# Engineering
## IN KENYA

ISSUE 002

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# Made Smarter: Industry 4.0 Adoption

KONZA
Technopolis

# Why invest in Konza?

## Strategic Growth Clusters

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Life Sciences

Engineering

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Education

Commercial Development

KENYA VISION 2030

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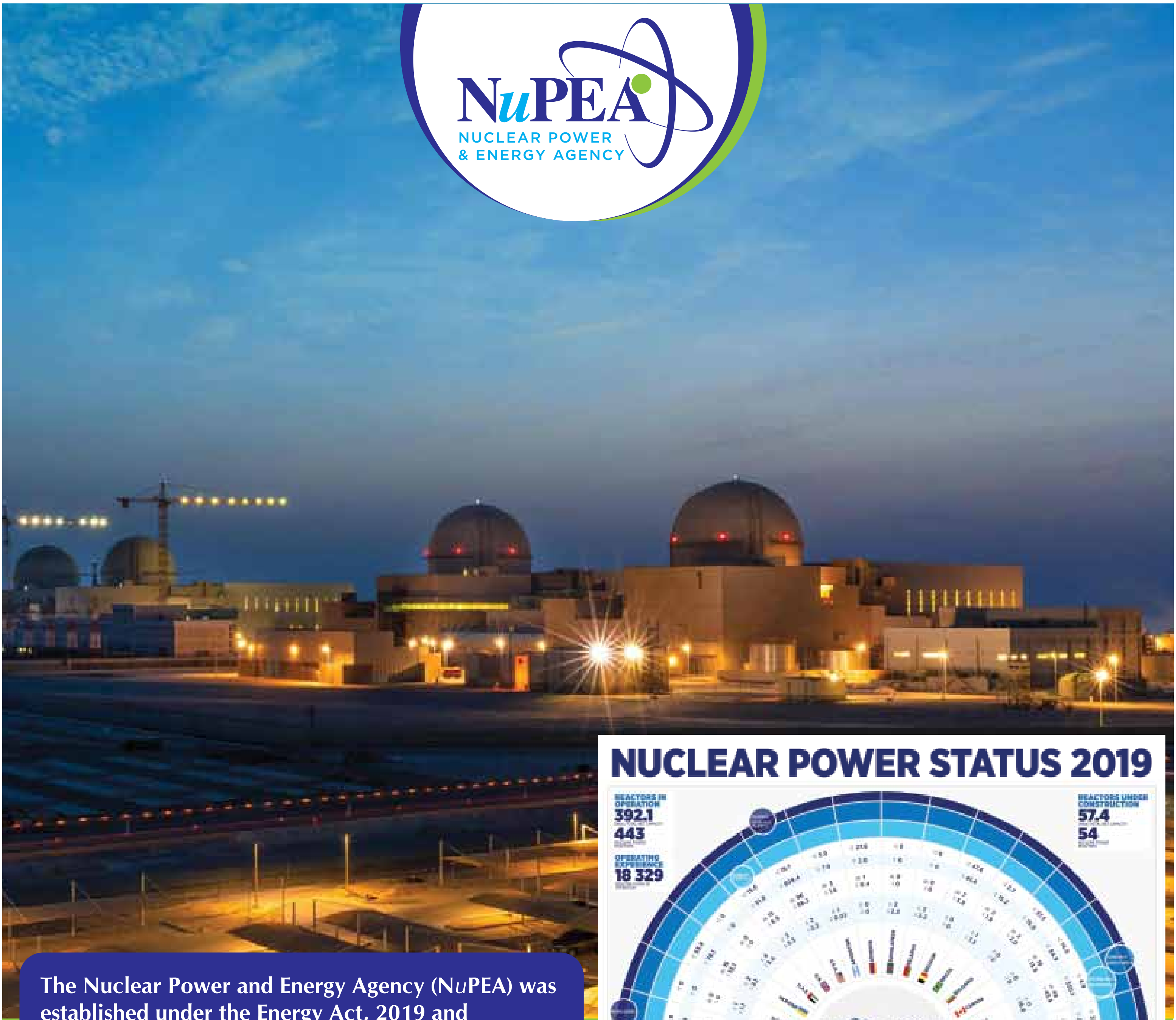
Engineering in Kenya Magazine is published bi-monthly by Michimedia Ltd for the Institution of Engineers of Kenya.



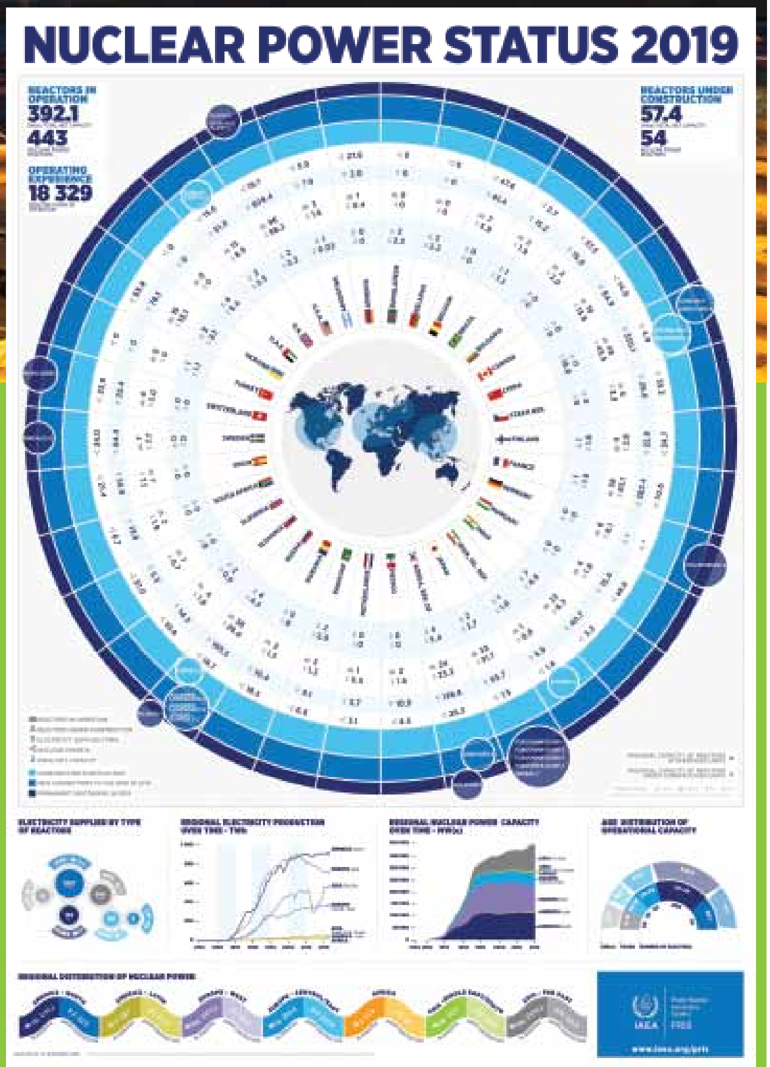
# Calendar of events 2021

| Date | Event |
|---|---|
| March 4 | World Engineers' Day |
| March 10 | Transportation modelling |
| March 11 | Trainers of trainers for PES on effective mentorship |
| March 19 | Agency based PIP for KenGen |
| March 20 | Webinar on work/job interview preparation |
| March 26 | Seismic retrofit of buildings<br>President's dinner |
| April 2 | Transforming business with migration from 4G to 6G via 5G network technologies |
| April 9 | Leveraging on regulatory framework to boost automotive industry in Africa |
| April 15 | Agency based pip for Huawei/Safaricom<br>Tree planting activities in all IEK branches |
| April 20 | Annual General Meeting |
| April 20 to May 20 | Benevolent fund webinar |
| April 28 | Engineers scheme of service webinar |
| May 6 | Agency based PIP for GDC |
| May 7 | Leveraging on e-resources for advancement of the engineering fraternity: launch of e-library |
| May 13 | The future of Kenya's agricultural industry |
| May 19 | Agency based PIP-county government (Nairobi/Kakamega/Kajiado/Garissa) |
| May 20 to September 3 | Cement processing in Kenya – role of engineering |
| May 21 | ADR webinar |
| June 4 | Engineers ethics in building industry |
| June 10 | Work zone safety |
| June 11 | Agency based PIP-water service boards |
| June 25 | President's dinner |
| July 2 | Fast tracking manufacturing of telecommunications equipment and devices in Kenya: current status, challenges and the way forward |
| July 7 | 4th IEK women engineers summit |
| July 9 | State of manufacturing in Kenya – potential and challenges |
| July 23 | Engineers golf tournament |
| August 6 | Industry 4.0 automation case study |
| August 12 | Irrigation systems design |
| August 20 | ADR webinar<br>Digital transformation and driving efficiency using IOT |
| September 7 | First IEK young engineers summits |
| September 8-10 | 28th IEK international conference |
| September 10 | KAA/KQ Covid-19 impact |
| September 11 | Engineering intervention with agricultural systems structures for post-harvest losses |
| September 17 | ADR webinar |
| December 10-23 | Selected CSR activities for branches |
| December 12 | Standard Gauge Railway |

NuPEA
NUCLEAR POWER & ENERGY AGENCY



The Nuclear Power and Energy Agency (NuPEA) was established under the Energy Act, 2019 and succeeded the Kenya Nuclear Electricity Board (KNEB). NuPEA is mandated to fast-track the development and implementation of the nuclear power programme in Kenya, carry out research and development and capacity building in the energy and petroleum sectors.




## VISION
Provider of Safe and Sustainable Energy Solutions

## MISSION
To develop nuclear power, and undertake research and capacity building in the energy sector for socio-economic prosperity

## CORE VALUES
**I-TEC**: Integrity, Teamwork, Excellence, and Creativity and Innovativeness

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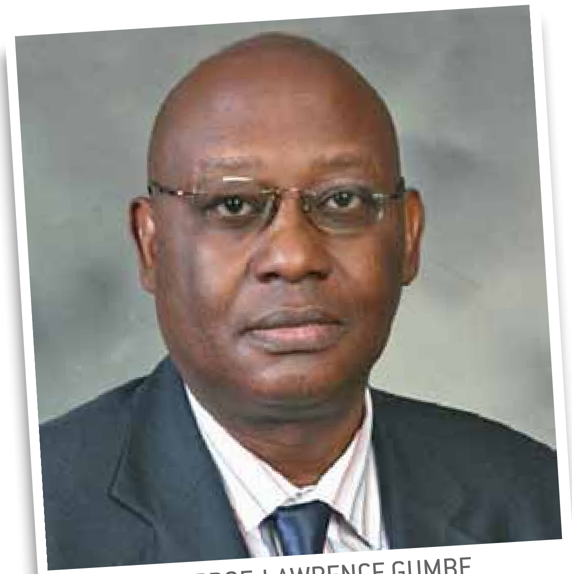

ENG. PROF. LAWRENCE GUMBE

> The transformation towards Industry 4.0 will involve retrofitting existing industrialized systems with Industry 4.0 technologies that could provide more sustainable solutions. Standardization, partnerships, and responsible policy design are all ways that lead up to maximizing the economic, social and environmental potentials of Industry 4.0.

# Industry 4.0: An excellent opportunity for Kenya and the world

WE welcome you to the second edition of Engineering In Kenya. The theme of this edition is Industry 4.0.

Industry 4.0 is the Fourth Industrial Revolution. It encompasses the automation of conventional manufacturing and industrial practices. It uses modern smart technology. Large-scale Machine to Machine Communication (M2M) and the Internet of Things (IoT) are used together to increased automation, improve communication and self-monitoring, and the production of smart machines that can analyse and diagnose issues without the need for human intervention. Engineers will play a major role in Industry 4.0.

Industry 4.0 could contribute to finding new ways of dealing with major global challenges, such as climate change, lack of clean energy access, economic stagnation and reducing the digital divide. Engineers will play a major role in Industry 4.0.

The world has benefitted positively from the previous three previous industrial revolutions.

The First Industrial Revolution started in England in late 1700s. It led to a transition from hand production methods to machines through the use of steam power and water power. It took full effect in Western Europe and USA by mid 1800s.

The Second Industrial Revolution, also occurred first in Western Europe, USA and Japan in the period between mid 1800s and early 1900s. This revolution resulted from installations of extensive railroad and telegraph networks, which allowed for faster transfer of people and ideas, as well as electricity.

Increasing electrification in the Second Industrial Revolution enabled factories to develop modern production lines. It was a period of great economic growth, with an increase in productivity.

The Third Industrial Revolution, also known as the Digital Revolution, occurred in the late mid to late 1900s. It occurred in Europe, USA, Japan and the newly industrial countries such as China, Korea and Singapore. This revolution was led mainly by microelectronics. This revolution led to the development and popularization of supercomputers, personal computers, the internet, mobile communication systems and digital manufacturing.

Vision 2030 sees agriculture as an important sector for the industrialization of Keya. Industry 4.0 uses smart sensors in farms and greenhouses to enable more efficient and effective inputs of water, fertilizer and other chemicals, by drones and other devices, as well as timely harvest of crops. In animal production, the sensors allow for targeted administration of feed and medicines leading to better yields and profits.

In engineering design and infrastructure Industry 4.0 has the potential advantage bringing about faster construction, lower labour costs, increased complexity and/or accuracy, greater integration of function, and less waste produced. 3D printing has great potential here.

There are a variety of 3D printing methods used at construction scale, with the main ones being extrusion (concrete/ cement, wax, foam, polymers, powder bonding (polymer bond, reactive bond, sintering, and additive welding. 3D printing at a construction scale will have a wide variety of applications within the private, commercial, industrial and public sectors.

In manufacturing, industry 4.0 gives us real opportunities in increasing effectiveness and efficiency leading to better micro-economics in factories. Smart modular factories, and cyber-physical systems monitor physical processes, can create virtual copies of the physical world and make decentralized decisions.

The internet of things(IoT) allows for communication between machines and also humans throughout the value chain of manufacturing leading to better systems.

Industry 4.0 can also provide predictive maintenance, due to the use of technology and the IoT sensors. Predictive maintenancee– which can identify maintenance issues in live– allows machine owners to perform cost-effective maintenance and determine it ahead of time before the machinery fails or gets damaged. An engineer in Nairobi can see in real-time, and correct, a machine which is malfunctioning in Wajir.

The transformation towards Industry 4.0 will involve retrofitting existing industrialized systems with Industry 4.0 technologies that could provide more sustainable solutions. Standardization, partnerships, and responsible policy design are all ways that lead up to maximizing the economic, social and environmental potentials of Industry 4.0.

Developing countries will have the opportunity to leapfrog stages which were taken by developed countries towards their industrialisation. The developing countries will effect this leapfrogging without repeating the mistakes of traditional development pathways.

Regions that are less developed can become candidates for the development of smart factories, decentralized and renewable energy microgrids There are exciting prospects for engineering and development of Kenya and the world in Industry 4.0.

We promise you that we will continue trying our best to inform, educate and entertain you!

***Eng. Prof. Lawrence Gumbe, Editor***

# Hire only qualified engineers for projects, IEK urges State and private developers

ENG. MATHANIEL MATALANGA

THE Kenyan government and private developers have been urged to always procure and retain the services of qualified and competent engineers for quality development projects.

According to Institution of Engineers of Kenya (IEK) President Eng. Nathaniel Matalanga, this will optimize the outcome of development projects and avoid economic losses that result from poor workmanship done by quacks.

"The Institution of Engineers of Kenya plays a critical role in making policy recommendations that aid government plans, such as the Big 4 Agenda. Until skilled and competent engineers are involved in these plans, we will not optimize the country's resources for the benefit of the common mwananchi," said Eng. Matalanga.

He said this competency should be considered both at the highest levels – in government boardrooms, project tender negotiations, awarding and technical valuations – and at all levels of day-to-day, such as hospitals and vehicle maintenance yards.

The president condemned the tendency to disregard competent engineering in favour of selfish competing interests in both small and mega projects, saying this exposes Kenya to corruption which in turn leads to sub-standard services delivered.

He said the IEK membership comprises highly competent engineering and technology experts a rich membership database the government of Kenya can easily tap into in order to grow the country's development, including manufacturing as a pillar of the Big 4 Agenda.

"Many Kenyan engineers are involved in steering fully-fledged local manufacturing and assembly initiatives. They are the people in charge all these technical process plants, construction projects, roads, factories and all manner of technical entities," said Eng. Matalanga.

"They ensure correct equipment is procured and that critical equipment are working safely and properly, and are serviced, calibrated and optimized, so that such investments can deliver value for money."

He said outsourcing of talent that ignores locally available engineers is ultimately expensive and do not serve the interests of Kenyans.

"The reason for some of the technical economic losses we suffer as a country such as broken-down equipment in hospitals and poorly maintained government vehicles is the failure to involve dedicated career professionals such as competent engineers in the leadership of critical institutions, by-passing their skills in favour of competing selfish interests," said Eng. Matalanga.

According to the president, requirements for positions of leadership that were traditionally a preserve of engineers with technical know-how have overtime been reduced to accommodate any other degrees to suit selfish interests, through unbecoming legislations.

This has in turn relegated competent engineers to the periphery, while exposing mega project resources to mismanagement and economic plunder.

"Engineers are the brains behind literally every facet of our lives today, including life-saving hospital equipment in surgical theatres. They are professionals whose contributions can help optimize agriculture, key sectors of the economy and grow the GDP, depending on how their skill is deployed, facilitated and allowed to thrive and innovate," said Eng. Matalanga.

He said Kenyan engineers have earned international recognition with such inventions as the UNESCO-recognized MPESA and invention of the smart meter in the water sector, to mention but a few.

The president also spoke on the role of the engineering in the pursuit of the government's Big 4 Agenda, especially industrial manufacturing.

"As IEK, we complement and work together with stakeholders like the Kenya Association of Manufacturers in developing the correct policies and legislation to support and enable fully-fledged local manufacturing and assembly," he said.

He said whereas engineers have a duty to specify what equipment work best in manufacturing, their role is also to try to economically use the available resources for maximum benefit of humanity.

"This is why as IEK, our position in support of local manufacturing industry and Buy Kenya Build Kenya initiative has always been that it is much cheaper to use what is locally available if the quality and technical specifications match what could be imported," said Eng. Matalanga.

The IEK president also decried the tendency by some agencies and development stakeholders to outsource foreign talent at the expense of local engineers and manufacturers.

"Supporting local manufacturing will open countless opportunities for citizens of this country and grow our economy. Had initiatives like the Nyayo Car been passionately funded, Kenya would today be manufacturing her own cars. It does not make sense to import a tuk tuk when our able engineers can fabricate it here at reduced costs," he said.

Eng. Matalanga urged stakeholders to optimize industrial manufacturing operations by allowing greater room for innovation, in line with global Industry 4.0 advancements.

"For you to get value for money, increasing local and global challenges – such as the Covid-19 pandemic – and the need to optimize operations call upon all of us in engineering and manufacturing to adopt greater innovation. The future is greatly limited if we sit pretty in existing comfort zones," he said.

Eng. Margaret Ogai

# Message from the Honorary Secretary Eng. Margaret Ogai

THE Institution of Engineers of Kenya (IEK) is the learned society of the engineering profession and co-operates with national and international institutions in developing and applying engineering to the benefit of humanity. The Institution has a membership of more than 9,000, ranging from professional and graduate engineers, engineering students, technologists and technicians.

The membership is drawn from practicing engineers in all sectors of the economy, including various departments of national and county governments, universities, parastatals, industries, consultants, contractors and designers in energy, telecommunications, transportation, manufacturing, water supply and sanitation, housing, medical, agriculture, among others.

Although many members of IEK work in Kenya, there is a sizeable number of members based outside the country. Our membership includes senior practitioners, policymakers, researchers, educators and young professionals, and represent diverse interests in all sectors of the economy.

IEK undertakes a number of programmes to engage our membership and support professional development, welfare of engineers and advocacy to promote engineering practice in Kenya. These include webinars, conferences, industrial visits, submission of memoranda on policy matters, among others.

This year, we expect the 28th International Engineer's Conference slated for September 8th -10th, which promises to be more engaging, following last year's Conference which attracted over 1800 participants. Another exciting event to look forward to in our calendar of events in 2021 is the First IEK Young Engineers' Summit scheduled for September 7th, 2021. We also look forward to the 4th Annual Women Engineering Summitt, also slated for later on this year in September.

The World Engineering Day was held on 4th March – together with The Career Week – both events which are covered in detail in this publication, while the IEK AGM was held on 30th April. We acknowledge the role played by participants during the Career Week, especially engineering students from the various universities through their Engineering Departmental Chairs, Deans of Faculties and Principles of Schools, who re-established contact with IEK and with whom we now work hand-in-hand in pursuit of the accomplishment of IEK Programs and events.

We also witnessed the Training of Mentors from 26-29th April, as well as a number of Webinars.

We are grateful to the Chairman of the Engineering Board of Kenya (EBK) Eng. Erastus Mwongera and his team, with whom we have built close collaboration and partnership. We thank the Committees in charge of implementation of various initiatives of the IEK, all the Chairs and their members.

Our special thanks go to the Editorial Board, all authors who sent in articles for this edition, and the Publisher MichiMedia for outstanding work. We thank NuPEA, Liquid Intelligent Technologies, Konza Technopolis Development Authority, KENHA, Isuzu East Africa, Engineering Board of Kenya (EBK) and all our esteemed advertisers.

Lastly, we immensely acknowledge the support and contribution of various stakeholders in all these, especially members across all categories: Fellows, Corporate, Graduate and Student IEK members who have been instrumental and steadfast in their participation and support for various IEK activities and programs. We acknowledges the contributions of these members — Kenyan engineers – for their expertise in planning, designing, supervising and construction of infrastructure projects, telecommunications and manufacturing processes which contributes immensely to the pursuit of national economic goals and Vision 2030. We recognize that making IEK Programs and events successful would not be possible without their support, good-will and contribution. Enjoy your read!


# Liquid Telecom rebrands, bets big on tech

LIQUID Telecom has rebranded to Liquid Intelligent Technologies, completing what the internet and networks engineering technology firm calls "a business transformation from being a telecommunications and digital services provider to a full one-stop-shop technology group".

