a series of sub-components. These are: Strengthening institutional governance and management; Institutionalizing industry linkages; Developing market relevant and competency-based training programs; Training of Managers and Teachers; Upgrading key instructional facilities and equipment; Outreaching and support for non-project National TVET Institution.

Key Project Achievements within RFTI-Highways

- Increased Enrolment
- Establishment of an Industry Advisory Board
- Formal Partnerships with key industry players and institutions
- Curriculum review and development
- Training of Teaching Staff
- Affirmative Action Campaigns for diverse student enrolment
- Acquisition of new training plant and equipment

New CBET Courses

- Certificate in Construction Site Safety ***(2 years)***
- Certificate in Drainage Construction (***2 years)***
- Certificate in Construction Plant Mechanics ***(2 years)***
- Certificate in Contract Management and Administration ***(3 weeks)***

Recently CBET Reviewed Courses

- Certificate in Road Construction
- Performance Based Road Maintenance Course (PBC) for Contractors, Road Authorities, County Governments ***(3 weeks)***
- Low Volume Sealed Roads Technology Course ***(3 weeks)***
- Cobblestone Technology Course ***(3 weeks)***
- Plant Operator Course ***(3 weeks)***
- Basic Driver Training Course ***(3 weeks)***

ROADS COURSES

- Highway Engineering (Higher Diploma, Diploma)
- Land Surveying (Diploma)
- Labour – based R2000 Contractors course
- R2000 Contractors and site supervisors' course
- R2000 performance based routine maintenance course
- Certificate in Construction Plant Mechanics

NEWLY ACQUIRED CONSTRUCTION EQUIPMENT TRAINING SIMULATOR

KIHBT has in the recent months acquired a construction equipment simulator from CM LABS Canada. The main aim of the acquisition is to improve the learning experience among the relevant trainees. The simulator comes with pre-installed modules of widely known construction machinery including the: Motor Grader, Wheel Loader, Excavator and Dozer.

With its acquisition, KIHBT expects learners and trainers to experience an immersive learning and teaching environment respectively, with the exclusion of the normal fears that arise in learners when placed inside such intimidating machinery. With its motion-response system, the learners are unable to miss the movements projected at them by the simulator. This provides a real life-like experience on the learners' impulses which when transmitted on the real vehicle enables them to perform tasks with precision and accuracy. KIHBT intends to be amongst the pioneers in digital technical learning and this simulator is one of the steps towards achieving that goal.

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Petroleum Crude Oil and its Role in Energizing Economies

By Eng. Selemia Opap

SCIENTISTS define Energy as the ability to do work. Modern civilization has been made possible because people have learnt how to change energy from one form to another and then use it to do work. People use energy to move cars, locomotives, ride bicycles, fly aeroplanes, cook, light homes and industries and its basic form to walk, among others.

There are many different forms of energy, including: heat, chemical, motion and electrical. These forms of energy can be grouped into two general types namely stored or potential energy and working or kinetic energy. Energy sources on the other hand can be categorized as Renewable, which can be easily replenished and Non-renewable, whose replenishment is impossible.

Crude oil as a source of energy;

This article dwells on crude oil whose products have driven various sectors of world economies in manufacturing, transport, aviation and even in domestic use.

What is crude oil?

It is a mixture of hydrocarbons formed from plant and animal remains that lived millions of years ago. Over the course of the many years, the remains were covered by layers of rock, sand and silt. A combination of pressure and heat from the layers turned those remains into crude oil. Petroleum products e.g. Jet fuel, kerosene, petrol are made from crude oil, natural gas, or biomass, among others. Crude oil forms differently due to the geographical makeup of the locations they are found.

Types of crude oil

Depending on the geographical formation locations, the classes below are obtained: Heavy sweet or sour, Medium sweet or sour and Light sweet or sour. Heavy oil types are used in making industrial products like plastics. Light oils are generally used in the manufacture of diesel, gasoline and aviation fuels. Sour crude oil has more sulphur and carbon contents than light crude and therefore requires more refining, using more advanced technologies or process plant capabilities.

Crude oil refining process

Distillation is the first step in crude oil processing. It takes place in the fractionation column. The column is divided at intervals by horizontal trays, maintained at very high temperatures at the bottom but as different hydrocarbons boil at different temperatures, the temperature gradually reduces towards the top. Crude oil is heated before being introduced into the fractionation column. This is done at first in a series of heat exchangers where heat is drawn from other process streams which require cooling.

Naturally, Crude oil contains some quantities of water and salt, which must be removed or separated. Salt removal takes place in the desalter and is achieved by electric field separation. Within the process, sulphur and other unwanted compounds like unsaturated hydrocarbons and nitrogen are removed too, in a complex process requiring a more detailed explanation beyond the scope of this paper, which only seeks to recognize and appreciate the role of Scientists and Engineers in the whole process.

Crude oil refining in Kenya

The only refinery in the East African region, Kenya Petroleum Refineries Ltd.(KPRL), was set up in the coastal town of Mombasa, during the colonial period, in 1950s. This was made possible by a consortium of Shell and British Petroleum (BP) Company and the Kenyan Government.

The refinery was to supply the region with the variant oil products. The company was originally incorporated as the East Africa oil Refineries Limited (EAOR) in 1960. The very first refining complex with distillation, hydro treating, catalytic reforming and bitumen production units was commissioned in 1963 and a second such in1974.

The company name changed to the present Kenya Petroleum Refineries Ltd. in 1983. Being a multidisciplinary undertaking, the success of the refining process was made possible by well-coordinated work by all engineering disciplines among other departments.

Crude oil refining processes at KPRL stopped in the year 2013 as a change in Government strategy and other technological challenges. However, there are other activities ongoing that are driven by science and engineering to date, which include oil product handling and hospitality in Liquefied Petroleum Gas (LPG), premium petrol(PMS), dual purpose kerosene(DPK), automotive gas-oil(AGO), fuel oil and certified laboratory quality testing services.

The Early Oil Pilot Scheme (EOPS) Project

The discovery of substantial Crude oil reserves at Lokichar in Turkana County, placed Kenya on the world map as the new entrant into the petrodollar league. As is synonymous with such new discoveries in oil, the Government of Kenya sanctioned the EOPS project with the aim of Introducing Kenyan Crude to the world market.

The multi-million dollar project involved extensive logistical as well as engineering designs for handling the crude at KPRL in Changamwe, Mombasa before export.Crude Oil was transported in insulated tank-tainers by road from Lokichar to KPRL Storage facilities where it would be consolidated to warrant a full vessel payload for shipment out.

