The Institution of Engineers of Kenya
Founded 1972

Engineering in KENYA

ISSUE 019

PUBLISHED BY THE INSTITUTION OF ENGINEERS OF KENYA | September 2024

Mining Engineering

ISSN : 2710-3951

In this Issue

ENGINEERS BOARD OF KENYA
Enhancing Professionalism

13
Key Achievements of the Engineers Board of Kenya in the Financial Year 2023/2024

22
Unlocking Kenya's Petroleum Potential: Exploring New Frontiers in Oil and Gas.

30
Tilt angle optimization of Grid tied solar PV system: A case study of 600 kWp Grid tied solar PV system.

35
Balancing Safety and Sustainability in Mining

42
Resource Management and Optimization in Mining: Techniques for Managing and Optimizing Mineral Resources in Kenya

48
The Tullow Oil Saga in Turkana: Delays, Impacts and the Future of Oil Exploration in Northern Kenya

53
Overcoming the Difficulties and Maximizing the Benefits of Artisanal Mining in Kenya's Border Areas

Engineering in KENYA

PUBLISHER The Institution of Engineers of Kenya

DESIGN LAYOUT & PRINTING Adcentric Communications Ltd

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

Call for Papers

Engineering in Kenya Magazine - Issue 020

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 invites you to contribute articles for our next and future editions. Articles should reach the Editor not later than 20th November, 2024 for our next issue, whose theme shall be "Environmental 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 readers in Kenya and beyond. The IEK Editorial Board reserves the right to edit and publish all articles submitted, in line with standing editorial policy. All articles should be in Word document format, 500-700 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: editor@iekenya.org

Message from the Editor

Eng. Prof. Lawrence Gumbe

Mining Engineering is an engineering discipline that involves the application of the science and art of engineering to the extraction and processing of minerals from the natural environment. Mining engineers ensure that underground resources such as minerals, metals, oil, and gas are extracted safely and efficiently. They plan and design mines to ensure safety and commercial viability.

Mining engineering encompasses all phases of mining operations, starting from exploration and discovery, feasibility, development, production, processing, and marketing. Additionally, it involves restoring and rehabilitating the land from which extraction has occurred.

Mining engineers are responsible for locating natural reserves of minerals, petroleum, and other useful resources, and they develop plans, design shafts, inclines, or quarries for the safe extraction of these resources. The resources can include coal, petroleum, metallic or non-metallic minerals, etc. While planning extraction, mining engineers must also consider the health, safety, and welfare of workers.

Mining engineers receive education and training in various subjects, including geology, civil and mechanical engineering, metallurgy, commerce, economics, management, law, and information technology. Their work involves determining the practicality of mining an ore deposit, designing ventilation systems for underground mines, supervising the construction of conveyors at open-pit sites, and researching new extraction processes.

Mining in Kenya yields high-grade quantities of gold, copper, ilmenite, and tantalum. The country is also an important source of non-metallic minerals, including soda ash, limestone, salt, niobium, fluorspar, and fossil fuels.

Many industries worldwide depend on the supply of mineral commodities from underground. Recent issues have arisen regarding the dependency of high-tech industries on rare earths, while coal remains one of the leading global energy resources. Consequently, the mining sector is pivotal to the world's economy. The revenue of the top 40 global mining companies, which represent a vast majority of the industry, amounted to a record 943 billion U.S. dollars in 2022. However, the net profit margin of the mining industry decreased from 25 percent in 2010 to 14 percent in 2022.

In terms of volume, the most exploited commodities worldwide are iron ore, coal, potash, and copper. China, Indonesia, and India are the largest coal-producing countries, with China also being the third-largest producer of iron ore. China is becoming the top mining country for many commodities, especially highly demanded rare earths, of which it produced 70 percent of the global total in 2022. Additionally, China is the world's leading gold mining country.