Liquid Intelligent Technologies currently boasts a wide digital infrastructure footprint in Africa, with a fibre optic cable network spanning over 73,000km.

The organisation has in recent years been aggressively pursuing expansion of its Cloud business, cybersSecurity services, and other technologies as add-ons to its existing telecoms and connectivity business.

The firm recently made a maiden entry into new African markets, including Nigeria and the Democratic Republic of Congo. The firm is currently a Microsoft Gold partner, implementing network security-driven from the cloud.

Liquid Intelligent Technologies recently launched its cyber security business unit aimed at protecting client's business' data throughout the business lifecycle.

"Our ongoing investment in our networks and data centers across Africa have uniquely positioned us to utilize our infrastructure to accelerate the availability of new intelligent technologies including the high computing power of the Cloud, Artificial Intelligence and Cyber Security to our customers," says Nic Rudnick, Group Chief Executive Officer, Liquid Intelligent Technologies.

"We are now excited to be executing our vision of bringing new technological opportunities to the market with a highly differentiated product set supported by our existing infrastructure and digital innovation."

> This strategic rebrand reflects Liquid's new digital-first product offerings, enabling employees and customers to interact with each other digitally irrespective of the time or location.

Founded in 2005, the firm currently has footprint across 14 countries, primarily in Sub-Saharan Africa. It also operates data centres in Johannesburg, Cape Town, Nairobi, Harare and Kigali. The rebrand furthers the Group's aim of accelerating growth by providing tailor-made digital solutions to businesses in the public and private sectors across the continent.

"This strategic rebrand reflects Liquid's new digital-first product offerings, enabling employees and customers to interact with each other digitally irrespective of the time or location," says the firm.

Under its new brand identity, Liquid Intelligent Technologies has eight business units: Liquid Networks, Liquid Business, Liquid Sea, Liquid Cloud, Liquid Cyber Security, Liquid Home, Liquid Innovation and Liquid Satellite.

WORLD ENGINEERING DAY

# Engineers urged to confront critical challenges to stay afloat in a changing world

KENYAN engineers joined the world on March 4, 2021 to celebrate this year's World Engineering Day for Sustainable Development with keynote speeches and presentations from guests and other participants.

This year's theme was 'Engineering for A Healthy Planet – Celebrating the UNESCO Engineering Report', which focused on celebrating the launch of the second UNESCO Engineering Report titled Engineering for Sustainable Development: Delivering on the Sustainable Development Goals. The report was launched in the afternoon by the World Federation of Engineering Organizations (WFEO) and attended by local engineers.

Mr James Macharia, the Cabinet Secretary for Transport, Infrastructure, Housing, Urban Development and Public Works, who was the chief guest at the celebrations held at the University of Nairobi's Chandaria Hall, said the engineering profession in Kenya must confront critical engineering challenges for it to remain relevant in a changing world.

The CS said in its bid to deliver on the Sustainable Development Goals (SDGs) and Kenya's Vision 2030, the country is implementing various key development projects under his ministry, but for which there is no adequate engineering manpower.

*IEK Council members at the launch of Engineering in Kenya magazine during World Engineering Day celebrations at the University of Nairobi.*

"There is a shortage of qualified engineers in Kenya as too few of them transition from graduate engineers to professional engineers," said Mr Macharia.

"The country urgently needs all licensed and professionally competent engineers to build the infrastructure, offices, homes and factories that are required for it to fulfill its vision of becoming an industrialized economy."

He noted that there is a declining interest in the profession that needs to be urgently addressed. This declining interest has led to an alarming drop in the enrolment of young people in engineering disciplines in Kenyan universities and colleges.

"The engineering profession urgently needs to come up with innovative ways of attracting and retaining the attention and interest of today's young men and women," said the CS.

Some of the key projects the government is currently undertaking or are complete include construction and rehabilitation of 10,000km roads, the Standard Gauge Railway, revamping of the existing meter gauge railway network, modernizing aviation facilities, expansion of the Port of Mombasa, bus rapid transit system in Nairobi, the Nairobi Expressway, the Lamu Port-South Sudan-Ethiopia-Transport (LAPSSET) Corridor project, among others.

"The engineering profession is


*IEK President Eng Nathaniel Matalanga and Editorial Board Chairman Prof. Eng. Larry Gumbe launch the Engineering in Kenya Magazine during the World Engineering Day 2021 at Chandaria Hall, University of Nairobi.*

therefore critical for the attainment of the government's development agenda and goals such as Vision 2030, development blueprint by His Excellency President Uhuru Kenyatta and the Big 4," said Macharia.

Institution of Engineers of Kenya (IEK) President, Eng. Nathaniel Matalanga, agreed that indeed engineers play a pivotal role in achievement of the socio-economic development envisaged by the SDGs.

"The onus is on Engineers to provide sustainable solutions. Engineers play a critical role in realization of the Pan African Vision of an integrated, prosperous and peaceful Africa, driven by its own citizens, representing a dynamic force in the international arena," said Eng. Matalanga.

He called on engineers across Africa to rise up to their calling to sustainably harness the abundant natural resources the continent is endowed with to facilitate realization of both the SDGs and AU Agenda 2063.

He said engineers continue to play an indispensable role in the realization of Vision 2030 and the Big Four Agenda to transform Kenya into "a newly industrializing, middle income country providing a high quality of life to all its citizens in a clean and secure environment".

> The engineering profession is therefore critical for the attainment of the government's development agenda and goals such as Vision 2030, development blueprint by His Excellency President Uhuru Kenyatta and the Big 4," said Macharia.

The IEK president hailed the engineering fraternity for their contribution towards managing the adverse effects of the Covid-19 pandemic that is still ravaging the world.

"As millions of lives were lost including those of frontline health workers, the spotlight was on Engineers to provide requisite Personal Protective and life support equipment and utilities to enable doctors carry out their work and prevent rapid transmission of the virus," he said.

Even though CS Macharia decried the alarming drop in the enrolment of students in engineering disciplines, all is not lost yet, as the Engineers Board of Kenya (EBK) is dedicated to ensuring every engineering graduate is put in a structured pathway to professional recognition.

"Over the past few years, the board has engaged with key stakeholders in academia and industry to ensure that the dreams of the young engineers who enter an engineering program with the hope graduating, getting relevant training and transforming into the practice are all realized in a timely manner," said EBK Chairman, Eng. Erastus Mwongera.

Eng. Mwongera said the board aims to transit 80 per cent of graduate engineers in their register to professional engineers in the next five years. The Principal Secretary, State Department of Infrastructure, Prof. Paul Maringa, hailed the EBK for introducing a card and security stamp for professional engineers, saying this will uphold ethics and integrity in the profession.

"That is a very welcome move and we recognise that technical competence and commitment to ethics by engineers is major and for prudent economic deployment of public and private resources and investment," said Prof. Maringa in a speech read by Infrastructure Secretary, Eng. Francis Gitau

Other keynote speeches and presentations were delivered by East African Federation of Engineering Organizations (EAFEO) Chairman, Eng. Collins Juma; IEK First Vice President, Eng. Lucy Mutinda; IEK Second VP, Eng. Erick Ohaga, who represented the Federation of African Engineering Organisations, and the President of WFEO, Prof. Gong Ke, among others.

The highlight of the day was the launch of the IEK bi-monthly magazine, Engineering in Kenya. The launch, punctuated with pomp and colour, was led by CS Macharia and facilitated by the magazine's Editorial Board Chairman, Eng. Prof. Lawrence Gumbe.

"This magazine will be a medium of communication for engineers, technologists, technicians and those who have interest in engineering," said Prof. Gumbe.

"It is a quality publication, which will carry quality technical articles and even those that will entertain us as engineers."

Also launched during the event was the IEK Career Week 2021, which took place from March 9-12.

While the event went down in Nairobi, simultaneously, the IEK branches also held celebrations in Mandera, Nakuru, Nyeri and Kakamega counties.

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ENGINEERS BOARD OF KENYA
Enhancing Professionalism

# THE ENGINEERS STAMP

## LEGAL PROVISIONS

The Engineers Rules 2019

Rule 10 (4): 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

Rule 10 (5): The rubber stamp issued under paragraph (4) shall be used for approving or certifying engineering documents including design calculations, drawings, technical reports and other engineering documents.

Rule 10 (6): 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 consulting engineer.

## PURPOSE OF THE STAMP

Enable the Public and other stakeholders to easily and correctly identify genuine engineering documents and the certifying engineer

## FEATURES OF THE STAMP

i. Self-inking with built-in internal stamp pad
ii. Protective cover on the base
iii. Serialization
iv. High quality rubber
v. EBK Logo to be affixed in the casing.
vi. The Name and Registration Number of the Engineer to appear on the stamp printout.
vii. Unique security features

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- Go to MPesa
- PayBill
- Paybill Number: ***839300***
- Account Number: Indicate your registration number e.g. A1234
- Amount: ***Pay Kshs. 5000/-*** as provided for in the Third Schedule of the Engineers Rules, 2019.

ENGINEERS BOARD OF KENYA
Enhancing Professionalism

# ENGINEERS IDENTIFICATION CARD

## LEGAL PROVISION

The Engineers Rules 2019, Rule No 10 (1), requires the Board to issue engineers with an Identification Card. The need for an identification card arose from the realization that there was no mechanism for engineers to easily identify themselves to the public or relevant authorities especially when providing services outside an office environment.

## EBK IDENTIFICATION CARD

Engineers Board of Kenya (EBK) has therefore partnered with the National Bank of Kenya (NBK) to generate Smart Cards (Visa Cards) which are customized to suit the requirements of the Board but also to offer additional conveniences to engineers.

## BENEFIT OF EBK IDENTIFICATION CARD

- The smart card will be your identification card as provided for in the Engineers Rules. This will help to easily weed out persons not licensed to practice as engineers. The public will be sensitized on this important identification document.
- Security – The partnership with NBK Visa Centre on the issuance of the Identification Card provides a secure identification system that is not easily replicated by unscrupulous persons.
- The Identification Card will enable engineers to conveniently carry out financial transactions such as payments for Board activities.
- The Identification Card will make it easier for you to access the Boards services, eg You will be able to avoid long queues at registration desks during the Board activities by simply swiping or scanning your card.
- The VISA – EBK co-branded card can be quickly cancelled and replaced.
- The Identification Card will offer you the control to manage and budget on expenses
- Convenience and ease of use.
- Simplified application and immediate issuance.
- The Card will be configured to be scalable and compatible with all the Board's systems.

# IEK Career Week inducts future engineers; inspires hope

THE Institution of Engineers of Kenya (IEK) held the first of a kind Career Week bringing together engineering students from 12 universities from March 9-12, 2020.

The four-day virtual conference, which was also attended by deans of engineering faculty from the various universities, was the culmination of weeks of meticulous preparation by the planning committee led by Eng. Grace Kagondu, assisted by Eng. Paul Ochola and Eng. Godfrey Marambe, who chairs the Young Engineers Chapter at IEK.

The Week was opened by keynote speeches from Engineers Board of Kenya (EBK) Chairman, Eng. Erastus Mwongera and IEK President, Eng. Nathaniel Matalanga.

*Career Engineering students train at a local University. PHOTO COURTESY*

Eng. Matalanga said the mentorship programme was one of the highlight activities organised by the IEK and EBK to celebrate the world engineering day, which had come less than a week earlier on March 4.

Eng. Mwongera took the students through the transition process from a student to a graduate engineer and ultimately to a professional engineer.

"As you grow your career further, you will transition to be a Consulting engineer, who is an expert consulted in particular field of engineering. This is a very exciting stage of engineering category and can be recognized as apex of career growth," said Eng. Mwongera.

"From here you will be allowed to have engineering consulting firms or even become Accredited Checkers."

An accredited checker, according to Eng. Mwongera, is a registered peer review consulting engineer, who has the powers to evaluate, analyse and review the engineering designs and perform such original calculations with a view to determining the adequacy of the design and compliance with safety requirements.

He urged the students to register with the Board as graduate engineers once they successfully graduate from university.

He advised the students to follow their passion and do what they are good at.

"As engineers, let the problems in the world dictate what you do. Do something that genuinely helps others and makes the world a better place in a major way. That is the way to have a happy, fulfilled life," he said.

Eng. Matalanga encouraged the students to join the IEK as student members, saying this would give them the right footing and a strong foundation as they begin their career.

"The Institution facilitates student and young engineers to publish research work, showcase their works and innovations at high level platforms like the Engineering in Kenya Magazine," he said.

"IEK has been at the forefront in advocating for the rights and welfare of the graduate engineers through lobbying for better remuneration and terms of service. This is in line with its vision of upholding the dignity of the profession."

He hailed the Young Engineers Chapter, a subcommittee of the Capacity Building & Mentorship Committee of the IEK for playing a major role in organising the Career Week. The president said he hoped the institution will be able to organize such a programme every year in celebration of the World Engineering Day.

Dr. Eng. Hiram Ndiritu, the Ag. Principal, College of Engineering and Technology at Jomo Kenyatta University of Agriculture and Technology (JKUAT) challenged the students to be reliable public servants, uphold integrity, seek for respect of the profession and change the society when they finally join the field.

He said the Council of Deans/Principals of Engineering of Kenya, of which he is a member, ensures universities meet the engineering courses accreditation requirements and supports the IEK/EBK effort to have engineering recognition by the Washington Accord.

Eng. Ochola, a member of the Career Week's planning committee, said the mentorship programme assured all students in each university undertaking an engineering course that they are all equally as competent at the time of graduation as students from the universities that have been in existence for little longer.

# Eng. Kagondu: How we planned the one of a kind event

THIS year's IEK Career Week was unique in so many ways. It was the first mentorship programme that brought a number of universities together on the same platform, breaking away from the norm of individual institution career talks. It was also held virtually in line with the Covid-19 protocols. Eng. Grace Kagondu – Chair of the IEK Capacity Building & Mentorship Committee – who led the team that planned the event shares her experience in the coordination and the future of the Career Week.

**What informed the idea of bringing together multiple institutions for the event this time round?**

Two things. First Inclusivity and outreach. Secondly, Optimisation of resources. During this year's World Engineering Day for sustainable development celebrations, we were keen to reach out to all our members, including students and have them in the celebrations. We also wanted to reach as many students as possible. Use of virtual platforms enabled us to reach over 500 engineering students from 12 universities as compared to other years when we did physical visits to one university at a time. Eventually some universities would miss out altogether due to challenges associated with physical visits, such as logistics. The IEK's Strategic Plan 2019-23 highlights inclusivity as one of its key pillars where all classes of our membership can feel part of the institution and its activities.

On optimisation of resources, the Covid-19 pandemic has affected the financial performance of many entities and IEK is conscious of this reality. A virtual event requires less financial outlay and enabled more optimal use of our resources. In short we achieved more with less.

**Share with us your experience planning for this event in comperison to previous ones?**

It was a busy and exciting experience but also an eye opener. The Career Week 2021 was organised by the Capacity Building & Mentorship Committee (CBMC), which has the Young Engineers Chapter (YEC) as one of its subcommittees. My role as chair of CBMC was to coordinate and facilitate linkage between YEC and other partners and stakeholders for a successful event. We had to loop in the targeted 12 universities, student engineering bodies, EBK, at least four speakers per day for each discipline focus over the four days, in addition to coordinating with other IEK committees such as PRAC, the IEK Secretariat, the communications team and poster design team. That was a busy time!

Students candidly shared their experiences and the challenges they face. We learnt their key concerns about a future in engineering. Most were keen to join IEK as student members but preferred an online process. We agreed on an easier approach through the University Deans, pending full automation of our processes.

**As committee what challenges did you experience planning and execution event?**

The co-ordination required was quite intensive so we resolved to have virtual meetings every two days. We also created virtual platforms looping in engineering students' leaders and university Deans/Chairs to ensure real-time communication and resolution of issues. One good outcome was realization of the need to launch social media groups for our student and graduate engineer members. This is now a work in progress to align with policies in place.

**What do participants gain from IEK career week events?**

The students are exposed to the truly wide range of engineering careers available to them after

> The students are exposed to a truly wide range of engineering careers available to them after graduation. Quite a number were surprised to learn that options such as Aerospace and Marine Engineering are available and have quite attractive prospects.

graduation. Quite a number were surprised to learn that options such as Aerospace and Marine Engineering are available and have quite attractive prospects. Deeper insights on the different careers are shared freely and students are better able to decide which specialisation to pursue, and the best way of going about it. Students are also advised on internship opportunities and on the path to follow in order to become professional engineers.

**What does this Career Week shift mean for the future of the programme?**

In future the IEK Career Week will be anchored in the World Engineering Day celebrations held every year on March 4. Sustainability in engineering depends a lot on the extent to which we can attract and retain young people into the career. We will use digital platforms for more effective access to the youth.

**Anything else you would like to add or communicate?**

Due to the high demand and popularity of the event, we are planning to hold a one-day summit for young engineers. It will be open to engineering students, especially those at advanced levels of their academic programme. This will allow more time to engage and address some of the concerns they wanted guidance on.

I would also urge our senior members (professional Engineers) to take up mentorship of the young engineers – either students or graduates – on a voluntary basis. As IEK we will be running webinars to educate members on how to effectively supervise and mentor young engineers.

# Jebet: The conference was insightful with critical lessons

PRESENTATIONS from IEK Career Week 2021 were insightful and intriguing, Patience, Resilience. These are the terms that Eng. Erastus Mwongera, Chairman of Engineers Board of Kenya (EBK), emphasised in his speech on March 9, 2021 as the Institution of Engineers of Kenya (IEK) Career Week kicked off.

Preparations for the week had begun over a week earlier, when leaders of university engineering student bodies, like me, and the IEK planning committee members, under Eng Grace Kagondu, met us and discussed how we could reach more students to participate in such an informative session.

Sharing the news with my fellow students was a pleasure. However, getting their feedback and hearing their eagerness and enthusiasm as they awaited the week was the highlight of it all. We were all very excited to get enlightened about the engineering bodies in the country and the opportunities they presented to us.

The first day of the week focused on all engineering disciplines. Keynote addresses came from Eng. Mwongera and IEK President, Eng. Nathaniel Matalanga, who both challenged and motivated us to pursue engineering resiliently, and for a healthy planet. The presentation: *'The Engineering Professional Life Cycle* by Eng. Grace Onyango particularly sparked my interest when she spoke on the attributes of a graduate engineer.

Engineering knowledge was just one of the 11 points she mentioned, showing how engineers ought to be all rounded, with other attributes such as

communication and ethics being vital as well.

The panel session was the most engaging for the students, as we got to ask questions and give feedback on our experience in the engineering field from our perspective.

Presentations on the third day focused on my discipline – Telecommunication and Information Engineering. I learnt a lot from the experienced engineers in the field, and found the presentation on Industry 4.0 by Eng. Andrew Masila especially intriguing.

In a nutshell, the week was more insightful than we thought it would be. I learnt more about the engineering bodies and their functions, and this motivated me even more to pursue the field.

I believe whoever had second thoughts about engineering walked out of the IEK Career Week feeling inspired and rejuvenated. As Prof. Eng. Edwin Ataro stated, we are in the engineering field because we are the best of the best.

Indeed, the Career Week reminded us of that, and gave us the energy we needed, and for that I am grateful.

Sylvia Jebet Kipkemoi – BSc. Telecommunication and Information Engineering, JKUAT .

# KeNHA enhances efforts to decongest the city of Nairobi

## *Nairobi Expressway Project*


Artistic impression of the completed viaduct section


Capture of the latest status

***Quality Highways, Better Connections***

# Made Smarter: Manufacturing and Industry 4.0 Adoption

- Industry 4.0 and Potential Opportunities
- Application of Internet of Things in Improving Energy Efficiency in Buildings and in Smart Grids.
- Kenya's Economic Recovery lies in Thriving Manufacturing Sector
- Tononoka Group: Why Iron and Steel Manufacturing hold the key to Big 4 Agenda
- Machine-Learning Use Cases in Electricity Distribution

# Industry 4.0 and Potential Opportunities

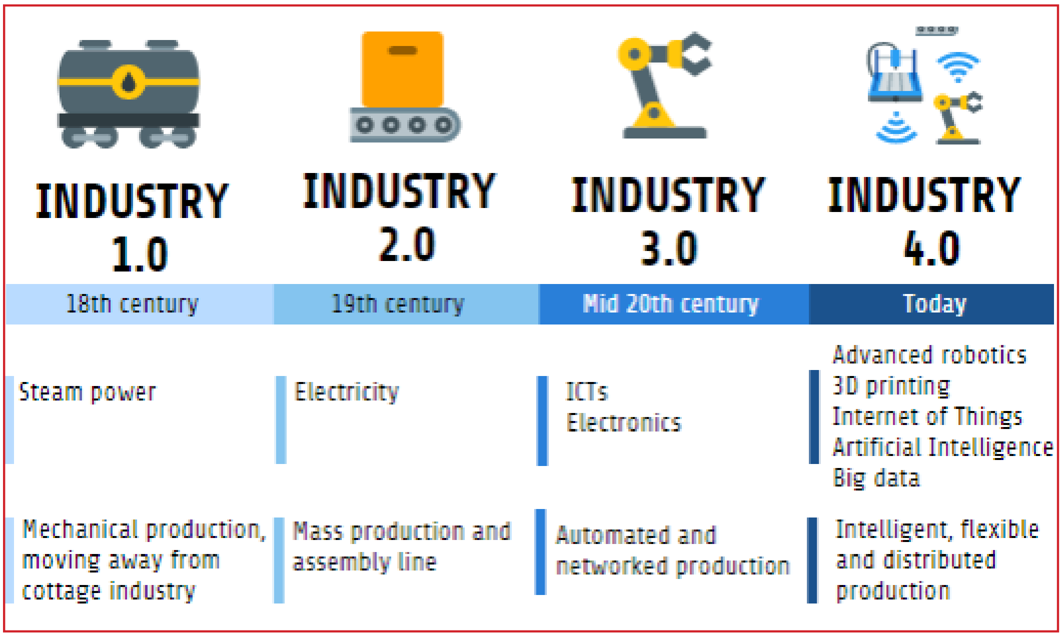



*Fig. 1. The Industrial Revolution from Industry 1.0 to Industry 4.0.*

## INTRODUCTION

INDUSTRIAL revolution has undergone several phases. In phase one mechanization was introduced through water and steam power. In phase two invention and wide us of electricity enabled mass production and assembly lines. In phase three computerization and automation added more efficiencies and ushered in the era of information technology. The subject of focus here is phase four also referred to as industry 4.0 with the advent of smart-factories and cyber-physical systems.