After several months of truckload shipments to KPRL from Lokichar,Kenya's dream of Joining Oil producing and Exporting Countries was realised, with the first ever export of Kenya crude oil on 26th August, 2019. The president of Kenya, H.E Uhuru Kenyatta presided over that memorable occasion and flagged off the shipment of about 200,000 barrels. The event took place at Kipevu Oil Terminal (KOT) within the port of Mombasa, flanked by a mammoth team of Engineers and Logisticians.

Engineering in the oil industry

The oil industry presents a very unique environment because of the hazards that are inherent in all the processes undertaken. Safety to personnel and assets is of utmost importance and priority. Being the key players and shouldering this delicate responsibility, the engineer has a duty to design and implement equipment that work safely in these environments bearing in mind the potential risks and hazards lurking all the time.

Selection of equipment according to Area Classification is key in ensuring process safety and plant availability. Besides, corrosion is a threat to equipment and installations integrity in the oil industry. Corrosion control is a major responsibility of the engineer in this industry.

Not only is the the oil industry accelerating industrial manufacture, there is also the aspect of very rich human skills development and technological transfer. So many students from leading local universities and technical training institutions have benefited from the engineering and other skills in form of industrial training attachments and internship programs at distinguished workplaces like Kenya Pipeline Company Limited (KPC) and Kenya Petroleum Refineries Limited (KPRL), which collectively boast of a reservoir of intellectual and cultural diversity and excellence.

As the world gradually moves away from energy from fossil fuels to other cleaner energy sources, one fact for sure is the recognition of the engineering skills development in this energy sector and discovery of alternative fuels.

Eng. Selemia N. Opap is a Graduate Electrical Engineer and an employee of Kenya Petroleum Refineries Limited. He writes on topical issues in the Engineering Sector. His contact is Selemia.opap@kprl.co.ke.

Eng. Maurice S. Nabende
Ag. Chief Engineer (Mechanical)
State Department for Infrastructure
Mechanical & Transport Division

How the Mechanical and Transport Division is Promoting e-Mobility

Most Scientific data from researchers across the globe point towards increase in atmospheric temperature by 4˚C at the end of the 21st century, through a phenomenon called Global Warming. This will have adverse effects on the global climate, which is likely to worsen the quality of life on earth. This increase is a function of green house gasses, emanating from human activities such as agriculture in which bovines produce a significant quantity of methane gas (CH_4), burning of fossil fuels for transportation and energy generation, that produce carbon dioxide (CO_2). In the 26th conference of parties (COP 26) that was held in Glasgow Scotland United Kingdom (31st October 2021 to 12th November 2021), it was reported that Kenya was among the 151 countries that submitted their updated nationally determined contribution (NDC) of emissions which should be cut by half by the year 2030, if the goal of keeping the limiting temperature rise to 1.5 ˚C above the pre-industrial temperature (1850-1900) is to be realized.

The cost of cutting Kenya's NDC of emission by half was estimated at $ 62 billion ≡ Ksh 7.16 trillion. The intervention measures that the government of Kenya will apply in cutting the NDC of emissions by half will include adoption and promotion of technologies that will result in decarbonisation of transportation and energy generation. Kenya is strategically positioned to decarbonise owing to the fact that the bulk of our electricity generation is from green sources, implying that the goal of cutting our NDC of emissions by half can be realized if efforts are geared towards "cleaning" the transport sector.

The Mechanical and Transport Division (MTD) in the State department of Infrastructure in the Ministry of Transport, Infrastructure, Housing, Urban Development and Public Works is best positioned in spearheading the above goal in conjunction with other stakeholders such as National Transport and Safety authority (NTSA), Kenya National Highways Authority (KeNHA), Kenya Bureau of Standards (KEBS), Ministry of environment, National Environmental Management Authority (NEMA), Ministry of industrialization, Kenya Transporters association, Kenya association of Manufactures, Boda boda Sacco's and Matatu Owners Association, Parent ministry, The Nairobi Metropolitan Area Transport Authority (NAMATA) and the General public. The division has a well trained human capital, nationwide presence with established garage infrastructure, legal mandate to advice the government on matters transport and a large fleet of construction equipment. The Division envisages the realization the NDC of emissions reduction through appraisal and adoption of the technologies highlighted below:

1. Battery Electric Vehicles (BEV)

Nissan Leaf BEV with a charger – Photo taken at Nissan Yokohama plant, Japan.

This technology is already in use in Kenya. There are taxi companies that are already using BEVs in their fleet. The Nairobi Metropolitan Area Transport Authority (NAMATA) will utilize BEVs in Bus Rapid Transport (BRT) system. There are companies already manufacturing BEV motor cycles in the county with local content

of about 45% as well converting vehicle powered with internal combustion engines (ICEs) to BEVs for off-road use. This technology utilizes the lithium ion batteries with lithium hexafluorophosphate ($LiPF_6$) dissolved in an organic gel as an electrolyte for most commercial cells. Most BEVs utilize these cells in the cylindrical or prismatic architecture. Stacking of these cells presents a challenge of temperature control especially to the local BEVs manufactures that need to establish the efficacy of the cooling methods they apply in supervision of a regulator. Stacked lithium ion batteries are susceptible to thermal runaway and safety measures need to be well elaborated in this type of technology until a commercially viable solid state electrolyte is realized. The BEVs are still pegged with "range anxiety" which can be addressed through economics and consumer choices. The government needs to draft a policy to encourage setting up of charging points as in line with fossil fuel distribution network. A schematic figure of a lithium ion battery is shown in Fig. 1.

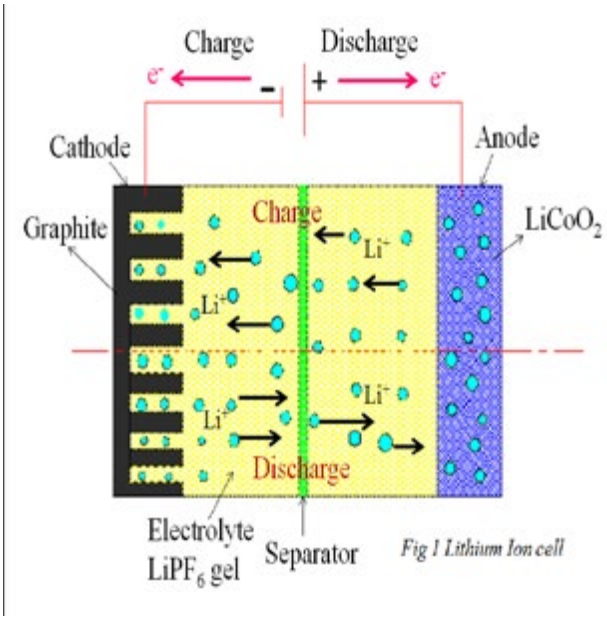


Fig 1 Lithium Ion cell

2. Fuel Cell Electric Vehicles (FCEVs)

This technology has not been applied in Kenya owing to the capital intensity in setting up hydrogen gas (H_2) supply chain. Worldwide, only a handful of vehicle manufactures are promoting this technology mostly in East Asia. If the costs of setting of the hydrogen gas charging infrastructure can be overcome, this can be a good starting point for our country to start local manufacturing as established vehicle manufacturers are willing to share their patents with organizations promoting decarbonisation. Leading models in this segment include the Toyota Mirai II, Honda Clarity Fuel cell and Hyundai Nexo. Fig. 2 below depicts a schematic diagram of a fuel cell.