Industry 4.0 is closely linked to an initiative by the German government which was then aimed at maintaining the global competitiveness of the German manufacturing industry. As per figure 1 it has been adopted in other corners of the world and in more industries apart from manufacturing.

Shifts in organization focus are closely related to developments that have led to industry 4.0. From the 1900's, there was organizational focus on efficient manufacturing and mass production through mechanization and adoption of electricity. From the 1960's, distribution was key and global connections through air transport and water transport across continents facilitated this. From the 1990's, information technology was a key differentiator especially with internet and this helped to create global value chains. From the 2010's. organization focus has been shifting to the customer. As the customers become more empowered there is need for higher levels of customer obsession. This underscores the need for adoption and application of industry 4.0.

Advances especially in telecommunication technologies and the entire ecosystem has also come to shape industry 4.0. Relevant technologies around 5G and IOT are key to enable cyber-physical ecosystems. These technologies support ultra-low reliable latency, Ultra-High Bandwidth and Massive Connective creating more efficient communication systems, connecting people and things and allowing for fully automated networks.

There are several pillars among them; advanced robotics, internet of things, bid data, augmented reality, horizontal/ vertical integration, simulation, cloud, additive manufacturing, and cybersecurity that are integral to application of industry 4.0. Contextual application of the pillars has the potential to yield competitive advantages as well as increase efficiency levels.

In this paper we will delve into these key pillars and how they can be applied. There will be case studies on the impact of application of the key pillars and also a look at emerging opportunities in Kenya driven by industry 4.0.

## Industry 4.0 Key Pillars

Industry 4.0 is supported by pillars that are distinct, and it is possible that more than one pillar is applied at any time as per need. Besides addressing known issues, the pillars can be used for total transformation. We will explore each of the main pillars looking at the both the description and potential application of each. The pillars we will be exploring are advanced robotics, internet of things, big data, augmented reality, horizontal/ vertical integration, simulation, additive manufacturing and cybersecurity.

Robots are an important pillar of Industry 4.0. Tomorrow's smart factories will depend on new types of machines, such as collaborative and mobile devices that are interconnected. The goal of Industry 4.0-enabled robotics is zero downtime and maximum efficiency.

As robots use more sensors and become more digitally connected, they will become much less susceptible to disruptions (Weber, 2020). Collaborative robots, which are going to work with humans in the industry, making a significant number of processes more efficient, are more sophisticated than their predecessors; these robots will allow to obtain a considerable decrease of costs related to the building of fences or safety cells that, in the previous days, kept the robots isolated from the humans. As robots become more autonomous, flexible and cooperative, they will be able to tackle even more complex assignments, relieving the workers from monotonous tasks and increasing productivity on the factory floor (AMFG, 2019).

As more systems and devices get connected in smart ecosystems there is need to ensure that the same is supported by proper platforms. Internet of things is a result of connecting all these things and the resultant smart ecosystems. This helps to bridges the physical and virtual worlds. The increasing networking of people, objects and machines with the Internet is leading to the emergence of new business models (Lisa & Alexander, 2019). This involves having sensors that generate the data, proper networks to support massive connections that are mainly autonomous and a platform to control all the devices, handle the data they are sending and control the ecosystem driven by use cases.

Smart systems in industry 4.0 generate high amounts of data at high velocity. This data needs to be processed to inform resultant action and insights in a proper pipeline. Big data analytics is the use of advanced computing technologies on huge data sets to discover valuable correlations, patterns, trends, and preferences for companies to make better decisions (RGBSI, 2020). In Industry 4.0, big data analytics plays a role in a few areas including in smart factories, where sensor data from production machinery is analyzed to predict when maintenance and repair operations will be needed. Through application of IT, manufacturers experience production efficiency, understand their real-time data with self-service systems, predictive maintenance optimization, and production management automation.

Augment reality is the superimposition of digital and virtual elements onto a physical environment enabling real-time combination of the various elements usually using 3D visualization. This is used to enrich experiences with several applications in industry 4.0. It bridges the gap between the digital and physical worlds by superimposing virtual images or data onto a physical object. For this, the technology uses AR-capable devices, such as smartphones, tablets and smart glasses.

Horizontal integration in industry 4.0. refers to connected systems from machinery, IOT devices to engineering processes for seamless operations. Vertical integration is the connection to other functions often outside engineering both within and without the organization to influence decisions and actions e.g., in sales functions (Copadata, 2020). This integration enables global operations and often automated processes with higher efficiency and productivity enabling Just-In-Time delivery.

Simulation modelling is the method of using models of a real or imagined system or a process to better understand or predict the behavior of the modelled system or process.

Further Industry 4.0 is the concept of digital twins which extends the capability of simulation from what may happen in the real world to what is happening in the real world. Digital twins enable the entire life cycle from design, execute, use to decommissioning (Raghunathan, 2019).

As smart actors in the industry 4.0 ecosystem generate more data coupled with vertical and horizontal integrations with global supply chains with need to compute and intelligence to handle complex use cases like digital twins, then the cloud becomes a viable option to rapidly scale for storage and computation. The cloud also offers high resiliency for smart ecosystems and lower barriers of entry to take advantage of smart ecosystems.

Additive manufacturing is an essential pillar in industry 4.0. In the age of the customer focus and need for personalization and customization there is need for non-traditional manufacturing methods. This is also linked to 3D printing and initially mainly used in prototyping and now embedded into manufacturing. It also enabled decentralized manufacturing where certain parts can be produced at place and point of need.

With cyber-physical systems and internet of everything scenarios, cyberattacks from various threat vectors are more likely. Hence it is key to embed cybersecurity practices in systems as a breach at any point can have huge implications. The rapidly increasing number of Industry 4.0 cybersecurity emerging incidents further stresses the need to strengthen cyber resilience (Enisa, 2018).

### Industry 4.0 Implementation Case Study
### Use of Augmented Reality in the Aircraft Industry

Boeing, an aircraft manufacturer, is leveraging augmented reality through wearables to increase productivity and minimize errors. This is specifically for the wiring process.

Over 100 miles of wiring go into every new Boeing aircraft, tucked away overhead and underfoot from the cockpit to the wheel wells. This translates to thousand of miles of wiring and tens of thousands of hours of work each year depending on the number of aircrafts manufactured. To ease this complex task, Boeing is now using smart glasses. Each aircraft model has its own wiring configuration and there is no room for error in this sensitive task.

Previously technicians used printed out circuit diagrams and laptops. This was complex especially when they had to look away from the highly sensitive process and as well take their hands off the wiring task. In addition, it was cumbersome when seeking remote support from the design engineers. It often meant the technician had to abandon the task at hand.

Using smart glasses employing augment reality to layer a virtual design onto real aircraft build, the technician on the ground does not have to take their eyes and hands off the actual wiring task as the reference wiring diagram is overlaid to the physical task at hand. Using voice recognition, the technician can get specific commands based on the task at hand and the current view of the smart glasses. In case remote support is required from the specialist engineers, then a video feed is available from the smart glasses and assistance is provided seamlessly.

Using the pillars of industry 4.0 Boeing has been able to cut its wiring production time by 25% and reduced the error rates to zero. Wearable devices drive efficiency, accelerate production time, increase first-time quality, and train workers (Ballard, 2017). Typical smart glasses are as per **figure 2 below.**

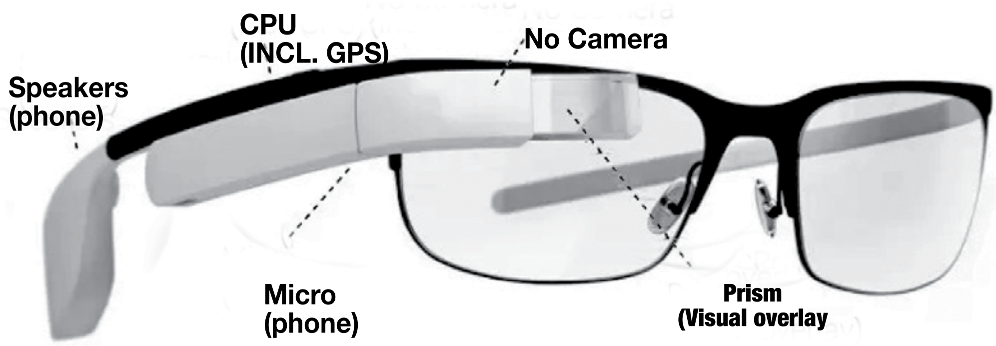



**Fig. 2. An illustration of smart glasses.**

## DISCUSSION

Industry 4.0 follows previous developments from the first, second and third industrial revolutions. Industry 4.0 is underpinned by several pillars which are some of the building blocks into Industry 4.0 integration into an organization. They can be widely viewed as an addition to existing operations and have the ability for total transformation.

The pillars can be viewed as elements that need to work together for a powerful combination. As machines become smarter and connected, they leverage IOT and emerging technologies like 5G for connectivity. As they generate vast amounts of data, then cloud technologies become necessary for compute and storage requirements. Big data technologies are required to take advantage of the vast amounts of data at high velocity and in real-time. All these capabilities enable advanced robotics, augmented reality, additive manufacturing and advanced simulations - digital twins. Digital transformation frameworks as well power horizontal and vertical integrations. With smart, interconnected, automated and autonomous systems there are cyber-threats necessitating cybersecurity which is key to ensure a safe interconnected ecosystem.

There are various reasons to adopt industry 4.0 into operations leveraging the various pillars. Due to the aircraft industry leveraging augmented reality there was a notable increase in productivity and reduced the time-to-market as relates to the aircraft wiring process. In the age of customer focus and personalization leveraging these pillars provides a competitive advantage and likelihood of organizations survival into the future.

Through global connectivity and adopting the pillars it is possible to leapfrog into Industry 4.0. The concepts of industry 4.0 are not only applicable to manufacturing only, but across most industries. In Kenya there is a great opportunity to leverage industry 4.0 in various industries for global competitiveness.

## CONCLUSIONS

Industry 4.0 adoption has a lot of promises especially around increasing efficiencies and productivity. It is important to appreciate the key pillars and how they build up into Industry 4.0 hence the focus on the pillars. The case presented helps to show how to leverage industry 4.0 into operations. In Kenya, there is a great opportunity to leverage Industry 4.0 and it is key for engineers to be at the forefront of the revolution. Strategy alignment at all levels in the society is key to ensure that intended outcomes are realized.

*By Eng. Andrew Nguli Masila*
*Telecommunications and Technology Expert*

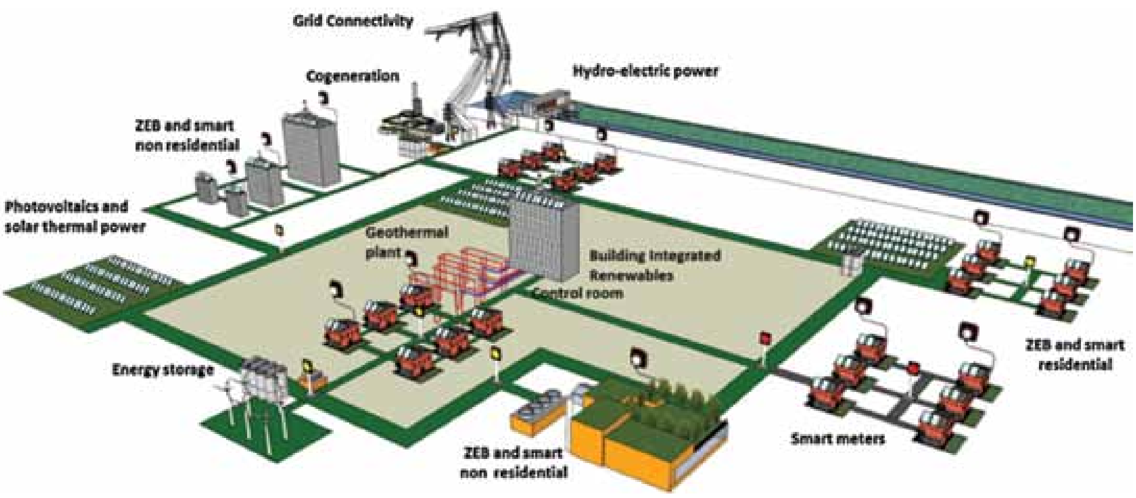
## INTRODUCTION

MAXIMISING energy efficiency with application of the Internet of things warrants the use of technology that requires less energy to perform the same activity without compromising quantity and quality. The Internet of Things is a network of physical objects ('things') that amass and exchange data with other devices using sensors embedded in them. It involves both software and hardware integration. The application of Internet of Things in buildings and in grids enables monitoring and control of energy flow. The processed and analysed data is made available to the various stakeholders for them to monitor remotely their energy consumption and detect areas and appliances where energy is wasted, hence improving efficiency. Energy efficiency is a critical driver of sustainable development and an effective analysis of the real-time data in the energy supply chain is paramount to achieving optimum energy efficiency.

## METHODOLOGY

This paper analyses the application of IoT in the energy space, from energy use in buildings to smart grids. We explore the IoT framework and its enabling technologies as a basis for discussing their role in the energy sector in improving efficiency.

IoT use entails a multi-stage technique for implementation: from putting up sensors, data collection, data storage, data processing and analytics, finally decision making. An accompanying command is sent back to the actuator installed on the system in response to the sensed data. An Energy management app or website can be used to allow users to switch between appliances and automatically control power loads, helping to control energy consumption and related costs. Cloud computing and data analytic platforms, which have data analysis and visualization tools that can be employed for different smart applications in the energy sector, from buildings to smart cities to smart grids.



## DISCUSSION

The current effective installed (grid connected) electricity capacity in Kenya is 2,651MW, with peak demand of 1,912MW. Demand has been rising at a calculated rate of 3.6 percent every year mainly due to the expansion of grid connections for public facilities and surrounding households.

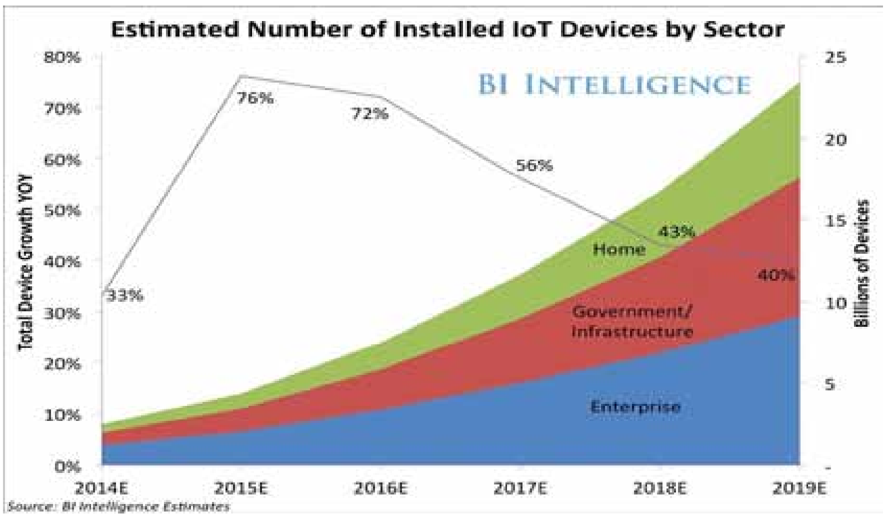
Energy figures point to significant opportunities to make Kenya's industries and buildings more energy efficient through improving demand-side (end-user) practices and reducing system losses. Kenya's entire building stock as of 2018 was estimated at approximately 37 million m2 and the figure is expected to grow to 47 million m2 by 2025. Significant growth is anticipated to come from the residential, commercial and hospitality space. Overall building sector energy consumption was 11.52 MT of oil equivalent in 2015, representing approximately 73% of total final energy consumption (IEA 2015). Ongoing economic growth, supply constraints driven by increasing energy access objectives, and the prevalence of the building sector in national energy use data all point to the critical nature of building energy efficiency to overall energy security and economic productivity objectives in Kenya, as well as to addressing climate change obligations.

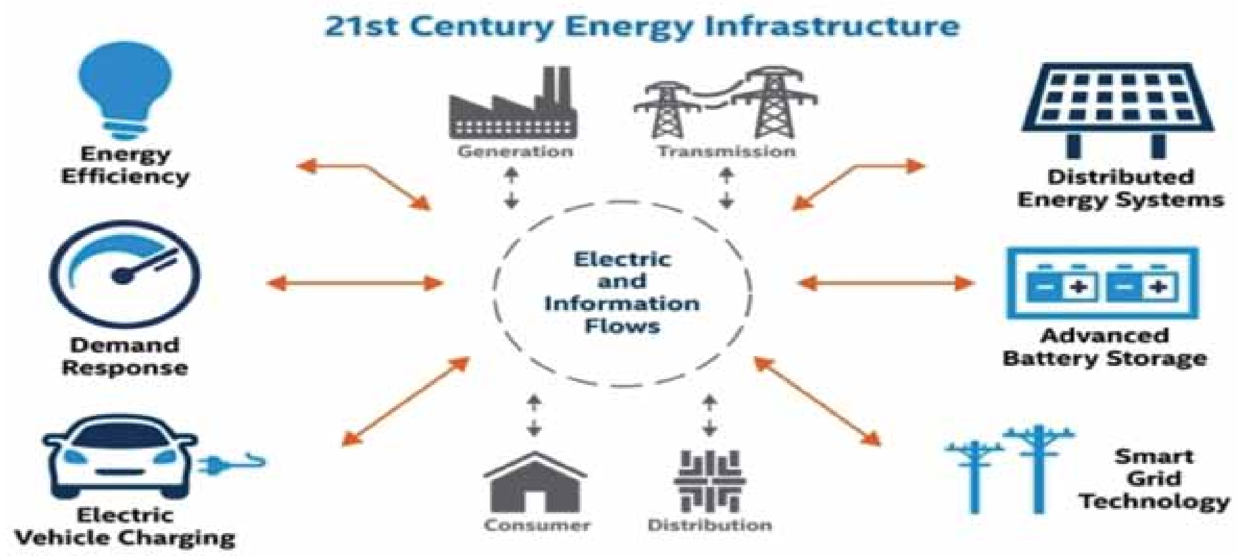
The Internet of Things (IoT) provides equipment and appliances with a gateway for communicating and making decisions autonomously, without human intervention. The sensors used could be pressure, light, temperature, proximity or motion sensors. Wireless communication systems play a crucial role in activating IoT. They connect the sensor devices to IoT gateways and perform end-to-end data communications between these elements of IoT. Wireless systems are developed based on different wireless standards and the use of each one depends on the requirement of the application such as communication range, bandwidth and power consumption requirements.

*Table 1: Comparison between different wireless technologies*

| Technology | Range km | Data Rate Security Installation | Power Usage | Security | Installation Cost | Example Application |
|---|---|---|---|---|---|---|
| **LoRa** | <50 | 0.3–38.4 kbps | Very Low | High | Low | Smart Lighting |
| **NB-IoT** | <50 | <100 | High | High | Low | Smart grid communication |
| **LTE-M** | <200 | 0.2–1 Mbps | Low | High | Moderate | Smart Meter |
| **Sigfox** | <50 | 100 bps | Low | High | Moderate | Smart Electric Plugs |
| **Weightless** | <5 | 100 kbps | Low | High | Low | Smart Meter |
| **Bluetooth** | <50 | 1Mbps | Low | High | Low | Smart home appliances |
| **Zigbee** | <100 | 250Kbps | Very Low | Low | Low | Smart metering in renewable energies |
| **Satellite** | Very Long | 100kbps | High | High | Costly | Solar & windpower plants |

The use of smart thermostats in buildings to maximise energy efficiency by adjusting the temperature. They can be used to control fans, room heaters and also in smart refrigerators to automatically adjust their temperatures and monitor power usage. One can also be pre-emptively notified when maintenance will soon be needed. The IoT devices connect through the Internet where each device has a unique IP address. The remote monitoring and control are done through cloud-based control systems. Light-Emitting Diode (LED) luminaires can be used as light sensors in smart buildings to control lighting. Energy smart meters and smart building management systems can be implemented to help in energy consumption forecasting. Sensors can be embedded in all electric devices for example TVs, air-conditioners, humidifiers to monitor and regulate their power use. The ultimate goal is to progressively automate our buildings while increasing the efficiency of processes.






The application of IoT enables demand-side management at a micro scale and offers flexibility to the system. Automation and digitalization of home appliances, as well as ready-made services for consumers, are key for demand management and demand response. Thermostats, lighting, and energy monitoring and controls are increasingly embedded with Internet-connected smart devices that can be controlled remotely by smart phones. Adding communication capabilities and remote controls to existing sensors and diagnostics creates a functioning energy management system.

The IoT can turn houses into smart homes and is expected to drive innovation and create new business models for the consumer, such as new forms of demand management and creative alternatives to traditional energy consumption patterns.

Internet of things is also a fundamental pillar of smart grids. A smart grid is an electricity network that can intelligently integrate the actions of each and every user connected to it.

They include power generators, distributors and ultimately the consumers. Features of smart grids include the controllable two-way flow of electrical power and the automated, bidirectional flow of information. Considering the decentralization of the system, through the deployment of distributed energy generation and battery storage, the IoT holds significant potential for new management and business model options due to its capacity to aggregate data.

The IoT enables accessing data from remote wind farms, solar farms or hydro stations in real time. Past generation and weather patterns, together with real-time data collected and communicated through digital systems, can help improve the accuracy of renewable generation forecasts.

This would enable renewables participation in electricity markets and help operate the system. The injection of renewable energy into the system whether on-grid or off-grid will help cheapen the energy costs. The use of solar in homes and institutions can be maximised to allow its use during the day. Light sensors installed in solar panels can indicate the points where the sunlight energy is the highest and tilt the panels accordingly.

As we progress into an ever more connected, digitalized world, data rights and privacy become increasingly important. Privacy has two issues: on the one hand, data might be exploited commercially (legally), and on the other, data might be stolen and exploited illegally. Issues such as secure authentication, standardization, interoperability and liability need to be properly addressed.