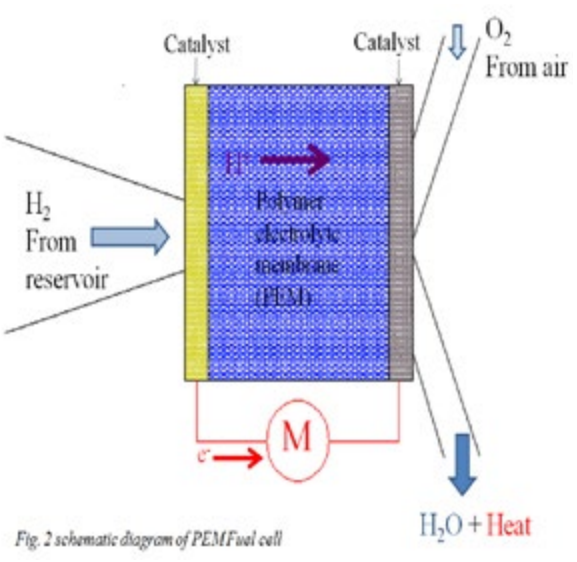


Fig. 2 schematic diagram of PEM Fuel cell

3. Plug in hybrid electric Vehicle (Phev)

These are a combination of battery electric vehicle (BEV) and internal combustion engine (ICE) and are designed to mitigate the problem of "range anxiety". Quite a number of such vehicles have been imported to our country as pre-owned imports. There is need to properly ascertain the remaining economic life (a function of charging cycles) of the battery stacks before such vehicles are shipped to our country. There is a business opportunity in battery stacks repair in this vehicle industry segment and investors are encouraged to invest in this front, though there is need to first build capacity. On construction equipment there are efforts to increase their efficiency and reduce the use of fossil fuel, for example, by utilizing electric motor for the swing function of the hydraulic excavator.

4. Emissions Control and Regulation

Emissions levels should be made one of the parameters determining vehicle road worthiness. This being a regulatory function it should be implemented by a government agency which can effectively detect "defeat devices" that can erode the efficacy of the regulation as it was in the case of Volkswagen's Diesel Emissions Scandal. MTD has enough human capital (65 Mechanical Engineers and over 88 Technicians/ Technologists) with a nationwide presence and can carry out this function with additional investment in Vehicle Operational Safety Review Equipment.

The Mechanical and Transport Division (MTD) will hence be the first-point-of-call organization in the implementation of the bi annual inspection of motor vehicles which are four years and above from the date of manufacture.

Grading works at Imenti Central, Meru County.

Gravel dumping at Imenti Central, Meru County.

Gravel excavation and loading at Nkomo Ward, Meru County.

Dozing works at Karama Ward, Meru County.

Overburden removal and gravel excavation in Nyaki East Ward, Meru County.

Gravel spreading at Kiirua Naari Ward, Meru County.

Road compaction works at Nakabune Nyaki East ward, Meru County.

SEAMLESS CONNECTIVITY

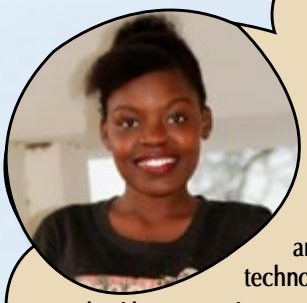
MINISTRY OF TRANSPORT, INFRASTRUCTURE, HOUSING AND URBAN DEVELOPMENT

CONTACT US

Any enquiries on services available should be made at the earliest opportunity to:

The Chief Engineer (Mechanical) Machakos Road, Industrial area, P.O Box 30043-00100 Nairobi.
E-mail: cmte@mechanical.go.ke / info@mechanical.go.ke

Students' Voices



GREEN ENERGY

Green energy projects are low carbon emission investments and are directly related to various Vision 2030 sustainable development goals such as SDG 7 – Affordable and clean energy, SDG 11- Sustainable cities and communities, SDG 13 – Climate action, SDG 14- Life below water and SDG 15 – Life on land.

Barriers to renewable energy projects

Challenges facing renewable energy projects include feasibility where green technologies are often in the earlier developmental stages and not commercially viable as compared to technologies in fossil fuels field. This makes green technologies more expensive and riskier ventures.

Lack of long-term financing – Renewable Energy projects require a large capital at the developmental stage, without long term financing such as loans private investors tend to draw away from actualizing such projects. Lack of capacity in market actors-Market actors are people, businesses or organizations that affects the market availability and implementation of energy efficient technologies, product, practices and designs; including but not limited to design professionals, contractors, retailers, suppliers, manufacturers, associations and institutions.

Sharon Achieng is graduate telecommunications Engineer, Technical University of Mombasa (TUM).

IMAGINATIVE PLANS CAN BRING DOWN ENERGY COSTS IN AFRICA

Today, Africa has a significant energy deficiency, which is a significant hindrance to its development and improvement. 43% of individuals in Africa - around 560 million altogether - have no admittance to electric power.

As per the 2015 African Progress Panel Report, regular power cuts bring about misfortunes assessed at 6% of turnover for huge firms and as much as 16% for casual area organizations. Despite the fact that environmental change presents difficulties to African change, the subsequent expanded temperatures and irradiance offer chances to saddle Africa's bountiful sustainable power assets.

These assets comprise of concentrated sun-oriented power (CSP), photovoltaics (PV), wind energy, geothermal energy and bioenergy. As indicated by the International Renewable Energy Agency, Africa's absolute energy potential from CSP, PV and wind energy is around 1,590 pet watt hours. Advancement of power asset frameworks for family, ranch and modern purposes will diminish biomass usage for energy, assist with further developing efficiency, lessen fossil fuel byproducts, and work on expectations for everyday comforts. Albeit the costs of RE frameworks have been falling consistently, the underlying capital expense is still high and is a significant boundary to section into the market.

Imaginative plans of action could be utilized to bring down costs. A genuine model for example is M-KOPA Solar of Kenya, carrying reasonable sun-based energy to off-matrix networks utilizing cell phone innovation. African governments can likewise speed up private interest in energy frameworks by working on the strategy and administrative systems, and by transforming exceptionally obliged, bad and wasteful state-possessed power utilities.

Caleb Nyongesa is a Civil Engineering student at Technical University of Mombasa. His Contact is calebsultan17@gmail.com

IEK Membership Report

The IEK membership committee meets every month to consider applications for membership of the various classes received at the secretariat. The IEK council at its 488th and 492nd council accepted the following members under various membership categories as shown below;

MEMBERSHIP CLASS	Number Accepted-488th Council-28th February, 2022	Number Accepted-492nd Council-7th April, 2022
FELLOW	2	3
CORPORATE	36	27
GRADUATE	95	85
GRADUATE ENGINEERING TECHNICIAN	3	4
GRADUATE ENGINEERING TECHNOLOGIST	4	4
STUDENT	30	3
TOTAL	**170**	**126**

During the period 5 members transferred from the class of Corporate to Fellow member and 63 transferred from Graduate to Corporate member. In addition 180 graduates, 7 graduate engineering technicians, 8 graduate engineering technologists and 33 students accepted as members.

Gender Data

Class	Male	Female	Percentage (Male)	Percentage (Female)
Fellow	3	2	60%	40%
Corporate	50	13	79.4%	20.6%
Graduate	157	23	87.2%	12.8%
Technologist	7	1	87.5%	12.5%
Technician	7	-	100%	-
Student	24	9	72.8%	27.2%
TOTAL	**248**	**48**	**83.8%**	**16.2%**

Summary

Gender	No	Percentage
Male	248	83.8%
Female	48	16.2%
	296	**100%**

488TH APPROVAL

FELLOW

S/NO	NAME	MEMBER NUMBER
1	Julius Micheni Mwathani	F.1249
2	Elisha Aketch	F.2556

CORPORATE

S/NO	NAME	MEMBER NUMBER
1	Eden Kigen Mereng	M.7367
2	Nyakundi Henry Kevin	M.6981
3	Lilian Wanjiru Mwangi	M.8285
4	Victor Nzamalu Vavu	M.8229
5	Roy Bwoma Nyamboga	M.8032
6	George Sing'ombe Ogeto	M.8126
7	Martin Murimi Ngari	M.7069
8	Samson Kipkemboi Ogao	M.7488
9	Stephen Wang'ombe Maina	M.6371
10	Narendra Ratna Hirani	M.1841
11	Rosemary Achola Oduor	M.4322
12	David Mpayian Kerembu	M.6917
13	Daniel Kilimo Too	M.8773
14	Irene Kavutha Makali	M.8700
15	Allan Kipkosgei Yego	M.6858
16	Linda Jelagat Rotich	M.7887
17	Peter Aloo Jamwa Onyango	M.7048
18	Emmanuel Echelo	M.8164
19	Edward Waweru Njuguna	M.7816
20	Steven Ouma Asiyo	M.6197
21	Felix Ouma Liwindi	M.8307
22	Lenny Kirimi Ntarangi	M.7547
23	Adam Chebon Cheptorus	M.5427
24	Cornelius Sailenyi Parsayo	M.6750
25	Martha Nyambura Kariuki	M.2101
26	Maxwell Karanu Kamwana	M.8684
27	Gati Charity John	M.6904
28	Annette Muthoni Miringu	M.3958
29	Purity Wanjiru Githehu	M.5434
30	Ruth Kabiri Mburu	M.9200
31	Misheck Waititu Ndung'u	M.9191
32	Kaburu Godfrey Mawira	M.4398
33	Killian Karanja Kimani	M.7503
34	Moses Mutuga Kariuki	M.8993
35	Godfrey Mugambi Mitheu	M.7178
36	Albert Muchika Murunga	M.5700

492ND APPROVAL

FELLOW

S/NO	NAME	MEMBER NUMBER
1	Christine Adongo Ogut	F.2566
2	Petronilla Apiyo Ogut	F.2948
3	Bernard Ochieng Oketch	F.4536

CORPORATE

S/NO	NAME	MEMBER NUMBER
1	Anthony Gichuki Nyagathu	M.7166
2	Denning Kiai Maina	M.6863
3	Edward Gisiora Maisiba	M.7500
4	Godwin Micheni Mutembei	M.6777
5	Calvin Dishon Maungu	M.8763
6	Samson Ling'abo Opanda	M.7388
7	Samuel Ndirangu Gathu	M.9099
8	Edith Auma Onyango	M.5680
9	Alice Nyawira Klmaru	M.8309
10	Yvette Rachier Olende	M.5878
11	Waleed Esmail Mohammed Ishak	M.6808
12	Martin Kibiwott Rotich	M.6990
13	Moses Mirikau Mukabane	M.6271
14	Chepkwony Kiprotich Erastus	M.5306
15	Maroa Chacha Samwel	M.7658
16	Melisa Awuor Ocholla	M.6802
17	Mwenda Jamlick Kinyuru	M.5666
18	Michael Mathea Nthiani	M.6936
19	Paschal Odhiambo Nyanjaga	M.4331
20	Elijah Ndung'u Ngugi	M.8251
21	John Wamunyu Mativo	M.4044
22	David Mwangi Kamau	M.8670
23	Wilson Mugendi Njue	M.7139
24	Paul Kimeu Sammy	M.7663
25	James Karanja Ndaaru	M.5888
26	John Mwenda Mutiria	M.8249
27	Christopher Maina Muriithi	M.2734

The council invites Engineers and affiliate firms to apply for membership in the various membership classes, kindly follow the link **Membership Classes (iekenya.org)** for a list of classes available.

The IEK condoles with family and friends of our members who have passed away in the recent past. May their souls rest in peace.

Deceased Members

1. Eng. Denis Musyoka Mulwa
2. Eng. Richard Francis Kabia Munene
3. Eng. Benson Muthemba Njoroge
4. Eng. Francis Ngigi Njuguna

"Death is not extinguishing the light . It is putting out the lamp because the dawn has come."

IEK Elects New Council, Holds 2022 AGM

By Mariah Monayo & Gor Ogutu

THE Institution of Engineers of Kenya (IEK) held its Council elections on 21st March 2022.

The process, which was entirely digitized, ran smoothly and seamlessly. At exactly 10 o'clock in the evening when polls closed, winners were declared. With a membership of over 9000, the IEK voter register has over 1600 registered, eligible voters.

The zeal and commitment of IEK members to decide leadership of the institution was evident in the impressive voter turnout of over 70%.

From the final tally, Eng. Erick Ohaga won the Presidential race with 62% of all votes cast, beating his closest competitor Eng. Lucy Mutinda, who garnered 38%.