As we automate controls, we may introduce the possibility of systemic failure or systemic cyber sabotage. The challenge is not only to make systems more secure to prevent unwanted intrusion, but also to make systems more resilient against the inevitable attempts at intrusion.

Super systems will be required to monitor and contain the effect of attacks, as well as systems that can be isolated and where no single point of failure (error or sabotage) can bring down the entire energy system.

Some of the other challenges of applying IoT in the energy sector, including challenge of identifying objects, big data management, connectivity issues, integration of subsystems, energy requirements of IoT systems, standardization and architectural design.

## CONCLUSION

Energy systems are on the threshold of a new transition era. Large-scale deployment of IoT in distributed energy systems and the need for efficient use of energy calls for system-wide, integrated approaches to minimise the socio-economic-environmental impacts of energy systems. More research needs to go into solving the challenges facing IoT deployment since the benefits are more.

*By Harriet Bosibori Ontiri and Victor Mungai Kamau*
*University of Nairobi, Department of Electrical and Electronics Engineering*

# Kenya's economic recovery lies in thriving manufacturing sector

*Inside a manufacturing plant at Tononoka Group. The manufacturing industry in Kenya makes a huge contribution to the national GDP. (INSET): KAM CEO Phyllis Wakiaga.*

AT a time when global economic stability has been greatly shaken by a raging pandemic, Kenya's economy looks up to industrial resilience, innovation and engineering to stage a comeback.

The middle-income economy has taken its fare share of the hit following Covid-19, braving rising costs of production and industrial lay-offs all through 2020, right into 2021.

A resilient manufacturing sector has kept the wheels of the economy rolling amidst great economic distress. And now, in 2021, the manufacturing industry in Kenya has its eyes set firmly on one thing: thriving.

According to the Kenya Association of Manufacturers (KAM), the national umbrella-body representing value-add companies and associated service providers, the only way forward for Kenya's economic recovery lies in manufacturing sector rebound for sustained job and investment growth.

"Covid-19 has had an impact on all sectors and the manufacturing sector has not been spared. Last year, we conducted a survey in partnership with KPMG.

From the survey, the pandemic led to reduced output and consumption, attributed to reduced working hours, difficulties in sourcing for raw materials due to supply chain disruptions and cash flow constraints," says Phyllis Wakiaga, the KAM Chief Executive Officer.

"78% of manufacturers had to swiftly shift their focus from increasing profitability, revenue and domestic market share pre-Covid to currently reducing costs, retaining jobs, and improving cash flow."

Ms Wakiaga says manufacturers are now solely focused on building resilience and sustainability of the sector to prevent the industry from suffering further shocks brought about by crises such as Covid-19.

As part of its recovery plan, KAM has developed a Manufacturing Priority Agenda (MPA) for 2021 themed, 'From surviving COVID-19 to thriving: Manufacturing sector rebound for sustained job and investment growth'.

The MPA has five pillars, including competitiveness and level playing field for manufacturers in Kenya; enhance market access; pro-industry policy and institutional framework; SME's development; and industrial sustainability and resilience.

"The Agenda also outlines the need to enhance market access. Promoting the consumption of locally manufactured goods will forestall the overdependence of the Kenyan economy on imported goods," says Ms Wakiaga.

With globalisation, she adds, competition has become even stiffer and local manufacturers must be prepared to battle it out with formidable competitors such as china, India, Egypt and South Africa.

"Improving regulatory efficiency, promoting access to quality, affordable

> "The Agenda also outlines the need to enhance market access. Promoting the consumption of locally manufactured goods will forestall the overdependence of the Kenyan economy on imported goods," says Ms Wakiaga.

and reliable energy, reducing transport and logistics cost, and enhancing cash flow for manufacturers will drive our competitiveness," says Ms Wakiaga.

"KAM is constantly engaging the government on policy measures to cushion businesses in the country to ensure their continuity. At present, we urge the government to concentrate its efforts on vaccinating as many people in the shortest time possible, as the economy cannot stand to be closed for a long time."

Current technological developments have created the new automated age, with developments in robotics, artificial intelligence and machine learning starting to deploy on industrial scale. But are manufacturers in Kenya ready for these developments?

"Local industries are ready for these developments; however, uptake has been slow," says Wakiaga.

The KAM, in partnership with the Overseas Development Institute (ODI), developed a 10-point policy framework in 2018, underpinning the gaps that need to be filled to ensure the local industry capitalises on digital technologies.

Before Covid-19, the world was positioning itself for the fourth Industrial Revolution, known commonly as Industry 4.0. According to the manufacturers association, digitisation of the manufacturing sector has ensured factories now maximise on their operational excellence through the use of technology for enhanced maintenance, such as real-time monitoring of machinery.

"The 10-point plan addresses issues related to building digital infrastructure, including through increasing access to digital services and updating policies on data; boosting the competitiveness of Kenyan manufacturing in an increasingly digitalised economy; and managing the digital change in an inclusive and sustainable manner," says Wakiaga, decrying the lack of policy guidelines in industrial digitisation.

She says appropriate policies need to be developed to ensure Kenya is able to maximise productivity gains from industrial digitisation, so as to be able to realise large-scale employment gains.

"Today, engineering and technology has greatly impacted safe and efficient planning, management and maintenance of production methods and processes, which are crucial for a sustainable and competitive manufacturing sector," she says.

Through engineering and technology, Kenya has seen advancements in manufacturing, including research and development that have further enhanced manufacturing processes, including automation, and consequently enhanced efficiency along supply chains and product development.

Engineering and technology have also promoted sustainability through advancements in energy, water and waste management as well as productivity, which helps industry produce value that relates to multiplication and improving systems to enhance speed of service delivery.

The World Economic Forum (WEF) has defined five trends in the future of manufacturing: virtual simulation, 3D printing, automation, cloud computing and human managed robotics, trends that are set to impact the engineering sector unprecedentedly. Just how is the manufacturing sector in Kenya going to ensure members and engineers in their service are up to speed with the future?

"The Association acknowledges the need for local industries to take up industry 4.0 in order to stay ahead of competitors," says Wakiaga.

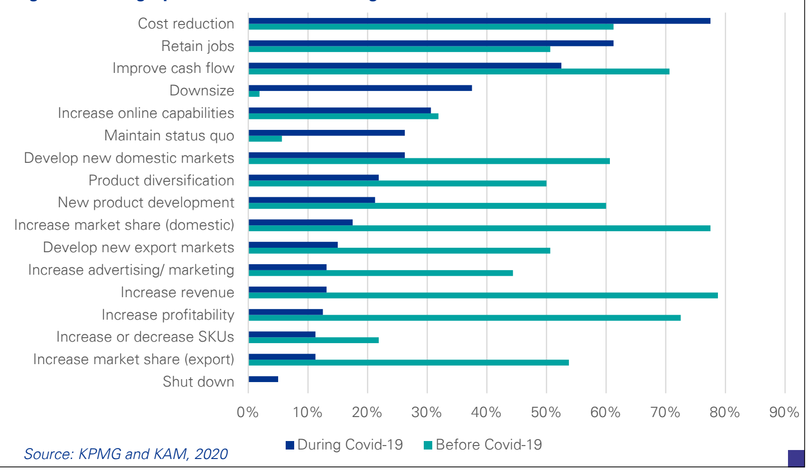
"To this end, we continue to engage the government and like-minded organisations for development of policies that encourage and incentivise local industries to take up digitisation in their processes."

KAM has been at the forefront of fostering industrial collaboration between players in manufacturing and the engineering space in Kenya.

"Manufacturing and engineering are interlinked. The manufacturing sector engages various engineers to support its processes, including mechanical, industrial, electrical and maintenance among many others. The Association fosters collaboration between players in the engineering space directly through their role in the manufacturing sector processes, more so, in research and development, key in enhancing the efficiency of manufacturing processes," says Wakiaga.

Manufacturers in Kenya, through

**Figure 1: Strategic priorities before and during Covid-19**




*Source: KPMG and KAM, 2020*

*A view of the Bamburi Cement Factory in Mombasa.*

the Technical and Vocational Education and Training (TVET) programme, also provide opportunities for technical students to gain hands-on skills through industrial internships. The internships provide experienced engineers with a platform to mentor and transfer knowledge to engineering and technology students, enhancing their technical students for work.

Wakiaga says even as Kenyan manufacturers strive to digitise their processes and join Industry 4.0, product competitiveness remains a key concern for the industry.

"This entails the nation's ability to produce goods and services that meet international standards whilst simultaneously maintaining and expanding the incomes of its people over the long term," she says.

Some of the issues hindering the competitiveness of Kenya's manufacturing sector, she adds, are regulatory overreach, high cost of energy, transport and logistics costs.

"Unfortunately, the cost associated with this is added to the price of a final product, thereby hindering our competitiveness," says Wakiaga.

She insists the sector will only remain competitive by adopting sustainable manufacturing practices.

"For instance, we are promoting operational excellence through green growth initiatives such as energy, water and water management, all geared to enhance industry's competitiveness against international brands," says the KAM boss.

She called for increased focus on research, development and engineering innovation as a means for rapid industrialisation in Kenya.


Wakiaga calls for a collaboration between the national and county governments, industry and academia to fully unlock local manufacturers' potential in the digital age.

The manufacturers' association also calls for support for small and medium enterprises (SMEs) to ensure they adapt to new technology, and at the same time, give them room to grow and scale up. Covid-19 has accelerated the uptake of digitisation in the country, with many non-essential employees working remotely, academic institutions utilising online platforms for learning purposes, automation of some manufacturing processes to manage the reduced number of shifts at factories and increase productivity, and the uptake of e-commerce by businesses to reach consumers, amongst others.

"Even so, a competitive manufacturing sector is paramount. As industry, we are looking at its ability to sustainably produce goods and services for which there is a market at a price and quality that the market is willing to pay for," says Wakiaga.

# TONONOKA GROUP:

## Iron and Steel Manufacturing holds the key to BIG 4 AGENDA

STEEL is the backbone of the economic activity of any country. In Kenya, the iron and steel industry forms about 13 percent of the manufacturing sector, which in turn contributes significantly to the GDP. As the country embarks on the development projects as part of the implementation of Vision 2030 and President Uhuru Kenyatta's Big 4 agenda, the demand and consumption of steel products is already high and is set to increase even further.

The projects include Lamu port development, railway and roads projects, housing, industrial parks and the development of the special economic zones, all of which utilize steel products.

One of the leading steel manufacturers in the country strategically placed to cash in on the increased demand is Tononoka Group, a company that started as a small hardware store in Nairobi some 36 years ago and has over the years grown to become one of the leading steel manufacturer in East Africa and currently produces close to 20,000 tonnes of steel monthly.

Tononoka Group Brand Manager, Mr. David Kioko, says with this growth, the steel manufacturer has significantly contributed to the growth of the country's manufacturing sector and the economy at large.

"As of today, we have a new state of the art rolling mill at our Dandora plant that's fully automated and can produce up to 18,000 tonnes of re-bars a month. This production has gone a long way in solving the Demand vs Supply challenge in the country and across the borders," says Mr Kioko in an interview.

The company also has a state-of-the-art BRC mesh machine and new slotting machine that has made it easy for steel consumers to access all the sizes they require when it comes to BRC as well as casings for all their water drilling solutions.

Kioko says the manufacturer's contribution towards Vision 2030 and Big 4 agenda cannot be gainsaid, as it provides free and timely deliveries of steel, value added services such as cut and bend as well as reduced rates on steel to contractors that are setting up the low-cost housing.

Every manufacturer is now striving to take a leap towards Industry 4.0, and Tononoka is not left behind. The Group uses qualified engineers to provide quality services and automate its systems.

"Currently we have moved into having engineers in-house and made it a mandatory requirement when applying for a vacancy within the mill sections because most clients will need advice from an engineer's perspective," says Kioko.

He urges engineers not to condone unethical practices as has been reported before, especially in cases of unfair competition between one manufacturer and another. Instead, engineers should be on the forefront in educating the masses on how to tell bad steel so as to bring sanity in the industry.

"One of the opportunities that has propelled our growth is the trust our clients have in our products and services, and the other is our dedication to produce quality steel products. We do not compromise of quality." he says.

All this growth and opportunities have however not come with challenges. Kioko says they have had to deal with high cost of production cost, power costs, high taxes on production, currency fluctuation, substandard materials in the market and crooked site managers and engineers.

"The government is now easily accessible and through bodies like Kenya Association of Manufacturers (KAM), we are able to share our challenges and have them addressed. On substandard materials we have made it our mandate to educate users on how to check for good quality steel products," he concludes.

*A steel manufacturing plant at Tononoka Group. PHOTO: COURTESY*

# Impact of COVID-19 on Industry 4.0 and Implications for Kenyan Manufacturing

## 1. INTRODUCTION

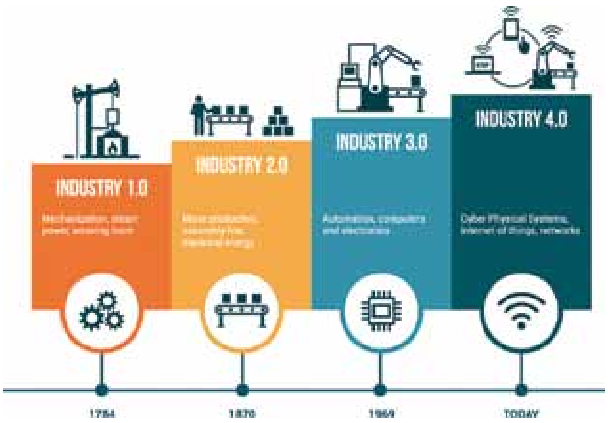
THE Fourth Industrial Revolution is a project in the high-tech strategy of the German government that promotes the computerization of traditional industries such as manufacturing. It portends the ongoing automation of traditional manufacturing and industrial practices, using modern smart technology. Large-scale machine-to-machine communication (M2M) and the internet of things (IoT) are integrated for increased automation, improved communication and self-monitoring, and production of smart machines that can analyze and diagnose issues without the need for human intervention. Industry 4.0 technologies were already transforming manufacturers' operations before the COVID-19 pandemic. The proverbial "business as usual" has been forced to consider new ways of working and this has forced the implementation of technology to be fast-tracked in order to digitize the workforce. It has been observed that players utilizing Industry 4.0 are better positioned to weather the storm, having moved faster and further than their peers during the crisis. However, on the flip side adoption is costly and diverging between technology haves and have-nots. The role of Industry 4.0 becomes even more critical in the backdrop of a crisis such as COVID-19. This paper will discuss the major features of a post pandemic future; reimagining manufacturing operations after COVID-19 and the implications for Kenya Manufacturing.

## 2. Approach

### 2.1 What is Industry 4.0

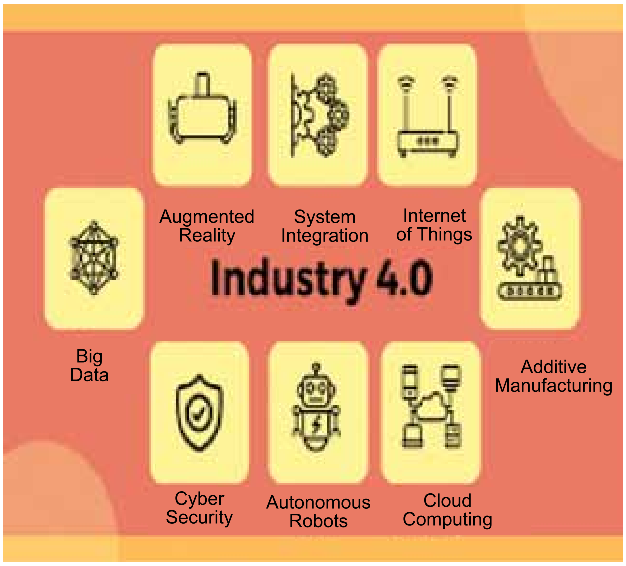
The phrase Fourth Industrial Revolution (4IR) was first introduced by Klaus Schwab, executive chairman of the World Economic Forum, in 2015 and was the 2016 theme of the World Economic Forum Annual Meeting, in Davos-Klosters, Switzerland. The term "Industry 4.0", shortened to I4.0 or simply I4, originated in 2011 from a project in the high-tech strategy of the German government, which promotes the computerization of its manufacturing industry. It was publicly introduced in the same year at the Hannover Fair. The characteristics given for Industry 4.0 strategy are: the strong customization of products under the conditions of highly flexible mass production. The required automation technology is improved by the introduction of methods of self-optimization, self-configuration, self-diagnosis, cognition and intelligent support of workers in their increasingly complex work. Basically, it refers to the next developmental stage in the organisation of the entire value chain process in the manufacturing industry. The concept is now wide spread globally across Europe, Asia and the US. The terms 'Internet of Things' (IoT), Industrial Internet of Things (IIOT), 'internet of everything' or smart manufacturing are often used as equivalents.

**Chart 1: Evolution of industry 4.0**




The widespread adoption by the manufacturing industry of information and communication technology (ICT) is increasingly blurring the boundaries between the real world and the virtual world, and is creating new production systems, namely cyberphysical production systems (CPPSs). CPPSs link IT with mechanical and electronic components that then communicate with each other via a network. Smart machines continually share information about current stock levels, problems, errors or faults, and changes in orders or demand. Processes and deadlines are coordinated with the aim of boosting efficiency and optimising throughput times, capacity utilisation and quality in development, production, purchasing, sales and marketing.

**Chart 2: Environment of 4.0**




Adopted from https://cervirobotics.com/the-revolution-of-industry-4-0/

Smart factories and their CPPSs are at the heart of I4.0, interfacing with other smart infrastructures, such as those of smart mobility, the smart grid, smart logistics and smart homes and buildings. Links to both business and social networks – the business web and the social web also play an increasingly important role in the digital.

## 2.2 Shifting comparative advantages in IR4.0 and the Digital Divide

Middle-income countries, particularly many emerging Asian economies, have scope to develop comparative advantages in the increasingly technology-led manufacturing, as shown by their relatively high scores on key competitiveness factors along with their growing domestic supply chains and consumer markets. The United States, Europe, and East Asia, which already dominate global manufacturing, are making the greatest investments in robotics and other I4.0 technologies, thereby raising the prospect of further concentration of manufacturing activity in these hubs. In 2017, around 75% of robot sales were concentrated in China, Korea, Germany, Japan, and the United States. China and the United States are leading in investment in artificial intelligence and its deployment in manufacturing and most of the investment in the IOT. The same cannot be said of Africa where Kenya is.

## 3. Discussions

### 3.1 Impact of COVID on Manufacturing

In April, 2020 the world was gripped by the Covid-19 pandemic which emanated from China. China contributes to about 19% of world GDP (Statista 2020) and is a traditional base for manufacturing and home for high technology and modern manufacturing. There was lock-down and closure of plants and stoppage of travel/transportation across the globe. The domino effect of that across the supply network has resulted in significant supply chain disruption. Some manufacturers ceased production completely, and others greatly reduced demand and others have seen a huge increase in demand. The pandemic also led to cancellation of technical and technological conferences leading to technology industry being likely to suffer from a downturn in innovation processes as a result of lost business opportunities for potential partnerships.

**Chart 3: Industry 4.0 Pillars**


The magnitude of the impact of the pandemic on a global level can be gauged from the statement of the World Trade Organization (WTO) which has projected that global trade in goods is set to decline steeply between 13% and 32% in 2020. Similarly, the IMF has revised downwards the Sub-Saharan Africa economic growth prospect for 2020 from an expected 3.5% to 1.6%. A Survey undertaken by Kenya Association of Manufacturers (KAM) and KPMG in about 180 industries in EAC found that about 40% of workforce has been reduced with most manufactures working to reduce cost, retain jobs and improve cash flows; 91% of non-essential goods manufacturers have seen a significant fall in demand compared to 74% of essential goods manufacturers; Production has dropped and 42% are currently operating at less than half their production capacity, while the average utilized capacity for MSMEs is 37% and 76% are having difficulties in locally sourcing or importing raw materials and 67% found access to market challenging

Previous industrial revolutions were inspired by the need to fulfil upcoming needs – mass production and high-speed and bulk movement of people and goods. This is similar to the current pandemic, which has hastened several trends, including local sourcing and innovation as manufacturers change their lines to produce critical essential items to be used in the fight against COVID-19, for example masks and ventilators. I4.0 has the potential to fill these gaps by ensuring continuity, reducing costs while increasing output. I4.0 technologies were already transforming manufacturers' operations before the pandemic and was gaining momentum before COVID-19, helping companies transform their operations in everything from production efficiency to product customization, with improvements in speed to market, service effectiveness, and new-business model creation.

The growing need for transfer of enormous amounts of data due to the isolation of humans due to the pandemic has highlighted the need for 5G technology. It also caused the use of virtual reality in businesses with most organizations offering employees and opportunity to work from home. Industries leaders' immediate response to the crisis was to go digital and leverage Industry 4.0 solutions. Unfortunately, the potential asymmetry in adoption in the wake of the pandemic has caused some companies globally to freeze their I4.0 initiatives to preserve cash. Many manufacturers now focus primarily on survival and on reducing the damage caused by a pandemic. The financial crisis for producers is already leading to a significant reduction in non-essential expenditure and less needed investment. In a survey undertaken by KAM/ KPMG, manufacturers have had to rapidly change focus. The top three priorities for the majority of businesses before Covid-19 were to increase profitability, increase revenue and increase domestic market share. These strategies have now been pushed down the agenda and are overtaken by 78% were focused on reducing costs, 61% retaining jobs, and 53% improving cash flow. Companies are now on the recovery path and it is believed that as more businesses emerge from the crisis, the case for further digitization at scale will likely be stronger than ever.

### 3.2 The significance of Industrialization and Manufacturing sector to the Kenyan economy

Manufacturing has been recognised as the main engine for vibrant growth and the creation of the nation's wealth and:

a) Accounts for the bulk of world exports (77 per cent in 2014), is less exposed to external shocks, price fluctuations, climatic conditions and unfair competition policies and the price of manufactured goods tends to be more stable than that of commodities.
b) Has the potential to create strong forward and backward linkages with other sectors of the economy such as pharmaceutical, agriculture machinery and capital good and the services sector such as banking, insurance, communication and transport.
c) Has the potential to offer employment opportunities directly or indirectly.
d) Generates externalities in technology development, skill creation, and learning that are crucial for competitiveness. For instance, manufacturing is the main vehicle for technology development and innovation at various levels. Globally, 95% of firms' R&D expenditure is undertaken within the manufacturing sector.
e) The internationalization of production and geographical distribution of the activities of multinational corporations (MNCs) has benefited manufacturing in the developing world more than other sectors of the economy. The trend towards the vertical disintegration of production activities means that developing countries have higher chances of integrating into global value chains.

Given the strategic importance of the manufacturing sector in Kenya, it must adjust to the challenges posed by COVID-19 and industry 4.0. As we work towards rebound strategies, we need to develop structures that work for the economy in the presence or absence of a crisis. The manufacturing sector has continued to develop solutions to keep the economy moving, such as ensuring that there is no shortage of supplies and partnering with the government to develop rebound strategies.

### 3.3 Status of Technology, Innovation and Industry 4.0 in Kenya

Research and innovation are key to sustained industrial growth and manufacturing, to move past the initial successful stages which are often largely the result of foreign direct investments (FDI). It enables greater product diversification and competitiveness in the long-run. In Kenya and the wider East African Community (EAC), R&D is still weak. Kenya is at the early stages of industrialization, with activities mainly oriented towards the absorption and adaptation of foreign technologies into existing production structures and processes, including adaptive design of products for local markets. Some firms undertake reverse engineering imported capital goods; learn about performing maintenance and repair operations, and production/adaptation of spare parts.

### 3.4 Implications of I4.0 Post COVID-19

Under the current circumstance most manufacturers have the following priorities today: Phase 1 – Survival; Phase 2 – Recovery; Phase 3 – Renewed work in a new post-crisis life. The goal of all manufacturers is to get to Phase 3 as soon as possible at the lowest price. When we define for the Phase 3 an Operating Model, we need to consider the experiences of the crisis period and try to build a more resistant and agile business. I4.0 enables;

a) Visibility of real-time availability of raw materials, finished products, people and property using artificial intelligence and machine learning to continually review and reschedule activities and Robotic Process Automation (RPA) to support labour intensive activities.
b) Remote work and collaboration. Beyond basic contact- and location-tracing mobile apps and videoconferencing applications, machine-vision algorithms and wearable technologies, are also helping maintain safe distancing.
c) Manufacturers to automate data collection by adding sensors or directly tapping into machines' programmable logic controllers (PLCs) to collect data and display it on live dashboards enabling monitoring factory performance remotely in real time. They can deploy interventions when needed remotely.
d) Utilization of mobile technology and augmented/ virtual reality to enable workers to more easily perform tasks for which they have not been trained. This could help with skills shortages due to isolation or restart of production technologies with digital twins and remote support from OEMs would improve resource availability.
e) 3D printing of spare parts stuck in the supply chain.
f) Use of autonomous electric vehicles and AGVs to reduce dependence on people and to further help with social distance.

## 4. Recommendations and Conclusions

Given Kenya's unique context, policymakers must ask the right questions to make sure the country can capitalize on the revolution. Currently the country has strong investment growth in new technology-led areas of AI, Big Data Analytics, block chain, additive manufacturing and drones. It is evident that the disruptions caused due by COVID-19 also calls for a relook the way the Kenyan manufacturing sector has set its priorities and offers an opportunity to revisit the competitiveness and consequently, the country's manufacturing policy. The country needs to move more towards self-sufficiency. Post-COVID-19 period marks the effective start of de-globalization and reshoring where most countries are bringing manufacturing and services back to their countries from overseas and the country needs to move in a similar direction. The following are recommended to strengthen the country's manufacturing sector post COVID-19:

### 4.1 It is recommended that the Government:

a) Boosts efforts aimed at creating a predictable and stable environment that makes it possible for the existing industry to invest in R&D in readiness to supplement efforts to leverage I4.0. This will allow industry to channel its resources and investments towards developing cutting edge excellence centers that are in sync with global trends, making them disruption-ready.

b) Increases local content by putting in place local content policies/ preferential procurement schemes: Such a policy would support strengthening linkages between the different sectors, particularly the manufacturing and primary sectors, provide manufacturers with market access and incentivize them to invest more thus bring in new technologies like I4.0.

c) Gives incentives to promote both foreign and domestic investments to foster technology acquisition and manufacturing. Factors which attract investment include labour skills, tax rates, infrastructure, and access to Special Processing Zones (SPZ) or Special Economic Zones (SEZs). For effectiveness, the incentives or interventions related to these should be time-bound and strictly linked to performance targets.

d) Directs more public resources to applied research and raise expenditure on R&D. Support in developing and making more effective industrial research and technology development centres and incubator services will attract FDI inflows as well.

e) Puts in place programmes to increase capacities of local suppliers to provide the products required by larger (exporting) firms in terms of product type, quality, quantity, price and reliability.

f) Upscaling, upgrading and modernization of MSMEs e.g. development of clusters is a common approach. For this, the 'one village one product' notion can be encouraged, and technology provided.

g) Provides Industrial Financing. In general, manufacturing firms require long-term financing options, which financial institutions normally are less willing to offer. Banks should be incentivised to provide such funds.

h) Encourages capital good imports: Capital good imports are critical for countries at early stages of their industrialisation process, as locally developed technology is still weak or inexistent. This can be done by strategically easing access to a selected set of capital goods and inputs required for production, without hampering sales of local/regional producers.

i) Supports TVET and universities to produce more valuable digitally oriented skills for industry. New technologies are demanding higher-level skills.

j) Builds digital infrastructure through increasing access to digital services and updating policies on data, digitizing the economy and managing the digital change in an inclusive and sustainable manner. Also provides financial and policy support to help manufacturers access and take advantage of ICT technologies.

### 4.2 It is recommended that Manufacturers/Private Sector:

a) Reorganise and reorient their supply chains, workforce and even suppliers to see how to develop new supply chains, undertake product diversification and higher value addition..

b) Acquire already developed technologies hence leap-frog and quickly creating new products/business models.

c) Take advantage of rapidly developing I4.0 technologies to adopt quick-win solutions that help companies respond and adapt to the new norms—such as tracking employee health, enforcing safe distancing on the shop floor, and supporting remote collaboration, digital work instructions for operators; among others.

d) Put in place cross-functional team and governance structures then help ensure quick execution including top-management commitment.

e) Undertake digital capability acquisition. Implementing agile working methodologies empowers teams with the tools, processes, and best practices for achieving success in a digital world.

### 4.3 Conclusion

As organisations begin to restart their operations post-pandemic they have an opportunity to re-imagine a future with digitized, resilient operations. Early successes have shown that companies can start on their industry 4.0 journey in a small way and then scale quickly—if they commit to Industry 4.0 transformation in line with their business environment and their strategic objectives. Automation of systems is one of the strategies of helping business to survive and a launching pad for rebound and if embraced, shall enable continuity and provide a platform to further make businesses resilient, both in the medium and long terms enabling increased efficiency, enhanced productivity, flexibility, costs reduction, innovation, and higher revenues and eventually, increased profitability. The COVID-19 pandemic should inspire us to strongly consider and hasten our taking up of Industry 4.0.

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# Machine-Learning Use Cases in Electricity Distribution

## INTRODUCTION

THE Kenyan electricity sector is experiencing significant growth in both the scale of grid extensions and system complexity. The key underpinnings of the growth include: increased geographical coverage of the grid, increased grid customer base, proliferation of smart grid technology in grid operation and customer relationship management, increased penetration of non-programmable renewable energy systems, interconnection to neighboring utility grids and regional power pools and the increased uptake of distributed generation. The result of all these features is the generation of huge amounts of variable, high velocity data from all facets of the electricity sector; from electricity generation, transmission, distribution and retail.

Traditional power system analysis has been the sole standard for techno-economic planning and analysis of the utility grid. However, as mentioned before, the complexity of the grid is increasing. As such, traditional power system simulation is severely limited when subjected to high volumes of high speed, variable data. Power system simulation tools lack flexibility to extensively interface with other data sources that offer more analytical value. As a consequence, efficient and suitable data management and analysis is required to leverage these large amounts of structured and unstructured data to meet the demands of planning, operating and maintaining a modern power grid. This is the gap that Big Data technology and machine learning analytics can fill.

### Big Data and Machine Learning

### 1.1 Big Data

Big data generally refers to vast sets of structured and unstructured data. For data to be classified as big data, it should have the following characteristics:

- **I.** Volume – The name "Big Data" in itself implies enormous data. Size of data is a key determinant in obtaining valuable insights out of data. In the context of the power system, real time monitoring of equipment, customer transactions and energy data inherently creates massive volumes of data.
- **II.** Variety – This refers to both the source and nature of the data. Aside from structured spreadsheets and databases, the big data context includes a wide variety of source including photos, videos, sensor data, audio etc. The variability of unstructured data presents certain issues for storage, mining and analysis of data
- **III.** Velocity – The term 'velocity' refers to the speed of generation of data. In the context of the power system, meter data, customer management systems and SCADA are examples of sources of high-speed data.
- **IV.** Veracity – This refers to the trustworthiness of the data.

**The big data ecosystem in the power system is summarised in the figure below:**

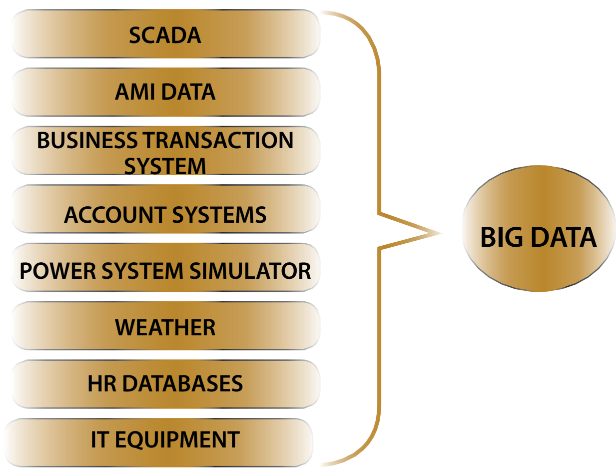



*Figure 1: Big Data and Power Systems*

Obtaining value from big data using traditional database and business intelligence approaches has over time proven to be technically and financially challenging enterprise. As such, technology has evolved, demanding specific technology for the storage, processing and analysis of big data. This is the province of big data technologies.

### 1.2. Machine learning

Machine learning is an important branch of artificial intelligence [3]. It uses largely obscure statistical tools that allow machines to improve on tasks with experience. Machine Learning algorithms enable the computers to learn from data, and even improve themselves, without being explicitly programmed. The basic premise of machine learning is to build algorithms that can receive input data and use statistical analysis to predict an output while updating outputs as new data becomes available.

Machine learning implementations are classified into four major categories, which are outlined below in turn.

I. Supervised learning: An algorithm learns from example data with provided categories or classes. The algorithm learns from existing data, and is then able to correctly classify new data into the predefined classes. An example would be to predict whether an action leads to a power outage or not.

II. Unsupervised learning: In this case, the algorithm is left to learn and decide the data patterns on its own. It achieves this by observing the degree of similarity between data points, and then deciding on the optimum clustering approach. Applications include: recommender systems for online purchases, electricity customer segmentation and fraud detection.

III. Semi-supervised learning: In this case the model is fed a dataset with some of the target outputs missing from the training dataset.

IV. Reinforcement learning: The machine seeks to optimize the solutions after each cycle of learning using a feedback loop. Applications include computer chess engines, self-driving cars and self-healing power systems

### 1.3. Big data and machine learning in Power systems

Within the power distribution sector, machine learning is used within a big data context to offer solutions in descriptive, predictive and prescriptive analytics. Descriptive analytics uses historical data to explain observations, predictive analytics leverages machine learning to predict future occurrences based on historical data. Prescriptive analytics seeks to offer recommendations based on insights gained from analytics. The interaction between big data and machine learning is illustrated below.

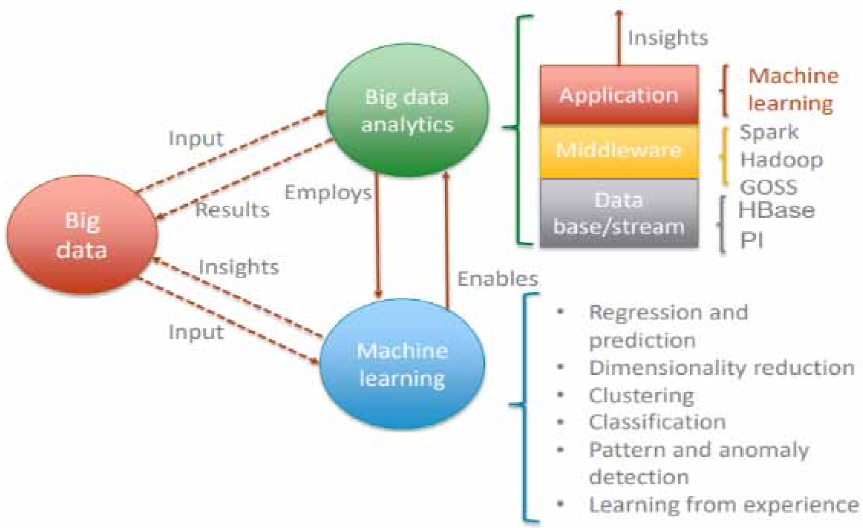



*Figure 2: Big Data, Machine Learning in Context [4]*

In the context of the electricity value chain, the following possible use cases are identified.

| Power System Data | Power Generation | Power Transmission | Power Distribution | Demand Side Management |
|---|---|---|---|---|
| • Equipment Data<br>• Environmental Data<br>• Management Data<br>• Operating Data | • Generation Efficiency Improvement<br>• Power Plant Operations<br>• Electricity Price Modeling<br>• Renewable Energy Planning management<br>• Economic Load dispatch<br>• Generation Market modeling<br>• Generation planning and optimization | • Power Transmission Planning<br>• Grid Loss Identification<br>• Islanding Detection and Isolation<br>• Asset management and Lifecyle Planning<br>• Outage Detection and Restoration<br>• Transmission Line Fault Detection and Monitoring | • Fault Detection and Identification<br>• Transformer Health Monitoring<br>• Outage detection and restoration<br>• Loss reductionPower Retail | • Customer Segmentation<br>• Revenue protection and loss detection<br>• Customer load forecasting<br>• Distributed Generation Monitoring |

*Figure 3: Big Data and Machine Learning Use Cases In the Electricity Value Chain*

The core advantages of machine learning in big data analysis is the ability of a machine to learn automatically, handle large varieties of data, continuous self-improvement, and the breadth of its applicability. Sample use cases are presented below in turn.

### Machine Learning- Sample Use Cases

**Case 1:** Unsupervised Learning: Anomaly/Fraud Detection

In detecting anomalies, the model seeks to establish a baseline for what it considers anomalous, and what if considers normal. It achieves this by learning from both historic and live data. With anomalies detected, it is easy to flag an anomalous occurrence in real time and precipitate corrective action, which will in turn reduce overall equipment downtime and failure. This case study involved analysing energy consumption data from a customer with a history of suspicious variations. An unsupervised learning model – Isolation Forests, was used to identify anomalies in the time series current data. With the anomaly range identified, it is possible to flag such issues ahead of time, before a business loss is incurred.

The plot below visualizes normal and anomalous readings from energy meter readings.

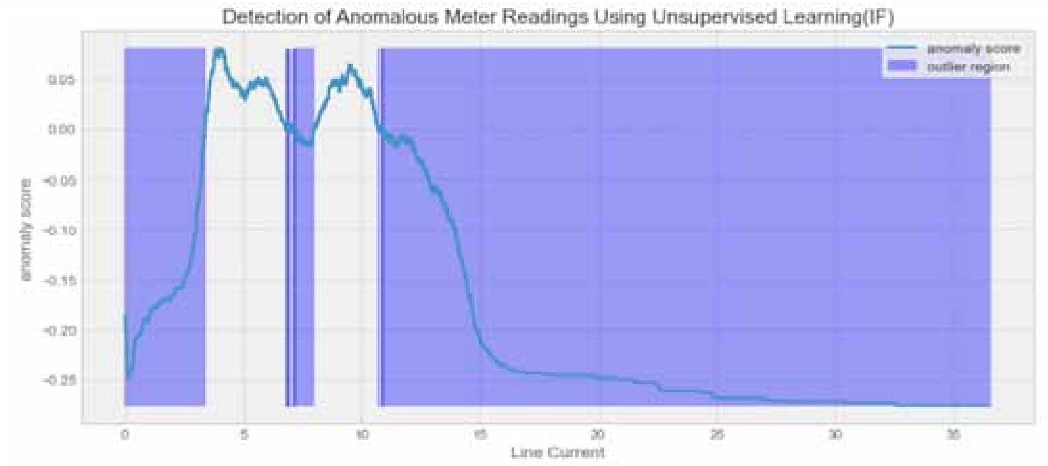



*Figure 4: Anomaly Detection Using Unsupervised Learning*

### 2.2. Use Case II: Supervised Learning

### Customer Demand Forecasting

It is of interest for a power distributor and consumers as well, to wish to not only keep tabs on their electricity costs, but also to afford themselves a level of predictability in consumption. Machine learning finds its use in this context. This case involved mining of data from a meter reading portal, for a certain customer, over a 1-year period, and deploying a Decision Tree Regressor model to identify consumption trends. Decision tree belongs to a class of models known as "Tree Based Models", which builds regression or classification models form of tree structures, by using statistical tools to breakdown data into subsets.

The meter data was pre-processed, split into a "training" dataset and a "testing" dataset. The training dataset is used by the model to identify the underlying patterns in consumption and attempt predictions on it, while the test dataset is used to validate the model. If the accuracy score of the model is high, then the model can be deployed in a real use case.

The dataset in question was pre-processed, and then used to train and evaluate the model. The model predictions are then visualized versus the actuals

*Figure 5: Customer Load Prediction Using Supervised Learning*

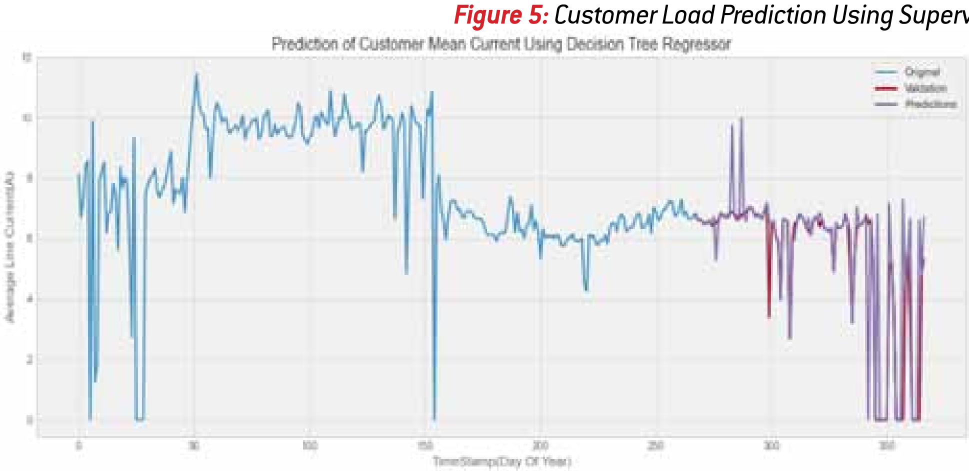



*Figure 6 :Customer Demand Forecasting*

## Solar PV Plant: Prescriptive Maintenance

Kenya presently has over 100MW of installed grid-scale solar PV systems. The sheer size of these plants, as well as the non-programmable nature of the resource, presents challenges for both grid operators and solar power plant developers. A key element, is the need to monitor performance of the plant, by comparing it to an ideal "digital twin". This comparison allows for identification of performance deviations due to component failure, shading or dust. This case utilized production data from a real solar PV power plant in South Africa, and compared its performance to an ideal representation of the plant. The digital twin utilized a linear regression model, which employed component data and weather/climate data obtained from weather APIs.

The actual power output was the resulting predictions was then compared to the expected ideal, and the anomalies from each date identified for prescription of the adequate maintenance intervention.

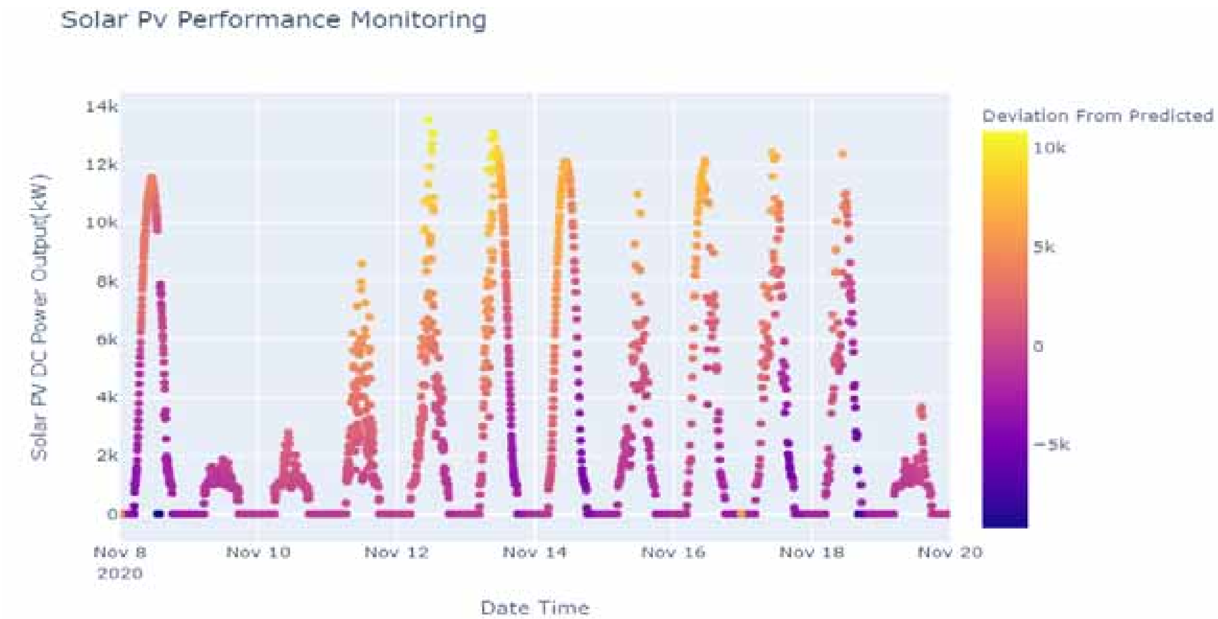



**Figure 7:** *Solar PV Plant Performance Monitoring*

## Risks and Change Readiness

Plea The use cases above have presented a strong case for leveraging machine learning and big data tools in power systems planning, operations and maintenance. However, there are requirements for adoption and attendant risks. These are summarized as below:

- Data Security: Some of the more efficient and powerful tools leverage cloud solutions. Cloud services bring with them serious concerns with information security
- Data Architecture and Availability: Machine Learning algorithms require massive training datasets. These datasets should be of good quality and unbiased. This is a challenge in a sector that is yet to fully automate processes.
- Value chain synergies. For instance, implementation of Automatic Generation Control (AGC) would require synergies between the System Operator, the TSO and Generating entities. AGC can then leverage machine learning to optimize dispatch and ensure system security.
- Capacity Gaps: There is a dearth of engineers in the sector capable of leveraging big data and machine learning in grid planning, operations and maintenance. There would have to be deliberate capacity building in this area for active uptake to occur.