Constitutionally, newly elected IEK Councils are declared officially at the AGM. This was held on 7th April 2022 at the University of Nairobi. No candidate submitted nomination papers for Honorary Treasurer, necessitating that the Council undertakes a constitutionally guided nomination process to find one.

Incoming IEK President Eng. Erick Ohaga will be steering the 2022/2024 IEK Council at the helm, assisted by 1st Vice-President Eng. Grace Kagondu and 2nd Vice-President Eng. Christine Adongo Ogut.

CHANGE OF GUARD: *Immidiate IEK Past President Eng. Nathaniel Matalanga hands over instruments of power to his successor Eng. Erick Ohaga.*

IEK members also elected Eng. Shammah Kiteme as Honorary Secretary, as well as Eng. Florah Mwendwa, Eng. Dr. Elisha Aketch, Eng. Jennifer Korir, Eng. Paul Ochola, Eng. Lilian Kilatya and Eng. Jennifer Gache as Ordinary Council Members.

ENG. ERICK OHAGA
PRESIDENT IEK

Eng. Erick Ohaga is the President of the Institution of Engineers of Kenya (IEK). He is currently the Director, Nuclear Energy and Infrastructure Development at Nuclear Power and Energy Agency (NuPEA).

He previously worked at the Kenya Power and Lighting (KPLC), rising through the ranks to County Business Manager. He has vast experience spanning over 17 years in Energy Policy Development, Nuclear Policy and Strategy Formulation, Design, Construction, Contract Management, Operations, Maintenance and Planning of Power Systems.

Eng. Ohaga has extensive experience in Power Purchase Contracts Administration and Regional Power Trade. He has participated in the development of Kenya's Standardized Power Purchase Agreements for Renewable Energy Sources under the Feed-in-Tariff Regime and developed the Kenya Distribution Master Plan 2015-2020. He holds an MSc. Nuclear Engineering (KINGS), Master of Business Administration (MBA), BSc. in Electrical/Electronic Engineering and Post-Graduate Diploma in Project Planning and Management.

Eng. Ohaga is a Certified Coach/Mentor, and a Certified Personal Development Analyst (SA). He is a full member of Kenya Institute of Management (KIM).Eng. Ohaga has also served the World Federation of Engineering Organization (WFEO) Committee on Engineering Innovative Technologies. He has Chaired the Membership Committee of IEK and is a ranking member of the Electrical and Electronics Engineering interviewing panel.

ENG. GRACE MUTHONI KAGONDU
1ST VICE PRESIDENT

Eng. Grace Muthoni Kagondu is the 1st Vice President, Institution of Engineers of Kenya. She has previously served as Chair of Capacity Building and Mentorship Committee and Vice Chair, Events Committee.

She presently works as Manager at the Research Department of the Central Bank of Kenya. Eng. Kagondu has a B.Sc. (Hons) in Civil Engineering and an MBA in Finance and Project Management both from the University of Nairobi. She is a Registered Engineer with the Engineers Board of Kenya as a Structural Engineer and has extensive working experience as a Structural Engineer and Engineering Projects Manager in both private and public sector.

Eng. Grace Kagondu has vast experience in Facilities Management, Risk Management and Procurement Practice. She is a Fellow of the Architectural Association of Kenya (AAK) and a Member of the AAK Board of Trustees. She has also served as an Executive Committee member of Association of Professional Societies of East Africa (APSEA) and is a past chair of the Engineers Chapter of AAK and past member of the AAK Governing Council. She has also served on the Council of Kenya National Qualifications Authority (KNQA). In 2018 she was awarded the Leaders & Legends Award for being a Legend in Leadership in the Built Environment.

ENG. CHRISTINE OGUT
2ND VICE PRESIDENT

Eng. Christine Ogut is 2nd Vice President, Institution of Engineers of Kenya. She works as Deputy Director Safety Audits and Inspections at the National Transport and Safety Authority (NTSA).

She is an accomplished, result- driven Civil Engineer with over 30 years' engineering work experience. Eng. Christine Ogut has served as Chief Officer Roads, Transport & Public Works as well as Chief Officer Environment, Energy & Water, Nairobi County Government. Eng. Ogut has also worked as Director, Nairobi Water and Sewerage Company and Manager (Roads) at Kenya Urban Roads Authority (KURA).

As a past 1st President of Africa TechNet, she provided training opportunities for technical officers in Africa. She is a member of WFEO Standing Technical Committee on Environment.

At IEK, she has served as the Chair of the Women Engineers Chapter, in the Governance Audit and Risk Committee, as member of Capacity Building and Mentorship Committee, member of Events and Conference Committee and as a leading mentor for graduates and women engineers.

She is panelist for professional interviews (in Civil Engineering), an advocate for engineers' welfare and a strong proponent of additional Continuous Professional Development (CPD) score areas, as well as a champion for Engineers' rights (professional, employee & membership rights).

Eng. Ogut is passionate about promoting Science, Technology and Mathematics Education (STEM) and engineering education in schools and universities. Her driving vision is Professional Excellence in Engineering.

ENG. NATHANIEL MATALANGA
IMMEDIATE PAST PRESIDENT, IEK

Eng. Nathaniel Matalanga is the Immidiate Past President of the Institution of Engineers of Kenya,. He is a member of Architectural Association of Kenya – Engineers Chapter, member of Uganda Institution of Professional Engineers, member of Institution of Engineers Rwanda, registered Engineer – Kenya, Uganda, and Rwanda, Executive Council Member of World Federation of Engineering Organizations (WFEO), Hon. Secretary of IEK 2015-2016 & 2018 - 2020, registrar at Architectural Association of Kenya – 2013-2017 and Chairman of Architectural Association of Kenya, Engineers Chapter – 2007-2013

He has over 32 years' experience in the structural and civil engineering design of buildings and surrounding infrastructure. He has hands-on experience in designing and implementing schemes in the Horn of Africa and the Great Lakes Region (Rwanda, Burundi, Uganda, Kenya, Sudan, South Sudan, Tanzania, and Somalia).

ENG. SHAMMAH KITEME
HONORARY SECRETARY

Eng. Shammah Kiteme is the Honorary Secretary of the Institution of Engineers of Kenya. He is a Corporate Member of the Institution of Engineers of Kenya and registered as Professional Civil Engineer with the Engineers Board of Kenya. He is also a Certified Project Management Professional (PMP)®. and the founder of CengProm Services Limited Civil Structural Engineers and Project Managers, where he is Principal Engineer and Director of Projects. He has over 10 years vast working experience in the engineering industry in Kenya. Eng. Kiteme holds a Master of Arts (MA) in Project Planning and Management (University of Nairobi) and Bsc. (Civil Engineering) from the University of Nairobi.