## Conclusions

The global transition to smart utilities is inevitable, and so is the widespread application of big data and machine learning in the planning, operation and maintenance of the Kenyan utility grid. The utility sector needs to create synergies that would ensure the mainstreaming if this technology in grid operation. The expected benefits of the technology outweigh the risks. The result would be a more efficient, reliable, secure and affordable electricity supply.

Adrian Omambia Onsare, Utility Management & Consultancy Department, KPLC. Email: adrianonsare@mail.com


*Ongoing construction works on the Nairobi Expressway that is set to easen traffic flow between JKIA and James Gichuru Road in Nairobi.*

# EASING TRAFFIC:

## Nairobi Expressway set to change the City's outlook

IF you live or work to the east of Nairobi city, you will most likely find yourself stuck in the busy Mombasa Road traffic during the morning and evening rush hours on any day. In recent months, this situation has become even worse because of the construction of the Nairobi Expressway, injecting a new level of chaos into the country's capital city.

When finished, the expressway will be a 27km highway, some of it elevated, that will connect Jomo Kenyatta International Airport to the Nairobi-Nakuru highway. The project being undertaken by the China Road and Bridge Corporation (CRBC) is set to dramatically change the city's skyline and is meant to ease traffic flows in and out of the centre of East Africa's main commercial hub.

This is a road of many firsts. It is billed as among the first public private partnership (PPP) projects in Kenya. The project company will therefore bear the risks for the entirety of the design, construction, operation and maintenance, on a "build-operate-transfer basis".

The road will also be the first expressway and toll highway in the country, and engineers clearly have their work cut out for them, not just at the design and construction stage, but also at the operation and maintenance phases.

Being a toll highway means the four- and six-lane dual carriageway, with 10 interchanges along the route, will not be free to use – drivers will have to reportedly pay a toll of between Ksh200 and Ksh300.

"The contracting authority undertakes quality control checks to ensure that the quality standards for the outputs are met. The contracting authority will benefit from knowledge transfer, particularly in the management of expressways and toll highways," says Eng. Julia W. Ondeyo, a Deputy Director Roads at the Kenya National Highways Authority, which is overseeing the project and is the contracting authority on behalf of the Kenyan government.

Eng. Julia describes the expressway as an essential infrastructure project that will spur modernisation.

The partially elevated highway was proposed about 10 years ago, but delays meant it was only launched in October 2020 by President Uhuru Kenyatta.

Yet the speed of its construction is leaving many Nairobians surprised. It already looks like a giant gash through the city and the constant hum of construction noise, lorries whipping up dust and beeping car horns all add to the confusion.

Being a PPP project also means the Kenyan government does not bear the Engineering, Procurement and Construction (EPC) costs, which stand at USD599 million (about Ksh65 billion). The government is only responsible for land compensation (Ksh10 billion) to facilitate and secure the right of way for the project, and Ksh4.5 billion for relocation of utilities.

Despite these costs, however, Eng. Julia is confident that the expressway has a positive value for money as the costs of undertaking such a huge project under normal procurement would be higher than through the PPP model adopted.

"In PPP projects, the government engages the private sector in the development of infrastructural projects using private equity. Thus, there is no debt financing and the private party bears the design and construction risks, thereby reducing the exposure of the Government of Kenya," she says.

"Private parties also bring expertise, consistency and timely project delivery for the benefit of the public, which spills over to operations and maintenance project phases in build – operate – transfer models."

When finally completed by December this year, according to the plan, the project is expected to improve travel time for both commuters using the Expressway and the existing Mombasa Road, as at least 30 per cent of traffic is projected to be diverted to the Expressway.

This means the currently common traffic snarl-ups will be a thing of the past.

With reduced traffic jams, the project will reduce the net emissions from vehicles and promote economic growth. Presently, millions of shillings are lost in reduced productive hours spent in clogged traffic along the highway.

In PPP projects, the government engages the private sector in the development of infrastructural projects using private equity. Thus, there is no debt financing and the private party bears the design and construction risks, thereby reducing the exposure of the Government of Kenya.

Besides creating jobs for Kenyans directly and indirectly through the supply chain, the expressway will also support the growth of suburbs such as Syokimau, Mlolongo and Athi River due to enhanced connectivity.

However, all these benefits do not come without challenges. One of the key challenges is that the existing A8 road (Mombasa Road) is currently operating beyond its capacity, especially during peak hours.

"Properties abutting the existing A8 road are also heavily built up, thereby increasing land acquisition costs significantly," says Eng. Julia.

This is a critical lesson for engineers and those involved in the planning for such projects to put enough controls to eliminate the need for several accesses that decrease the service levels of highways for future projects.

In her parting shot, Eng. Julia builds a case for PPP projects, saying they are ideal in addressing the infrastructure deficit and overcome the challenge of mounting debt that has progressively posed a burden to the country.

"The annual fiscal requirement for infrastructural projects in Kenya exceeds the financial capability of the country, leaving a significant gap in funding," she says.

*Progress on the Nairobi Expressway Road as seen from the Airtel-Ole Sereni Roundabout on April 20, 2021.*


# Branding makes Enterprises Distinct and Identifiable

Branding is defined as "the promotion of a particular product or company by means of communication and distinctive design". Branding can and is actually done for two levels – Corporate, where it is known as corporate branding, and individual or person, referred to as personal branding. A brand is, therefore, a name, term, design, symbol or any other feature that identifies and distinguishes an organisation, firm or individual from others. Branding makes a firm distinct and identifiable. It is a necessary – actually indispensable – business attribute that is requisite for a successful enterprise. For a start, let us delve a little into the motor industry, which is heavily driven by the engineering discipline, to articulate the power of branding. One will never struggle to identify the leading global vehicle brands – Toyota, Mercedes, BMW, Nissan, among others. Because of the power of branding, customers all over the world choose their preferred vehicle types based not necessary on the performance of the vehicle, but on the cognitive opinions they have formed out of the respective brands.

I need not emphasise the fact that engineers need to understand the power of branding, both at the personal and corporate level.

Personal branding is the conscious and deliberate effort to create and influence public perception of an individual. People do this by positioning themselves as an authority in their profession, elevating their credibility and differentiating themselves from the rest, to ultimately advance their careers, increase their circle of influence, and have a larger impact. And this is absolutely necessary for engineers, just like all other professions.

To build a personal brand, one has to find and embrace uniqueness, acquire reputation on the things he or she wants to be identified with and known for. Personal branding will therefore involve your unique style of doing things, how you appear in public, differentiated leadership style, public speaking, dressing and other etiquettes that distinguish people. Engineers who want to be distinct will therefore adopt these and other personal branding attributes that will distinguish them from the rest. The benefits of a reputable personal brand are many and worth it. When you acquire a reputable personal brand, the following will likely come your way:

You become more visible and recognisable. You can easily and comfortably leverage your network and other social capital.

You become more identifiable as a person, getting higher elevation than others. The business you run will have a better chance to become stronger and successful. You easily become the talk of the town … in a positive way. And now, corporate branding. Engineers run firms. These firms, ranging from the smallest (start-ups) to the largest, must be well branded to be distinct and differentiated. What are the key branding attributes of corporate branding?

**Relevance** – A strong brand must be relevant and resonate well with the market. An engineering firm that shows relevance and value on its area of operation will manifest a strong brand.

**Proper positioning** – A strong brand should be positioned so that it makes a mark in the target audience's mind, making them prefer it over other brands. Whether road construction, housing or any other engineering area, relevance in terms of better value and effective delivery is necessary.

**Sustainability** – A strong brand makes a business competitive and sustainable. Other aspects of corporate branding include identifiable items such as business cards (e-business cards as well as physical cards), letterheads, information flyers, email templates/formats, PowerPoint templates and other convention displays. Branding is indispensable. Engineers must understand, appreciate and use branding as a successful business tool.

*Peter Mutie, FAPRA, FPRSK, is a leading global Public Relations professional with experience spanning over two decades.*

# OTIENO: We need to engineer ways to fight corruption

THE engineering profession in Kenya is guided by the Code of Professional Conduct (also referred to as Code of Ethics or Code of Conduct) as envisioned in the Engineers Act 2011, which every engineer is expected to uphold in order to advance the integrity, honour and dignity of the profession.

The Engineers Act 2011 defines the Code of Ethics as "a set of standards for engineers' obligations to the public, their clients, employers and the profession encompassing right conduct."

This essentially means the mandate of engineers stretches beyond just solving complex problems. In fact, today's engineer is expected to not only engage in matters engineering but also matters advocating for and advancing good socio-economic governance.

First, we should actively collaborate with county and national governments through legal institutions (including non-governmental organisations) that are mandated to fight corruption.

The Ethics and Anti-Corruption Commission (EACC) is one such government body, which engineers, through the Institution of Engineers of Kenya (IEK) and the Engineers Board of Kenya (EBK), must work with in the fight against corruption. The EACC has in the past stated that engineers facilitate cases of white-collar corruption in the country.

The IEK, under the current leadership of Eng. Nathaniel Matalanga, has in the recent past engaged with engineers in a number of forums to sensitise them on this vice and it should be applauded and supported. Secondly, the EBK should find mechanisms to enhance the confidence of engineers and the public in the reporting and dealing with complaints and disciplinary processes and actions against suspected and convicted engineers as part of its mandate to regulate engineering professional services in Kenya.

Finally, the synergistic relationship between the need to flag and/or report corruption cases in the engineering profession and sensitisation of the public on what they should expect of engineers should not be underestimated.

As engineers, we must be willing to be held to higher account in society, just like public officers as stipulated in Chapter 6 of the Constitution of Kenya 2010. Engineers should be seen to shun corruption so that instead of becoming enemies of society, we constantly align ourselves to the demands of the society we serve.


*Ethics and Anti-Corruption Commission (EACC) Chief Executive Twalib Mbarak at a past function. IEK collaborates with EACC in training and capacity building for engineers in the fight against corruption.*

Corruption threatens our core values and sense of purpose [beyond just making money] as engineers and must therefore be stopped. We cannot compromise our standards for the sake of expediency. Inasmuch as profitability is a necessary condition for existence, it is not the end in itself for us as engineers, especially if facilitated by corrupt activities.

> The Code of Ethics should be the overarching guide in our day-to-day professional practice. It may not change but it does inspire change. Ultimately, as engineers, we have a duty of care to use our agency to condemn corruption in order to preserve the status of the profession.

The Code of Ethics should be the overarching guide in our day-to-day professional practice. It may not change but it does inspire change. Ultimately, as engineers, we have a duty of care to use our agency to condemn corruption in order to preserve the status of the profession.

The fight against corruption is binary and almost cult-like; we as engineers are either in or out – there is no middle ground.

As engineers, we must continue to harness the resources of nature for the benefit of society in a mutually beneficial manner, but never at the expense of our core values.

In fact, if you are not serving the society, or supporting the folks who do, then we do not need you in the profession because, in the words of Hardy Cross, the purpose of engineering, just like education in general, must be service and not self-promotion.


*Mike Otieno, Associate Professor, School of Civil and Environmental Engineering, University of the Witwatersrand, Johannesburg, South Africa. Email: Mike.Otieno@wits.ac.za*

# IEK MEMBERSHIP REPORT

THE IEK Membership Committee meets every month to consider applications received at the Secretariat to enable clear the backlog of applicants wishing to become members of the Institution in the various classes. Between January and March 2021, the number of new applicants processed were 224 as reflected in the table 1 below:

| Member Entry class | | Number process in Jan, Feb & March |
|---|---|---|
| Graduate Member – GE | | 218 |
| Graduate Engineering Technician - GT | | 1 |
| Graduate Engineering Technologist - GTL | | 3 |
| Student Membership - S | | 2 |
| **TOTAL NUMBER** | | **224** |

***Table 2: Discipline Data***

| Discipline | Agriculture | Mechanical | Electrical | Civil |
|---|---|---|---|---|
| | 289 | 1,688 | 1,917 | 4,233 |

***Table 3: Gender Data***

| S/N | Gender | No. |
|---|---|---|
| 1 | Female | 635 |
| 2 | Male | 7,490 |

In the same period we have had fifty(50) members who transfered from Graduate to Corporate class.

***Their details are given below:***

| S/N | Member Name | M/No |
|---|---|---|
| 1. | Alexsandra Kokonya Nabucha | M.5918 |
| 2. | Anthony Gichira Wandu | M.3525 |
| 3. | Benson Kioko Muange | M.6823 |
| 4. | Daniel Areba Machoka | M.3424 |
| 5. | Olali Calleb Lawrence | M.9102 |
| 6. | Sebestian Idalia Indiazi | M.3152 |
| 7. | Simon Mwangi Kibachio | M.5372 |
| 8. | Alfred Samwel Murimi Munyi | M.3837 |
| 9. | Alfrick Otieno Owuor | M.7087 |
| 10. | Annastacia Waitima Maina | M.8530 |
| 11. | Catherine Auma Nyambala | M.2663 |
| 12. | David Ngibuini Mwangi | M.4530 |
| 13. | Edwin Otieno Ochieng | M.5628 |
| 14. | Erick Tuei Meli | M.6728 |
| 15. | Eric Simiyu Juma | M.6138 |
| 16. | Ezra Onduso Mauti | M.6845 |
| 17. | Geofrey Mwangi Wanjiku | M.6807 |
| 18. | Gloria Kwamboka Orare | M.9231 |
| 19. | Harold Chisano Oyando | M.7043 |
| 20. | Henry Kibett Tonui | M.6681 |
| 21. | Henry Ndegwa Njuguna | M.8133 |
| 22. | Jafeth Juma Akira | M.5912 |
| 23. | James Kimani Waweru | M.7060 |
| 24 | James Kinyua Kariuki | M.5127 |
| 25 | Jeremia Otieno Oyoo | M.4433 |
| 26. | Joel Kipruto Chirchir | M.5241 |
| 27. | John Ouko Otieno | M.7035 |
| 28. | Joseph Mbuti Nyaga | M.8550 |
| 29. | Julius Kilonzi Charles | M.5854 |
| 30. | Leornard Kibet Langat | M.4025 |
| 31. | Lilian Mumbua Kilatya | M.6758 |
| 32. | Mark Gathiga Kirichu | M.8639 |
| 33. | Robinson Martin Sauka Muhuni | M.4155 |
| 34. | Nicholas Mahinda Wanjiku | M.7104 |
| 35. | Nixon Richard Otieno Oloo | M.5439 |
| 36. | Robert Ochieng Owuor | M.4790 |
| 37. | Ruth Njoki Njuguna | M.6620 |
| 38. | Samuel Misaro Mochache | M.4473 |
| 39. | Samuel Mwangi Mwaura | M.3726 |
| 40. | Samwel Otieno Obonyo | M.6623 |
| 41. | Stariko Nyakora Nyamori | M.5361 |
| 42. | Stephen Gitonga Njiru | M.6157 |
| 43. | Stephen Mwenesi Usagi | M.7167 |
| 44. | Victor John Onyango Ombogo | M.6426 |
| 45. | Vincent Kiprotich Rono | M.5366 |
| 46. | Zacharia Mahugu Maina | M.6603 |
| 47. | Zacheus Mbogo Kimata | M.6805 |
| 48. | Cornel Otieno Ofwona | M.7158 |
| 49 | Fenwicks Shombe Musonye | M.7638 |
| 50 | Mark Owuor Olonde | M. 7176 |

The council is callling upond its members to apply for transfer of class from Corporate to Fellow and Graduate to Corporate Members can check requirement eligibility and how to apply Fellow class on our website using the following link: https://iekenya.org/downloads/REQUIREMENTS/FELLOW%20REQUIREMENTS%202020.PDF

**The IEK condoles with family and friends of our members who have since passed on. May their souls rest in peace.**

- Eng. Philemon Chamwada
- Eng. Kuldip Sondhi
- Eng. Clement Nduati
- Eng. Alfred Masha Nyanje
- Alfine Agiro Ngaji
- Eng. Maurice Namiinda
- Eng. Jeremiah Musuva
- Eng. Philemon Chamwada
- Eng Mangat I B Patel
- Eng Jan Mutai
- Prof. Eng. Maurice Mangoli
- Eng. Florian Muli
- Newton Karumba
- Eng. Hudson Kihumba Wanguhu
- Eng James Rughendo
- Eng Edward M'mgendi
- Eng. Kuldip Sondhi
- Eng. Clement Nduati
- Eng. Alfred Masha Nyanje
- Afline Agiro Ngaji
- Eng. Kenneth Shako

And any other engineering fraternity member we have lost in the last few months.

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



IEK CSR

# IEK puts a smile on many

AMIDST a raging pandemic, IEK Coast Branch members (Women's Chapter) put a smile on the faces of many Likoni residents last year, as part of the institution's nationwide **Christmas Cheer** initiative.

Like true Santas, they came bearing loads of gifts: over 30kg of maize and wheat flour, 50kg bag of beans, exercise books, tooth paste, sugar, milk, bread, rice, cooking oil, soap and other basic human necessities.

They donated essential goods worth tens of thousands of shillings, all thanks to a brilliant idea that was first mooted in Engineering Fraternity WhatsApp group. The Coast Women's Chapter visited Likoni AIDS & Orphanage Home, taking part in what was arguably one of the most successful initiatives of the engineering fraternity in Kenya in the recent past.

Originally proposed by Eng. Ezekiel Fukwo, other engineers from across the country generously joined hands to actualise the idea, including Eng. Isaiah Onsongo. The Christmas Cheer initiative instantly became popular with IEK members, attracting

SOUTH RIFT, NAKURU

IEK's South Rift Branch, led by Christmas Cheer initiative Chair, Eng. Michael Kamau, Eng. Dominic Mutai, Graduate Eng. Benard Morintat, Graduate Eng. George Mutai and Graduate Eng. Diana Macodawa donate food stuff at New Life Home Trust in Nakuru.

CENTRAL, CHUKA TOWN

IEK Central Branch members visit Kenya Connection Kids Children's Home in Chuka Town, led by team leaders: Eng. Hannah Njeri (Chair) and Eng. Daisy Karimi (first vice chairperson) and Eng. Cyrus Kanda (ordinary committee member).


WESTERN, VIHIGA

In Western Kenya, Christmas Cheer Initiative was led by branch coordinator Eng. Erick Ngage, Eng. Prof Augustine Makokha, Eng. Christine Ingutia, Eng. Owen Munene and Ms Cynthia Awuor. The members visited Shangilia Children's home in Vihiga.

CAPITAL BRANCH, GOTA CITY

IEK Capital Branch members led by 1 st Vice President Eng. Lucy Wanjiku, 2 nd Vice President Eng. Erick Ohaga Council Member Eng. Grace Kagondu, Eng. Isaiah Onsongo Graduate Eng. Abdifata Jama and Graduate Eng. Radiance Mungu and visit underprivileged women and children in Gota City slums in Embakasi.

NORTH RIFT, ORTUM GIRLS

IEK North Rift Branch, led by Chairperson Eng. Kibias Kipkemoi, Eng. Stanley Soi, Graduate Eng Hosea Borok and other branch members visit Ortum Girls Rescue Centre in West Pokot, delivering essentials to vulnerable schoolgirls threatened by early marriages and FGM.

# faces with Christmas Cheer



support all the way from the top leadership.

Eng. Onsongo initially stood in as treasurer, collecting funds on behalf of members. Graduate Engineer Abdifatah Jama of IEK South Rift branch stepped up coordination efforts, rallying support among institution's members countrywide. In the end, the initiative reached out to hundreds of vulnerable children in care homes from Isiolo to Nakuru, Mombasa to West Pokot. The engineers provided essentials to FGM and early- marriage-threatened schoolgirls in West Pokot at the IEK North Rift Branch and put a smile on the faces of under-privileged children in Nairobi's Gota City slum.

In the Western Kenya branch, Christmas Cheer initiative was led by branch coordinator Eng.

Erick Ngage, Eng. Prof. Augustine Makokha, Eng. Christine Ingutia, Eng. Owen Munene and Ms Cynthia Awuor. The IEK members visited Shangilia Children's Home in Vihiga and Mukumu Children's Home in Kakamega.

NORTH EASTERN, ISIOLO

IEK North Eastern Branch's Eng. Abdurazak Ali, chair of the initiative, alongside Eng. Abdinoor Takoy, Graduate Eng. Roy Okello (Chairperson Isiolo County), Graduate Eng. Grace Mativo and Civil Engineer Dr Hussein Jama lend a hand in the North Eastern region.


WESTERN, MUKUMU

In Mukumu Western Kenya, IEK members visited Mukumu Children's Home in Kakamega.


NORTH RIFT, WEST POKOT

IEK North Rift Branch members visit Ortum Girls Rescue Centre in West Pokot, delivering essentials to vulnerable schoolgirls threatened by early marriages and FGM.