ENG. JUSTUS OTWANI
HONORARY TREASURER

Eng. Justus Otwani is the Honorary Treasurer of the Institution of Engineers of Kenya (IEK). Eng. Otwani is a Fellow of the Institution of Engineers of Kenya and a registered Civil Engineering Consulting Engineer, with over 24 years' experience in design and construction supervision of urban and rural roads in Kenya and South Sudan.

Eng. Otwani holds a BSc. (Civil Engineering) and a Master's Degree in Project Planning and Management. He is currently pursuing a Master's Degree in Transportation Planning at the University of Nairobi. Eng. Otwani is a Corporate Member of the Architectural Association of Kenya, Engineers Chapter, where he currently serves as the Chairperson. From 2015 to 2018, he served as a Director at the Rural Electrification Authority (now REREC). He was the Chairman of the Human Resource Committee of the Board, as well as a member of the Strategy and Project Implementation Committee.

ENG. JENNIFER KORIR
ORDINARY COUNCIL MEMBER

Eng. Jennifer Korir is an Ordinary Council Member. She is a Corporate Member of IEK and a Civil Engineer (Civil Engineering, University of Nairobi, 2006). She is currently pursuing a post-graduate MSc. (Transportation Engineering, University of Nairobi) and boasts 16 years working experience. She currently works at Kenya Urban Roads Authority (KURA), where she holds the position of Senior Engineer, Regional Urban Road Co-ordination, Nairobi.

She serves in the IEK Transportation Sub- Committee member, and in PRAC Committee as Secretary. She has actively participated in multiple reviews of policies and webinars organized by the Institution of Engineers of Kenya. She loves being an engineer and enjoys utilizing her skills and abilities to touch people's lives. She believes she is a leader who can influence people to get things done in the right way.

ENG. PAUL OCHOLA,
ORDINARY COUNCIL MEMBER

Eng. Paul Ochola is an Ordinary Council Member and Fellow of the Institution of Engineers of Kenya. He is a Consulting Engineer with Engineers Board of Kenya. He holds an MSc. in Information Systems with specialization in Artificial Intelligence and Bsc. In Electrical and Electronics engineering, both from the University of Nairobi.

Currently, he is the Senior Manager, Network Infrastructure at KCB Bank Kenya. Previously, he has served in the role of Power Systems Manager at the same Institution; Graduate Engineer in KPLC rising to the position of 3rd Assistant Engineer, IT & Telecoms; and Telecommunication's Supervisor with the then Electro-Sigma Company Ltd.

He has been involved in the deployment of various projects that have led to the consolidation, convergence, and virtualization of voice, video, data center and data infrastructure platforms.

He is a member of KEPSA ICT Sector Board; current Chairperson of the IEK Legislation and Regulations Committee; current Vice Chairperson of the IEK Membership and Mentorship Committee; current Chairperson of IEK Mentorship Sub-Committee; previously served in IEK PRAC Committee; and former Chairperson of PRAC Telecommunications Sub-Committee. Eng. Ochola is Passionate about the mentoring of young career professionals, currently part of the mentorship team of the graduate engineers in electrical preparing for corporate admission at IEK. He is a Professional Interview Panellist member in the category of the Electrical and Telecommunications Engineering at EBK.

His vision for the IEK is to see it grow into a globally recognized authoritative Institution of Engineering Professionals covering aspects of strengthening of devolved IEK Mashinani, capacity building, building strong and value generating partnerships and strengthening of the governance framework for the application of Engineering Science.

ENG. DR. ELISHA AKECH OCHUNGO,
ORDINARY COUNCIL MEMBER

Eng. Dr. Elisha Akech Ochungo is an Ordinary IEK Council Member. He holds a Ph. D (UoN), MSc. (UoN), BSc. (JKUAT) and is a Fellow of the Institution of Engineers of Kenya and a Consulting Engineer registered with Engineers Board of Kenya.

A Civil Engineer of more than two decades, Dr. Elisha is a Senior Lecturer at Multimedia University, where he is the Transportation Engineering Thematic Leader.

In 2003, he founded GA Consultants Ltd, a civil engineering consultancy firm where he has been the Managing Director since. During the period 2015-2018, he served as a Board Member at Rural Electrification & Renewal Energy Commission (REREC).

He has spent much of his working life as a Highway Engineer doing CAD Applications with Otieno Odongo & Partners, CAS Consultants, APEC Consortium, Runji & Partners, LEA Associates International (INDIAN) and Tertiary Consulting Engineers.

His competency is in technology applications, being accomplished in AUTOCAD and associated highway engineering design software as a user since the year 2000.

In research, his focus is on sustainability analytics and climate change action under Climate Change & Sustainability Basics Association of Kenya in collaboration with Stanford University's MAHB program.

ENG. LILIAN MUMBUA KILATYA, ORDINARY COUNCIL MEMBER

Eng. Lilian Mumbua Kilatya is an IEK Ordinary Council Member. She is a professional Civil Engineer, currently working for the Kenya Bureau of Standards (KEBS) as a Quality Assurance Officer.

She previously worked for local civil engineering consultancy firms as a Civil/Structural Engineer and has seven years' experience in Structural and Civil design, supervision of construction projects, concrete mix designs and quality control of construction materials and processes.

As the KEBS Civil Engineering Forum chairperson, she steers discussions revolving around registration of engineers and other interests.

ENG. JENNIFER GACHE, ORDINARY COUNCIL MEMBER

Eng. Jennifer Gache is an IEK Ordinary Council Member; a regional expert in Industrial Development and Energy Sectors. Eng. Gache works for GFA Consulting Group, subcontracted by GIZ to support implementation of the 'Support to the East African Market-oriented and People Centred Integration Process- SEAMPEC' in the East African Community (EAC) comprising Burundi, Kenya, Rwanda, South Sudan, Tanzania and Uganda.

She is passionate about increasing intra-EAC regional trade by promoting value addition, development of micro, small and medium enterprises (MSMEs) and engagement of private sector in the EAC. In her role, she supports the creation of enabling framework and opportunities for the manufacture and trade of safe and quality assured manufactured products.

Eng. Gache has worked for the Kenya Bureau of Standards, Kenya Power and Lighting Company, Geothermal Development Company and the East African Community Secretariat (EAC). She holds a Bsc. (Hons) Mechanical Engineering from the Jomo Kenyatta University of Agriculture and Technology, and a Master's in Business Administration (MBA) Operations Management and Research from the University of Nairobi. She is a Registered Engineer with the Engineers Board of Kenya and Corporate Member of the Engineers Board of Kenya.

ENG. FLORAH KAMANJA, ORDINARY COUNCIL MEMBER

Eng. Florah Kamanja has fourteen years of experience working in the Energy Sector. She is currently a Senior Engineer in Business Development Department at KenGen.

Eng. Florah has vast experience in Project Appraisal, Project Management, Consultancy Services Supervision, Value for Money Analysis, Public Private Partnerships (PPP), Energy Resource Assessment, Energy Planning, Energy Forecasting and Strategy Formulation, Power Plants Maintenance and Operation.

Eng. Florah holds a MSc in Nuclear Engineering, BSc. in Mechanical Engineering and is currently pursuing MBA in Finance Management. She holds a certificate in Environmental and Social Impact Assessment and solar PV installation.

She is a Corporate Member of the Institution of Engineers of Kenya and a Professional Engineer with Engineers Board of Kenya. She is a member of the Least Cost Power Development Plan Committee in the Energy Sector and a certified Change Agent. Eng Florah is a mentor to Engineering Students and has keen interest in sustainable energy solutions.

ENG. ERIC NGAGE, IEK WESTERN BRANCH CHAIRMAN

Eng. Eric Ngage is the IEK Western Branch Chairman. He is a Professional Engineer and Fellow of the Institution of Engineers of Kenya. He holds a BSc. (Engineering Mechanical, University of Nairobi) and MSc. (Project Management, JKUAT). He is a Certified Practical Operations Manager (Yokohama Kenshu Centre, AOTS JAPAN). He is also an Internationally Certified Sugar Manufacturing expert (Robert Antoine Sugar Training Centre (Mauritius).

He currently works as Director of Mechanical Engineering and Transport at the County Government of Kisumu. Eng. Ngage's core competencies are in the area of Project Management, Strategic Planning, Installation & Commissioning, Machine Operations & Maintenance, Budgeting & Cost Optimization.

He has served in numerous positions of responsibility in engineering, including as Chairman at the Institution of Engineers of Kenya, as Chairman of Infrastructure Committees in Boards of Management of Onjiko Boys and Ahero Girls High Schools, as well as Chairman of Engineering and Process Division, Kenya Society of Sugar cane Technologist and Committee Member, Process, Research and Marketing East Africa Society of Sugar Cane Technologists.

ENG. MWAKA MUNGATANA,
IEK COAST BRANCH CHAIRMAN

Eng. Mwaka Mungatana is Chairman of Coast Branch of the Institution of Engineers of Kenya. He holds an MBA and Bsc. (Hons) Degree in Mechanical Engineering both from the University of Nairobi.

Eng. Mungatana is a Professional Engineer and Corporate Member of the Iinstitution of Engineers of Kenya. He has vast experience in the field of Project management, Power Generation, Manufacturing and Corporate Management.

He has served on the Board of Tana and Athi River Development Authority (TARDA), a Council Member of Kibabii University, and is the current Chairman of the Board of Garsen Technical &Vocational College.

He is employed by Tsavo Power as the Chief Technical Engineer. He has previously worked with Kenya Power, Kenya Breweries & Kenya Pipeline.

ENG. ABDULRAZAQ A. ALI,
IEK NORTH EASTERN BRANCH CHAIRMAN

Eng. Abdulrazaq A. Ali is IEK North Eastern Branch Chairman. He holds a BSc. (Hons) Civil Engineering, University of Dar es Salaam and MSc (Irrigation Engineering) University of Leuven, Belgium.

He is a Fellow of the Institution of Engineers of Kenya (FIEK) and a Lead Expert-in Environmental Impact Assessment/Audit, an Associate Member of the Chartered Institute of Arbitrators (UK) and a Licensed Water Engineer duly registered as a Consulting Engineer with Engineers Board of Kenya.

He has previously served as Permanent Secretary, Ministry of Trade where he developed trade and trade related policies including the National Trade Policy for Kenya. He also served as Chairman East African Community negotiation team for the EAC-EU economic partnership Agreement.

He is Chairman and Chief Executive Officer of Africon Universal Consulting Ltd and a leading expert in Environmental Impact Assessment. As a CEO of Africon, he has served as a consultant with Inter-Governmental Authority on Development (IGAD) Trans-Boundary Water Resources Assessment and Treaty, Arid and Semi- Arid Lands Policy Review in Kenya, Review of Leather Products in Kenya.

He has also worked as Managing Director, Ewaso Nyiro North Development Authority where he guided responsible, visionary and strategic leadership program; leading to effective and quality improvement of operations and sound management of financial and human resources.

ENG. PROF. LAWRENCE GUMBE
CHAIRMAN, IEK EDITORIAL BOARD

Eng. Prof. Lawrence Gumbe holds a Ph.D (Ohio State University, USA), an M.Sc. degree (Cranfield University, UK) and a B.Sc. degree from the University of Nairobi, Kenya. He is a Registered Professional Consulting Engineer (CE) by the Engineers Board of Kenya.

He is a Lead Consultant with the National Environment Management Authority (NEMA), and is a Consultant and Chief Executive Officer (CEO) of Log Associates, a firm of Consulting Engineers, Economists, Environmentalists and Planners working in Eastern, Central and Southern Africa. He is a Chartered Environmentalist in the United Kingdom. He was chairperson of the Centre for Multiparty Democracy-Kenya, CMD-K, in the period 2007 to 2012. During this period, he chaired many relevant meetings and negotiations, which resulted in important actions in the country

He is a member of several learned societies including Fellow of the Institution of Engineers of Kenya (IEK), member of the Association of Consulting Engineers of Kenya (ACEK),member of the Architectural Association of Kenya (AAK), member of the American Society of Civil Engineers (ASCE),member of the American Society of Mechanical Engineers (ASME), Fellow of the Kenya Society of Environmental, Biological and Agricultural Engineers (KeSEBAE), member of the American Society of Heating, Ventilating and Air-Conditioning Engineers (ASHRAE), member of the American Society of Agricultural and Biological Engineers (ASABE), member of the Institution of Agricultural Engineers (IAgE), UK, and Fellow of the Kenya National Academy of Sciences (KNAS).

He currently serves as Chairman, Editorial Board of the Institution of Engineers of Kenya (IEK), where he spearheaded launch of the ***Engineering in Kenya*** magazine in 2021. He is also Editor of the ***Journal of Engineering in Agriculture and the Environment*** quarterly, owned by the KeSEBAE. The Journal publishes peer reviewed research and innovation articles. Its Editorial Board has eminent engineering professors from Kenya, South Africa, Tanzania, Nigeria, USA, UK and China.