COAST BRANCH, LIKONI

IEK Coast Branch (Women's Chapter) members led by Eng. Rosaline Jilo, Eng. Catherine Karue, Eng. Angela Wairimu, Eng. Bernice Nzamba and Graduate Eng. Christine Ndolo visit the Likoni AIDS & Orphanage Home.

CAPITAL BRANCH, EMBAKASI

First Vice-President Eng. Lucy Wanjiku and Eng. Isaiah Onsongo accompanied by graduate Eng. Abdifata Jama donate food to vulnerable and single mothers at Gota City in Embakasi, Nairobi.

# Bearing Vibration Analysis for 1000kW Electric Motor in Kenya Pipeline Company

## 1.0 Introduction

KENYA Pipeline Company (KPC) Ltd operates a pipeline system for refined petroleum products from Mombasa into the hinterland. The pipeline system currently consists of 450 Km of Line-1 and 450 km of line 5 running from the port of Mombasa to Nairobi, 325km of Line-2 from Nairobi to Eldoret, 325km of Line-4 from Nairobi to Eldoret, 121km of Line-3 from Sinendet to Kisumu, and 121km of Line 6 from Sinendet to Kisumu. At intervals along the Pipeline, there are Pump stations for boosting the line pressure. The equipment in each Pump station includes a set of redundant motor driven centrifugal pumps of various sizes and ratings. Each pump is driven by a 3300V or 6600V Motor. Fig 1 shows a pump station with a Motor and Pump set in the foreground.

***Fig 1. KPC Pump station showing a Pump-set with a 1600kW Motor (left).***

Each pump-set consists of a motor drive, fluid coupling for pump speed control, and a multistage centrifugal pump. To ensure safety of the pump, each pump-sets is equipped with a Bentley Nevada Pump monitoring system that monitors Motor winding temperature, motor bearing temperature, pump casing temperature, pump speed, fluid coupling temperature and fluid coupling vibrations.

## 2.0 The problem

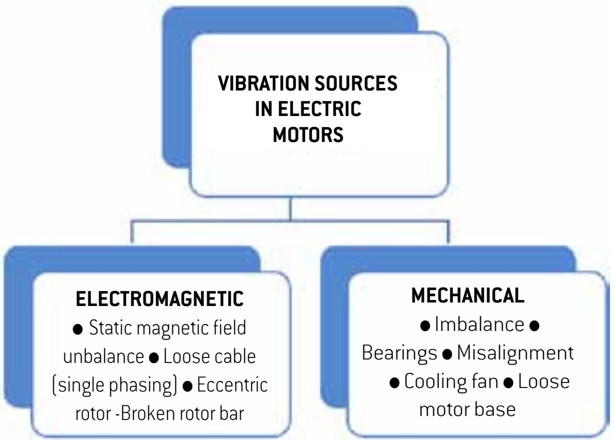
A 3.3kV, 1007Kw (1350 HP), 2900 RPM Squirrel cage induction motor coupled to a centrifugal pump through a fluid coupling in the Kenya Pipeline Company pumping station at Pump Station 22, Ngema was noticed to be unusually vibrating and shaking the Motor foundations. The motor vibrations are not monitored by the pump monitoring system. Initial troubleshooting could not identify the cause of the failure. Each motor is fitted with 2 No. sleeve bearings, TYPE ENLB, with a 90 mm bore, one each at the drive end (DE) and Non-Drive end (NDE).

## 2.1. Motor bearing vibration

Induction motors are the most used electro-mechanical device in industry because of economic considerations and their rugged nature. One of the defects that motors exhibit during operation is high level of vibrations. Every motor vibrates, and usually within acceptable limits, but if excessive vibrations are left unchecked, equipment damage will result. Vibrations are characterized by amplitude and frequency. Amplitude, or displacement shows how strong the vibration is, while frequency shows the rate of vibration.

## 2.11 Vibration sources

Vibration is a repetitive movement around a point of equilibrium, characterised by its variation in amplitude and




frequency. The causes of vibration are outlined in **Fig.2.**

*Fig 2: Sources of vibration in electric motors [2]*

## 2.12. Vibration analysis

The vibration of a system can be expressed as a displacement, velocity, or acceleration. Measurement and analysis of vibration signals is carried out using dedicated equipment as is shown in ***fig. 3 below.***

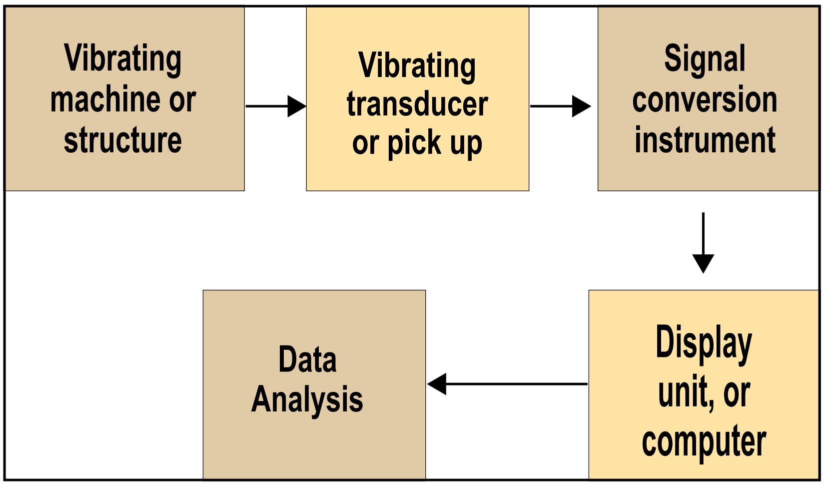



*Fig 3: Process of vibration analysis*

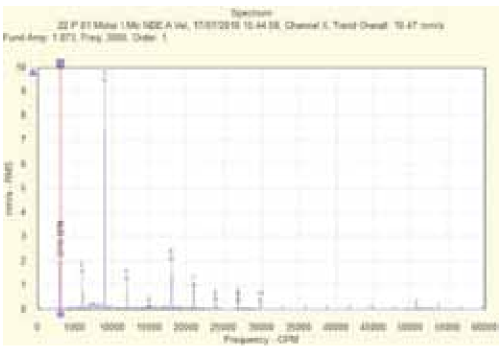
A vibration transducer or pickup is attached to or kept in proximity to the machine or structure undergoing vibration analysis. Vibration of a motor housing is measured with accelerometers, while shaft vibration is measured with proximity sensors. Accelerometers provide a voltage output whose amplitude is proportional to the acceleration of the vibration. Subsequently, the analyzer can integrate this signal to obtain the speed and displacement making the accelerometer the most versatile sensor. The signal from the vibration transducer is then amplified, filtered, and digitalized by an analog-to-digital converter. It can then be presented in time domain, or processed further, by FFT for example. Time domain analysis methods attempt to analyze the amplitude and phase of the vibration signals to detect faults. Frequency (spectral) domain analysis include Fast Fourier Transform (FFT), Hilbert Transform method, and power spectrum analysis. Frequency domain analysis achieves both objectives of fault identification and determination of the cause.

## 3.0 Methodology

Vibration data was obtained using a Microlog Accelerometer probe while vibration spectrum analysis was carried out using an SKF Microlog spectrum Analyzer for axial, radial, and horizontal axes. Vibration data was obtained from the motor DE and NDE bearings. The vibration analysis was carried out by Products services and solutions ltd in conjunction with KPC.

| Equipment | POINT name<br>Date 18-Jul-18 | Last value | Units | Alarm status |
|---|---|---|---|---|
| 22P01 | Mtr NDE V Vel | 9.538 | mm/s | Overall - Danger |
| 22P01 | Mtr NDE H Vel.1 | 11.469 | mm/s | Overall - Danger |
| 22P01 | Mtr NDE H Acc | 0.766 | g | --- |
| 22P01 | Mtr NDE A Vel | 10.468 | mm/s | Overall - Danger |
| 22P01 | Mtr DE V Vel | 12.017 | mm/s | Overall - Danger |
| 22P01 | Mtr DE H Vel | 10.675 | mm/s | Overall - Danger |
| 22P01 | Mtr DE H Acc | 0.7 | g | --- |
| 22P01 | Mtr DE A Vel | 9.569 | mm/s | Overall - Danger |

## 4.0 Findings



The overall vibration readings for the motor bearings are as shown in table 1.

**Table 1:** Overall vibration reading for the bearings

The spectrum for the NDE bearing in the axial direction is as shown in **fig. 4.**

**Fig4: Spectrum for NDE motor bearing**

The motor was inspected for alignment, bearing clearance, mounting, and the only area of concern was the clearance between the bearing and the bearing housing which was found to be 0.2 mm beyond the manufacturer (ABB) recommendation.


*Eng. Tony Washike, PE, MIEK,B Tech (Electrical and Communication Eng), Msc (Eng), Senior Electrical Engineer, Kenya Pipeline Company.*

# The Potential Application of Solar Thermal Powered Adsorption Chillers for Cooling Houses in Nairobi

## INTRODUCTION

KENYA is a tropical country in East Africa and enjoys relatively good climate throughout the year. According to the 2019 Kenya Population and Housing Census, Kenya had a total population of approximately 47.5 million. Notably, Nairobi county had a population of approximately 4.4 million people, and with a land area of 703.9 square kilometers, this translates to 6,247 people per square kilometer. This population density was by far the highest among the counties, which only serves to increase competition for the resources available in the county. To address the perennial challenge of scarce housing facilities in the country, the Government of Kenya under the 'Big 4 Agenda', has set in motion a rigorous plan to construct a projected 500,000 units by 2022. Markedly, the capital county, Nairobi, with its high population density, is set to be the biggest beneficiary of this plan with its high population density.

To improve the living conditions in the constructed houses, one of the factors that needs to be considered is air conditioning. Of particular importance is the ability to cool these houses during the hot seasons to make the spaces more habitable to those occupying these houses. This study investigated the potential of using adsorption chillers in place of the conventional air conditioning systems. Because adsorption chillers need hot water to run, the possibility of using solar thermal heating systems to meet this requirement is investigated. Therefore, the paper first sets out to review the housing situation in Nairobi county and the status of electricity consumption, especially, on meeting the cooling load demand. Next, a model is developed to calculate, based on the climatic conditions in Nairobi, the solar thermal heating potential for per square meter for Flat Plate Collector (FPC) solar thermal heaters, the cooling load for standard 3-bedroom house is then evaluated, assuming a Coefficient of Performance (C.O.P) of 0.3. Finally, the model determined the size of FPC's need to heat the water needed to meet the cooling demand and the practicability of this system is evaluated.

## Approach

The study developed a solar thermal run adsorption cooling system for a three-bedroom residential housing unit. The performance metric adopted by the study was a C.O.P of 0.3 that was based on literature review of the performance of other systems. The methodology involved developing an Excel model to first, estimate the heat generated by location specific solar irradiance per square meter. The system then computed the average cooling capacity per square meter, followed by an evaluation of the cooling load of a three-bedroom residential house as case study. Finally, the model determines the size of the solar collector system needed to provide the cooling load and the practicability of the system is appraised.

The proposed system contains two beds, which operate intermittently to create a continuous cooling cycle. The choice of this system is based on its superior efficiency compared to a single bed adsorption system. The other components include the condenser, hot water tank, evaporator, solar heat energy collector, pipes, valves, and sensors. An illustration of the

The solar heat collector comprised of flat plate collectors. Essentially, the flow of working fluid would be:

- Flat plate solar corrector gathers heat from the sun
- The heat is transferred to the hot water circulating through the solar

thermal collector

- The hot water is stored in an insulated storage tank where heat losses are minimal
- The hot water is passed to the adsorption chiller bed 1 where adsorption occurs by heating. At adsorption bed 2, cooling water is used for the desorption process
- The water is then cycled to the hot bed where is reheated by the sun
- The adsorption system receives water from demand to cause further cooling
- The chilled water from the adsorption system is conveyed to the demand to cause cooling

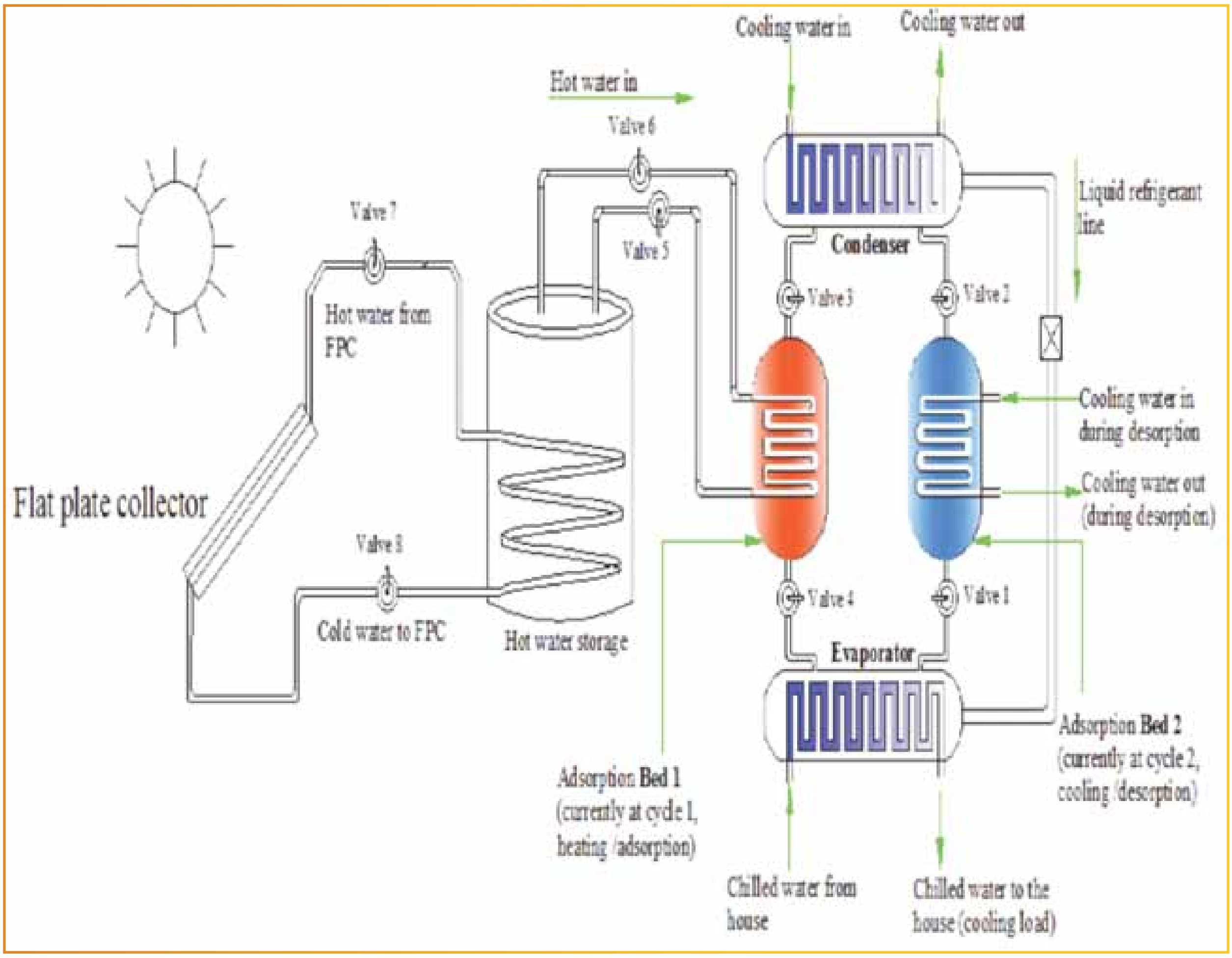



**Figure 1. Components of the proposed adsorption cooling system**

The model was then programmed to estimate the average solar irradiance, followed by the average heat available at the collector. Next, the heat transferred to the water storage tank was determined using the approach proposed by Mahsa & Behbahani-nia, (2013), as per the equation 1 below:

Where is the mass flow rate of water through the storage tank; is the volumetric flow rate, is the density, is the specific heat capacity of water = 4.18kj /kgK, is the temperature difference between the circulating water and the collector temperature.

The average cooling loads of the building was then determined in the model with focus being on a 3-bedroom residential building after which the rate of heating was computed assuming an average Coefficient of Performance (C.O.P) of 0.3. Finally, the performance of the system was evaluated based on its practicability, economics, affordability, durability and feasibility in Nairobi region.

## Results

Based on the inputs to the model, automatic calculations were done by the model and the following outputs are discussed: 1) the estimation of the solar irradiance received during the study time; 2) determination of the energy used by the adsorption system, and 3) the number of collectors used to provide the required cooling load.

### Average solar irradiance values

First, the average solar radiation per square meter of the FPC was determined. Notably, the amount of radiation received from the sun on a tilted surface is dependent on the location, the slope of the collector, and the efficiency of the absorption. The models depended on inputs that include the location (longitude and latitude), the solar day of the year, the direct global solar radiation GB, and diffuse solar radiation GD. GB was obtained from satellite data showing the solar irradiance in Nairobi (Table 1)

**Table 1: Solar insolation values for Nairobi**

The average monthly direct global solar radiation GB on a tilted surface measuring 1m2 was 849 W (Table 14).

| **Parameters** | **Values** | **Units** |
|---|---|---|
| **Solar radiation values** | | |
| Average Monthly Direct Global Solar Radiation ($G_B$) | 849 | W/ $m^2$ |
| Average diffuse radiation on horizontal surface ($G_D$) | 208 | W/ $m^2$ |
| Total Collector Area ($A_C$) | 3 | $m^2$ |
| Direct Beam radiation on tilted surface ($G_{Bt}$) (*without considering absorptance -transmisivity*) | 1016 | W/$m^2$ |
| Diffuse beam radiation on tilted surface ($G_{Dt}$) (*without considering absorptance -transmisivity*) | 299 | W/$m^2$ |
| Ground reflected radiation on tilted surface ($G_{Gt}$) (*without considering absorptance -transmisivity*) | 42 | W/$m^2$ |
| Total radiation falling on FPC ($G_t$)without considering Absorptance - transmisivity of the FPC-Isotropic model | **1357** | W/$m^2$ |
| Final Absorbed radiation by FPC ($G_t$) including Absorptance - transmisivity of the FPC-Isotropic model | **1065** | W/$m^2$ |

Considering an average of 8 hours of sunshine per day, this translates to approximately 6.79kWh/m2/day. The results were consistent with the current literature. A Study by Wasike (2015) demonstrates that three areas in Kenya had monthly insolation levels on a horizontal surface of about 6.5 to 7.0 kWh/m2/day between January and March. This reduced to 4.8 kWh/m2/ day in May and further downwards to 4 kWh/m2/day from June-July, attributable to the considerable cloud cover (Wasike, 2015)2. The results are also similar to those obtained by Hille et al. (2011).

### Total energy transferred to adsorption system

The thermal energy collected by the FPC is transferred to the adsorption system. Assuming a collector efficiency (F') of 0.8, and the average heat absorbed by the collector per square meter, Qnet = 813.668 W; the total energy transferred to the water into the storage tank, was calculated as:

### Number and Size of FPC Required for a Three Bedroom House

The model also evaluated as a case study; the number of flat plate collectors needed to cool a normal three-bedroom residential house. In the model, it was assumed that a standard three-bedroom house has a kitchen, living room, one en-suite bedroom and two standard bedrooms. The estimated cooling load for the case study house was found to be 6.265 kW. Assuming that the adsorption cooler supplies all this energy, then, the air conditioner must supply a cooling load of 6.265kW. Since the adsorption system has a COP of 0.3, then, the total cooling load is:

Each solar collector of size 1m2 supplies 658 W of heat. To correctly match the demand, the total area that should be occupied by the collectors is:

## Discussion

### Evaluating the practicability of the system

From the model, the total size of FPC's required is 32m2; if each collector has an area of 2 square meters, a total of 16 FPC's will be required. For this study, it is assumed that the three-bedroom house has a gable roof with medium pitch (6/12 or a rise of 6 inches for every 12-inch horizontal), and a further assumption is made that the roof does not have a complex design. Furthermore, it is assumed that the roof runs parallel to the long side of the building. With these estimates, the total roof area is approximately 118.22m2, while the average area required for the FPC installation is about 32m2. Therefore, a standard three-bedroom house would expertly be installed with a roof-mounted adsorption cooling system running on solar energy. Alternatively, the panels could be located on the ground in cases where the roof design does not allow effective installation of the FPC.

In a study by Chang, Wang & Shieh (2009), they developed a 10kW adsorption plant in Taiwan, which used tube and fin exchanger collector with an area of 108.5m2, and a storage tank of volume 1.3m3. The system had a COP of 0.33 and a cooling capacity of 7.79KW. This plant closely resembles the current modelled system, with the differences in the FPC size attributable to different climatic condition and location (latitude/longitude).

Another experimental system was developed by Luo et al., (2006), who designed and developed an adsorption chiller plant to cool grains in China. The plant was rated 3.2-4.4 kW but had a very low COP of 0.13. Zhai and Wang (2009) also developed a solar driven silica gel adsorption system powering an 8.5kW chiller plant. This design used evacuated tube collectors instead of FPC's. The total evacuated tube collector area was 150m2 while the storage tank was 2.5m3 and had a COP of 0.35. This system was developed in Shanghai, China where average temperatures are much lower than in Nairobi, while wind speed is much higher as compared to Nairobi.

## Comparison with absorption cooling

Absorption cooling systems have higher COP ranging between 0.6-0.8, which contrasts with adsorption systems whose average COP is 0.3. Moreover, absorption systems have commercially been used over long periods with significant success (Shanmugam & Boopathi, 2012). They are less costly as compared to the adsorption system, and due to their high COP, they require fewer FPCs. Notably, most adsorption systems are still under development while absorption cooling has been widely developed to run on waste heat as well as solar power.

In terms of thermodynamic properties, absorption refrigeration is superior to adsorption systems. Economically, absorption chillers are cheaper, viable and widely applied as compared to adsorption types. In future, extensive research on adsorption chillers could result in materials that outperform vapour compression systems.