Eng. Prof. Gumbe served as an academic member of staff at the University of Nairobi from 1981 to 2014. He was Chairman of Department of Agricultural Engineering of the University of Nairobi in 1998 to 2003 and Chairman of Department of Environmental and Biosystems Engineering 2003 to 2006. He is a member of the Kisumu City Board since 2018. He is fluent in English, Kiswahili, Dholuo, French and Lingala, and has basic knowledge of Arabic.

ENG. KAHORO WACHIRA

Eng. Kahoro Wachira is a Fellow of The Institution of Engineers of Kenya and a Registered Professional Engineer (PE) with the Engineers Board of Kenya. He holds a Post-Graduate Diploma (Energy Management) from the University of Nairobi and a BSc. (Electrical and Electronics Engineering) from the University of Nairobi.

Eng. Kahoro Wachira is currently the Chief Engineer Technical Services Department at Kenya Power and Lighting Plc.

He is affiliated to several associations including member of the Kenya National Committee of the IEC (KNIEC), member of the Africa Electrotechnical Standardization Commission (AFSEC) TC 57, a member of the Society of Professionals with Visual Disabilities (SOPVID) among others.

ENG. HANNAH NJERI KAMAU, CHAIR IEK CENTRAL KENYA BRANCH

Eng. Hannah Njeri Kamau is the Chair, Central Kenya Branch of the Institution of Engineers of Kenya. She is a registered Professional Engineer with Engineers Board of Kenya and a Corporate member of the Institution of Engineers of Kenya

She is currently the Head of Capital Projects at Dedan Kimathi University of Technology. Prior to this, she worked in the Ministry of Water and Irrigation, Kenya as a WASH expert. She holds a B.Sc. in Civil Engineering from the University of Nairobi, is a continuing Master's student in Water Resources Engineering at the University of Nairobi and a Post-Graduate Diploma I holder in Project Management (DeKUT). She has over 16 years' experience as an Engineer in both Structural and Water Services Engineering.

ENGINEER HARRISON KETER, CHAIRMAN, IEK SOUTH RIFT BRANCH

Engineer Harrison Keter is the Chairman, South Rift Branch of the Institution of Engineers of Kenya. He previously served as the founding Branch Council member for IEK South Rift Branch. He is currently the Assistant Operations Manager, Geothermal at Kenya Electricity Generating Company PLC.

He is a Corporate Member of the Institution of Engineers of Kenya (IEK) and registered Professional Engineer with the Engineers Board of Kenya (EBK). He is also a professional member of Geothermal Association of Kenya (GAK) and Institution of Engineering Technicians and Technologists of Kenya (IET).

Eng. Keter has extensive experience in the energy sector spanning over 17 years. His areas of expertise ranges from electromechanical engineering projects, project management with specialization in design, development, operation and maintenance of power plants and renewable energy technology, particularly in Geothermal, hydropower and solar energy technologies.

He holds a BSc in Mechanical Engineering (UoN) and post graduate Diploma in Geothermal Technology and Utilization (UNUGTP). He is currently pursuing an MSc. in Energy.

ENG. DAMARIS K. OYARO, CHAIR, IEK CAPITAL BRANCH

Eng Damaris K. Oyaro is the Chair, Capital Branch of the Institution of Engineers of Kenya. She is a lecturer at the University of Nairobi Department of Civil and Construction Engineering.

Eng. Damaris has a B.Sc in Civil Engineering from the University of Nairobi and an M.Sc in Sanitary Engineering from Leibniz University of Hannover. She is a Corporate Member of the Institution of Engineers of Kenya, with over fifteen years' experience. Her field of expertise is Water, Sanitation and Environmental Engineering. She is also the Chair of the Outreach Committee for the Institution of Engineers of Kenya.

REPUBLIC OF KENYA

ENGINEERS BOARD OF KENYA

ENGINEERS BOARD OF KENYA

THE ENGINEERS STAMPS

Introduction/ Background

Pursuant to Part II, Rule 10 (4-8) of the Engineers Rules, 2019 the Board procured the Engineers Stamp. It states that "the Board shall, issue an official rubber stamp to every professional and consulting engineer registered under the Act on payment of the fees prescribed in the Third Schedule of the Rules. In addition, the rubber stamp issued shall be used for approving or certifying engineering documents including design calculations, drawings, technical reports, and other engineering documents. A professional engineer or a consulting engineer shall sign and date and affix the rubber stamp issued under paragraph (4) on any approval or certification given by the professional engineer or a consulting engineer.

Furthermore, in fulfilment of Section 7 (1) (m) of the Engineers Act, 2011, that mandates the Board to "set standards for engineers in management, marketing, professional ethics, environmental issues, safety, legal matters or any other relevant field" the Board developed Guidelines for use of the Engineers Stamp.

Purpose of Engineer's Stamp

To identify and distinguish all work prepared by a professional engineer, or under his/her direct supervision

- By affixing the stamp, the professional engineer assumes responsibility and is answerable for the quality of work presented. Signing and stamping of an engineering document by a professional engineer certifies that the professional engineering services rendered have been completely, adequately and/or reliably performed.
- Proper use of the stamp is essential, not only for complying with the Engineers Act, 2011 and the Engineers Rules 2019, but also for assuming the public that the stamp represents the profession's commitment to the set standards.

Importance of Engineer's stamp

- It gives assurance that the work meets the standards of professionalism expected of a professional engineer.
- By affixing the stamp, professional engineers assume full responsibility for their judgments and decisions based on their knowledge, skills and ethical conduct.
- It is a statement by a professional engineer to the intended recipient of the engineering document that he/she can rely upon the contents of the engineering document.

Features of the Stamp

- Self-inking with built-in internal stamp pad;
- Protective cover on the base;
- High quality rubber;
- EBK Logo affixed on the casing;
- The name and registration No. of the engineer on the stamp printout; and
- Unique security features

To apply, Kindly, pay Kshs. 5000 to Mpesa Paybill: 839300; Account Number: Your Reg. No

From left: Eng. Margaret Ogai, Registrar EBK; , Prof. Arch. Paul M. Maringa (PhD), Corp, Arch, (Maak), Mkip, the Principal Secretary for the State Department of Infrastructure; and Eng. Erastus Mwongera FIEK, RCE, MBS during the launch of the Engineers'stamp at KICC

The Board Launched the Engineers' Stamp on 9th December 2021 at Kenyatta International Convention Centre graced by the Principal Secretary for the State Department of Infrastructure, Prof. Arch. Paul M. Maringa (PhD), Corp, Arch, (Maak), Mkip.

The issuance of the Engineers' stamp has officially commenced. The Board, through the Registrar, Eng. Margaret Ogai issued the 1st stamp to Eng. Christopher Atsyaya on 7th February 2022

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