Adsorption refrigeration requires less maintenance compared to the absorption type. The absorption method requires regular monitoring of liquid, boiler, system control, air leakages, heat exchanger, dilution process, and corrosion (Ahmed et al., 2016). Adsorption systems, on the other hand, requires cleaning annually and adopt a simplified control system. Moreover, the operational lifetime of an adsorption system is very long as compared to 7-10 years for the absorption cycle, which is attributable to pitting and corrosion (Ahmed et al., 2016)8.

## Comparison with vapour compression cooling system

Vapour compression systems are the most widely used system in HVAC systems. They have a high COP, typically ranging from 2-4. Their high efficiency makes them more suitable as compared to adsorption systems. Therefore, in terms of thermodynamic efficiency, vapour compression systems perform better as compared to the adsorption system. However, a vapour compression system run on electricity supplied by grid or solar PV cells. If grid electricity is used, then the operational costs will increase remarkedly, which makes the adsorption system more attractive in the long run. Additionally, if solar PV is used, a 1m2 solar panel will generate approximately 100 watts of electrical power. Therefore, a cooling load on 6.26 KW will require; i.e. .

These solar panels will occupy 63m2 of space, which is twice the space occupied by the FPC's for solar adsorption coolers. Moreover, the cost will also increase significantly.

## Conclusions

Please The study investigated the application of solar thermal run adsorption system in cooling houses using the case study of a three-bedroom residential house in Nairobi. With the increasing population and the need for additional housing in Nairobi County, the country can exploit its abundant solar insolation estimated at 6.0 kWh/m2/day.

In most times of the year, solar energy is present and therefore, a cheap alternative to conventional fuel sources. It is approximated that heating and cooling of housing units account for over 30% of all energy consumed causing a remarkable increase in the power bill. The cooling loads depend on the climate, the number of people, building design, equipment generating heat, human activities such as cooking in interior food lounge or restaurants and the type of walls and glazing. This study aimed at determining the amount of solar thermal energy received per day, evaluate the cooling load required for a three-bedroom house and compute the number of FPC needed to provide this energy.

The results of the Excel model developed shows that a solar thermal adsorption system is viable in terms of size and meeting the cooling demand. The adsorption cooling system was also evaluated in comparison with other refrigeration techniques. The results indicate the solar adsorption was a practical system, despite the low COP prevalent in such systems. The system was compared with other cooling technologies. Although adsorption system had the most depressed COP, unique advantages such as low maintenance costs, silent operation, few mechanical parts, reducing the carbon footprint, and use of low temperature make it an attractive cooling alternative. Most adsorption systems are still in the development stage and further research is required to improve on materials, COP, the number of beds, operation cycle among other areas.

*Dickson Giconi Kivindu - Part time Tutorial Fellow, Murang'a University of Technology, dickiegiconi@gmail.com*

# KONZA TECHNOPOLIS:

## An ecosystem of top-notch engineering technology

WHAT would it take to build a futuristic smart city hosting 250,000 residents, all living, studying and working within one ecosystem, in close proximity of 5,000 acres?

When magnificent, modern smart cities like Beijing, Tokyo, Manhattan or Los Angeles were conceptualised, no one, not even the presiding engineers and architects, pictured they would become lasting edifices, blueprints for future smart cities.

Kenya is in the process of achieving its first engineering marvel of this kind. Designed and engineered as a smart city, the Konza Technopolis project located in Konza at the intersection of Machakos, Kajiado and Makueni counties promises more than just a built-up area of urban metropolis.

Engineering works for Phase I of the project are in high gear, happening on 400 acres of land that will host an estimated 30,000 residents upon completion. Slightly more than half of this number is catered for in the blueprint to work within Phase I alone, once the smart city urban environment is built up.

Konza has widely and correctly been touted as both a future smart city and an upcoming ICT Silicon Savanna. The rapidly developing Technopolis anchors on three major components that have often gotten overlooked: engineering, life sciences in the form of a research and development post-graduate teaching and learning university, IT-enabled services as well as a highly potential future backbone for commerce and the light manufacturing industry in Kenya.

### Engineering trailblazer

Apart from its magnificent boulevards atop a 9km utility tunnel, in terms of infrastructural engineering, the Konza Technopolis will also be traversed by 40 kilometres of large-sized multi-

*Konza Technopolis Development Authority CEO Engineer John Tanui. (Background) The Konza City main office block.* PHOTOS: Gor Ogutu purpose throughways, referred to as streetscapes.

Currently underway at the site is grading of these streetscapes, the development of the drainage facilities, a wastewater reclamation facility, water distribution and treatment, and the setting up of sewage collection and treatment plants.

Landscaping of the streetscapes is expected to follow completion of horizontal engineering works.

The Technopolis is set to host the first of its kind Kenya Advanced Institute of Science and Technology (KAIT), a fully built-up postgraduate university dealing with life sciences, research and development.

On the engineering front, the Konza Technopolis project is literally blazing the trail in construction engineering, not only in Kenya, but also in the entire East and Central Africa region. At the heart of the futuristic development is the science of engineering at its best.

To solve the problem of constant excavations when need to entrench critical infrastructure in parts of the smart city arises, Konza Technopolis engineers, stewarded by Chief Construction and Operations Management Engineer Anthony Sang, settled on a utility tunnel running under streetscapes of the smart city.

This tunnel is the Konza City utility duct, carrying fibre cabling, power supplies and water piping around the Technopolis, and is estimated to be of 2.5m square vertical width. The city will be interspersed by 40km of tarmac roads.

## Completion deadlines

The project aims to achieve both horizontal infrastructure in the form of streetscapes featuring roads, bus lanes, walkways, bicycle lanes, smart sewer and water treatment infrastructure, hand in hand with vertical infrastructure as the framework for the Technopolis.

The best part is that much of the horizontal infrastructural works are set for completion by February 2022, paving way for the commencement of the vertical built-up infrastructure.

"We are simulating life in one smart environment, in one smart industrial area interfacing with smart human residence, smart work, and light industrial manufacturing. Our task is to engineer a smart city that has all components of smart living; a master-planned modern city," says Eng. Sang.

The Konza development features key components of smart urban planning: efficient mobility, waste management, enhanced technology, energy, water, security, housing development – all components that call for the best of engineering skills.

The entire project enjoys a 10km buffer zone within the three counties of Machakos, Makueni and Kajiado, within whose proximity the smart city sits.

"The Konza project was designed based on the stitch pattern, with a green transit corridor, 20m-60m wide local roads as opposed to the normal country roads with a utility tunnel running North to South," says Eng. Sang.

## Water and waste management

The Konza technopolis development envisages uninterrupted waste and water treatment and management, utilising water that has been treated for irrigation purposes, according to Eng. Sang. The city's drainage and water supply system runs for 170km; with recycled water intended for irrigation and reuse.

"Different types of waste within the smart city will be segregated, put into receptacles that exist within parcels of Phase I of the development, and at some point the waste sucked by vacuum technology to a central repository, filled-up, compacted and handled for incineration, with others heading to specific dumps where appropriate," he explains.

A 66kv electricity sub-station, located right in the middle of the Technopolis, backs up the power needs of the future smart city.

## Project milestones

The development has recently registered a major milestone in the completion of the national data centre, based right inside the Technopolis. Eng. Sang underscores the importance of the data centre for the future, emphasising that the facility has recently backed up the national war against the Covid-19 pandemic as a data-hosting centre for Kenyatta National Hospital (KNH).

According to the project chief engineer, contrary to common belief that Konza is all about a future ICT hub, the Technopolis is engineered as a huge functional science ecosystem, engineered to attract opportunities in terms of future investment from a wide spectrum of industry; including residence, work, school, ICT, health and life sciences research, development and light manufacturing.

Plans are also underway to pipe into the smart city permanent water supply from Ol Turesh springs in Kajiado, as well as from Makueni's Thwake Dam, complete with standard water and waste treatment plants.

## Opportunities and challenges

The smart city, Kenya's first, is coming along with plenty of design and engineering challenges, that field engineers, led by Eng. Sang, his colleagues and project contractor engineers, grapple with daily.

"Engineering a smart city of this magnitude has come along with its fair share of challenges. From designs and coordinating the works of different contractors to fixing long-term challenges such as water supply and natural problems like occasional flooding, we continue to overcome setbacks," says Eng. Sang.

The Konza Technopolis project has so far provided employment opportunities for over 2,000 Kenyans currently working at the site.

*Chief Construction Engineer Anthony Sang instructs engineering staff working on site at Konza.* PHOTOS: Gor Ogutu

# What makes Konza a Smart City?

## KEY NUMBERS

THE Konza Technopolis project was conceived in 2008 during the development of Kenya Vision 2030. The mission behind engineering Konza Technopolis as a city of the future is the desire by the government to develop a sustainable smart city, mainly an innovation ecosystem – contributing to Kenya's knowledge-based economy.

Essentially, the smart city is being engineered by Konza Technopolis Development Authority to become a leading global technology and innovation hub. The ambitious development stands on 5,000 acres.

Konza City technopolis will accomodate approximately 250,000 residents upon completion, with Phase I set to take in pioneer 30,000 residents, about 17,000 anticipated to be the city's labour force earning a living from opportunities within the smart city ecosystem.

The technopolis is fashioned as a mid-density urban environment. With a population of quarter a million, the Konza smart metropolis will compare favourably with Tokyo's Ku area of the Japanese Capital that has a population of 275,420 under 13.771 square kilometres.

## STREETSCAPES

The Technopolis is engineered to be criss-crossed by three major tunnels, running under boulevards. The longest of these tunnels is the auto boulevard,


*Ongoing construction at Konza Technopolis.*

cutting right through Phase I of the city development.

The university and technology tunnels are found south and north, respectively. Konza Smart City Engineers have planned for 20-60m-wide roads, encompassing access roads, bus lanes, walkways, bicycle lanes and plenty of trees and greens in between.

The Konza City streetscape facilities are currently under stocking and excavations, installations, preparations and compaction of the roads and manholes.

### UTILITY TUNNEL

The future smart city features a 9km tunnel, running under the streetscapes. The tunnel is expected to domicile the city's automatic waste collection system. Currently, ongoing works to bring the utility tunnel to life include excavations of main lines and crossings, screed casting, steel reinforcement placements and concrete pouring.

The drainage and water supply system for the smart city is about 170km, and is a critical framework for future irrigation and water reuse system inside the technopolis.

The automatic waste collection system consists of a vacuum solid waste conveying system that runs 15km of pipes, four waste inlets for residential and commercial purposes, 124 connection points and a programmable logic controller system with four operation modes.

The Konza City water reclamation facility has already taken shape, with construction works in high gear.

### LANDSCAPING AND PARKS

The Technopolis sits on approximately 1.5 million square metres, upon which will sit an estimated 10,000 trees, with 50 different plant and shrubs species, sorrounded by water storage and recreational ponds and more than 15km of cycling paths. The landscape also includes a green transit corridor, the city perimeter wall.

> Konza City technopolis will accomodate approximately 250,000 residents upon completion, with Phase I set to take in pioneer 30,000 residents, about 17,000 anticipated to be the city's labour force earning a living from opportunities within the smart city ecosystem.

### ELECTRICAL AND ICT CONDUITS

The Konza Technopolis National Data Centre has just recently been completed. Construction engineers working on the smart technopolis are mulling about a network of electricity supply of approximately 40km of power lines, with one main electrical station backing up 50 electrical substations.

Within the city, engineers are painstakingly laying out about 500km of ICT conduits, the framework that will become the backbone of the Konza City ICT and technology innovation hub.

### PUBLIC AND RECREATIONAL FACILITIES

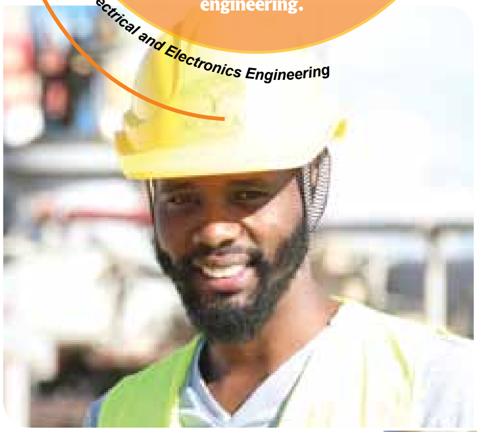
Residents of the Konza Technopolis will enjoy a 2,500 square-metre solid waste handling facility, as well as a 7,000 square-metre police and fire stations with entrance and security features, preceded by a 7,000 square-metre welcome centre.

# Student voices

**JOHN LUKO HIRBO**

Graduate Engineer, Electrical and Electronics Engineering

Since coming to Konza in February, I have gained better understanding of real-life working of engineering construction, operations and maintenance. Additionally, I have learnt a lot about engineering drawing – particularly the drawings and working of an engineering masterplan, the construction of power stations and structural engineering. The multi-disciplinary nature of the ongoing engineering works at Konza have broadened my personal understanding of the engineering trade, bringing me to appreciate the role of each facet of the art and science of engineering.



**Prof. John Githaiga**

Associate Professor of Materials Engineering at Moi University

Opportunities like this help us establish strong linkages between engineering academia and industry. It fills in graduates with existing knowledge gaps and helps with curriculum improvement at the academia. These interventions are useful as they help us identify the challenges facing both the engineering industry and academia in Kenya, besides promoting professionalism of the science of engineering, and promoting membership to professional bodies.

**DAVID KINOTI**

Graduate Engineer, Electrical and Electronics Engineering

We are part of the latest intake, cohort of graduates who joined Konza in February 2021. As graduate engineers we have had the chance of a lifetime, with so much to share on what we have gained thus far at Konza Technopolis. In a bid to provide unlimited learning experience opportunities for young graduate engineers fresh out of college, Konza Technopolis Development Authority collaborates with the Engineering Board of Kenya (EBK) to embed the graduates into ongoing engineering projects from time to time.

**VIVIAN ASIKE KHAYANGA**

Graduate Engineer, Electrical and Electronics Engineering)

I have gained immense skills since arriving at Konza, guided by our mentors appointed by EBK and Konza Technopolis Development Authority. The best thing about this initiative is that Konza has widened my multi-disciplinary perspectives in practical civil, electrical and mechanical engineering, all at the same time—including learning a lot in regards to the interaction between engineering and survey. I have also learnt design and review, developing an interest in Auto Card – the engineering design software; and learning how to interpret engineering drawings and designs in the process. Above all, this opportunity has helped build my personal confidence to face the future as a career Engineer.

**WANJOHI KIBG'ORU**

Graduate Engineer, Electrical & Electronic Engineering

I have learnt a lot about construction engineering operations, given the magnitude of the Konza Technopolis projects. What I found intriguing is the availability of actual designs that engineers are then tasked to translate into actual works. As a young graduate engineer, and with classroom work having been more theoretical, the field activities have given me a more practical view of engineering and a rare chance to interact with engineering equipment first hand.

# Editorial Board Profiles

**PROF ENG. LAWRENCE GUMBE**
Chairman

Eng. Prof Lawrence Gumbe has a Ph.D degree from the Ohio State University, USA, an M.Sc degree from Cranfield University, UK, and a B.Sc degree from the University of Nairobi, Kenya.
He is a Professional Consulting Engineer with the Engineers Board of Kenya. He is also a Lead Consultant with the National Environment Management Authority, NEMA, as well as a Chartered Environmentalist in the United Kingdom.
He is a member of several learned societies including the Institution of Engineers of Kenya; Association of Consulting Engineers of Kenya; Architectural Association of Kenya ; American Society of Civil Engineers; American Society of Mechanical Engineers; Kenya Society of Environmental, Biological and Agricultural Engineers; American Society of Heating, Ventilating and Air-Conditioning Engineers; American Society of Agricultural and Biological Engineers; Institution of Agricultural Engineers, UK; Kenya National Academy of Sciences.
Eng. Prof. Gumbe has vast management experience. He is the CEO of Log Associates which is a firm of consulting engineers, economists, environmentalists and planners. The firm has worked in many countries in Eastern, Central and Southern Africa. Some of the projects he led include the Development of Bomet County Water Masterplan, Detailed Design, Preparation of Tender Documents and Supervision of proposed Sewer Extension projects for Nyeri Water and Sewerage Company, Industrialization Policy and Strategy Development for the East African Community, Evaluation of Performance Contracting Process for the Government of Kenya, National and Nairobi Metropolitan Disaster Preparedness Policies and Strategies, Kenya National Water Storage Policy and Environmental Management Plans for Urban areas. He started his academic career at the University of Nairobi in 1981, where he rose from tutorial fellow to professor, and was Chairman of Department at some stage. He currently continues his academic career as professor and adjunct professor at the Technical University of Kenya and Kenyatta University. He has published widely and has successfully supervised many masters and doctoral candidates.
He has a wide consultancy experience in: Human resources development; politics; economics; trade and policy analyses; feasibility studies; energy; water supply; valuation of machinery; design and construction supervision of factories; design, construction and testing of machinery; project appraisal, monitoring and evaluation of industries; and structural design. I have worked In Kenya, Malawi, Uganda, Tanzania, Sudan, Ethiopia, Rwanda, Zambia, the UK and USA.
He was elected Chairperson of the Centre for Multiparty Democracy- Kenya in January 2007. He was re-elected in March 2009 for a final term of two years. CMD- K is an umbrella institution of political parties in Kenya.
He is a member of the Kisumu City Board since July 2018, serving a five-year term. He is chairperson of the Planning and Infrastructure Committee. He speaks several languages including English, Kiswahili, French, Dholuo, Lingala and basic Arabic.

**ENG. NATHANIEL MATALANGA**
Ex-officio Member

Member of Institution of Engineers of Kenya, 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. MARGARET NGOTHO OGAI**
Ex-Officio Member

Member of Executive Committee, member of Editorial Board, Joint Secretary of Constitution Review Committee, Vice Chairperson of Policy Research and Advocacy Committee and member of Transportation Sub-Committee
Registered as a Consulting Engineer with Engineers Board of Kenya and Fellow of IEK. She currently works at Kenya Roads Board as General Manager Planning and Programming responsible for preparation and monitoring of road maintenance programmes funded by Road Maintenance Levy Fund. She has a Bachelor's Degree in Civil Engineering and Master of Business Administration from University of Nairobi. She has over 25 years' experience in the field of transportation, planning and management gained in both private and public sectors. She is a board member of Women in Water and Sanitation Association. Committed to strengthening corporate governance and enhancing professionalism in engineering practice in Kenya. Also passionate on promoting diversity and inclusivity.

**ENG. PAUL OCHOLA**
Secretary

Member of Prac Committee, Chairperson of Prac Telecommunications Sub-Committee
A Fellow of the Institution of Engineers of Kenya (IEK) and a Consulting Engineer with Engineers Board of Kenya (EBK). 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 rising to the position of third Assistant Engineer, IT & Telecoms at KPLC, and Telecommunication's Supervisor with the then Electro-Sigma Company Ltd. He has over 20 years' experience in Telecommunications and Data Communications Infrastructure Evolution delivery and management. Eng. Ochola has industry experience in Technology migration from proprietary protocols to open systems inter-connect, contract administration, and project management. He has been involved in the deployment of various projects that have led to the consolidation, convergence, and virtualisation of voice, video, data centre and data infrastructure platforms. He is a member of KEPSA ICT Sector Board, class A1 holder of Energy and Petroleum Authority licence, and class A holder of Communications Authority licence. 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.
His vision for ***"Engineering in Kenya"*** magazine is to see it grow into a globally recognised, authoritative publication of professional and content reference, appealing to its wide spectrum of target audience.

**ENG. SAMMY TANGUS**
Member

A corporate member of the Institute of Engineers of Kenya (IEK), registered Engineer with the Engineers Board of Kenya (EBK) and member Institute of Directors (Kenya) – IOD. He holds a BSc Civil Engineering from the University of Nairobi and his MBA Executive is ongoing at Strathmore University Business School. He is a Senior Roads Engineer at Otieno Odongo and Partners Consulting Engineers responsible for RFPs, claims and overall supervision of projects. He is also currently the Chairman of the Kenya Yearbook Editorial Board responsible for policy, oversight and overall strategy of the institution. Previously, he has chaired the Board of Directors, Postal Corporation of Kenya, and has been the Team Leader for the Technical Assistance Consultant for the European Union Funded Roads 2000 Spot Improvement Project of roads in Eastern Province. Eng. Tangus has also carried out the Technical Audit for Kenya Roads Board in the Northern Region of the Rift Valley. He has extensive experience working in the government as a roads engineer, starting with the Ministry of Public Works and Housing then Ministry of Roads and Public Works. He has also been a design engineer for Abdul Mulick Consulting Engineers, Kenya, Technical Audit Engineer for Runji and Partners Consulting Engineers and Team Leader, Roughton International, Kenya.

**ENG. LINDA OTIENO**
Ex-Oficio Member and IEK CEO

Heads the IEK Secretariat, whose responsibility is to help the council serve the interests of all members of the institution, coordinating all its activities. The CEO is responsible for the day-to-day management of all affairs of the Institution in accordance with the IEK constitution. She serves as a link between the Council and the staff and oversees implementation of policies, procedures and guidelines to ensure all IEK operations are in conformity with prevailing statutory and regulatory requirements. Her roles include, but not limited to: implementing the decisions of the Council; performing human resource responsibilities for the secretariat; execution of the institution's strategic plan; developing and implementing financial and operational plans of the Institution; administering and managing the Institution's resources and staff; resource mobilisation to support Council's activities. To effectively carry out these roles, the CEO works with a competent team of 10 staff members in accounts, membership and communications departments, who report directly to her. This team coordinates office activities and operations; provides quality customer care to the IEK members and non-members and helps the CEO keep charge of the institution's record keeping, membership data management and preparing a financial report.
Eng. Otieno holds a BSc in Civil and Construction Engineering from the University of Nairobi and is currently pursuing MSc in Transport Engineering in the same institution. She has over eight years' experience in Highway Engineering.

Engineering IN KENYA

# Call for Papers

## Engineering in Kenya Magazine-June/July 2021 Issue

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 10th of June 2021 for our next issue whose theme shall be "Leveraging Telecommunications and Information Engineering" 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 the article 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!

*Send your article to:*
***iek@iekenya.org and cc:***
***ceo@iekenya.org;***
***editor@iekenya.org and***
***engineeringinkenya@michi-media.com.***