The Kenya Chamber of Mines (KCM) has stated that Kenya is generally not regarded as a mining country, yet it hosts a variety of mineral deposits, mines and exploration projects. The country-wide airborne geophysical surveys, are expected to generate many new exploration targets and to contribute to fully appraise Kenya's real potential for mineral development.

KCM states that nested in the Rift Valley on Lake Magadi, close to the border with Tanzania, Tata Chemical's soda ash operation is among the largest in the world. The mine has been in operation for over a 100 years. KCM further states that Base Titanium's heavy mineral sands mine, which was commissioned much more recently in 2013, has now become an industry leader in the production of rutile, ilmenite and zircon. The mine has reserves of 110 Mt at 5% and currently produces about 90,000 tons per year of rutile, 460,000 tons per year of ilmenite and 35,000 tons per year of zircon. The Kenyan coast hosts more heavy mineral sands resources which could be developed in the future.

Kenya has a vibrant limestone mining and cement manufacturing industry, with players such as Bamburi Cement, Athi River Mining, and East African Portland. Until recently, the country was producing about 150,000 tons per year of fluorspar. The mine closed, but there are various plans to revive it as the resource is not exhausted. Other industrial minerals development opportunities include diatomite, vermiculite, baryte, bentonite, gypsum, and graphite, according to KCM.

KCM goes further that the country also has significant potential for gold production, particularly in the Nyanzan greenstone belts of Western Kenya, where artisan mining is rife. Acacia Mining recently defined a maiden resource of 1.31 Moz at 12.1 g/t at the Liranda Corridor. Karebe Mining (near Kisumu) and Kilimapesa Gold (in Lolgorien) are fully-mechanized small-scale operations which have been producing gold for a few years. Kenya offers significant potential for the development of formal small-scale gold mines. These typically have a higher ratio of jobs created per ounce produced than large-scale mines, and thus a strong positive economic impact on rural communities.

Some base metal occurrences are known in Kenya and exploited on a small scale. These include copper, chromite, and iron ore deposits. The most immediate development potential, however, lies in the manganese deposits located between Mombasa and Malindi.

Kenya has known lignite deposits in the Mui basin, and legacy airborne geophysical surveys on limited parts of the country show that the potential for uranium deposits exists in a variety of geological environments. The infamous Mrima Rare Earth Elements and Niobium deposit in Kwale County, despite the fact that it is a relatively small resource, is high grade and well positioned, only a few kilometers away from the Indian Ocean. More potential for REE exists in other carbonatite occurrences, particularly in Western Kenya. The same rock formations also have potential for phosphates, according to KCM.

KCM states that many parts of Kenya are producing colored gemstones. Tsavorite, a vibrant green variety of garnet, was named after the Tsavo National Park and is a widely recognized precious stone. Other colored gemstones produced in Kenya include ruby, sapphire, spinel, aquamarine, rhodolite, kornerupine, and a variety of magnesian tourmalines. Emerald has not been confirmed yet in Kenya, but the proximity of the Ethiopian deposits to the North and the Manyara deposit in Tanzania to the South strongly suggest that it is only a matter of time before Kenya becomes another emerald source.

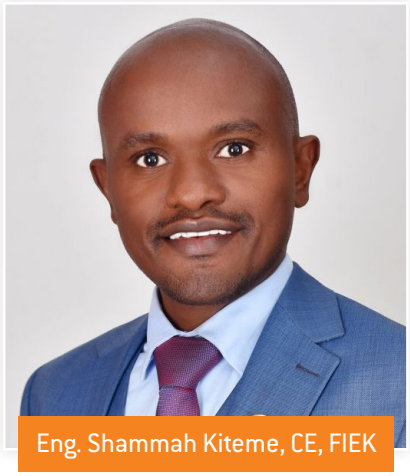
The mining sector is crucial to the industrialization and development of Kenya in line with Vision 2030. Mining engineering is crucial to the development of the mining sector. It is an engineering discipline that we must expeditiously develop.

The mining sector is crucial to the industrialization and development of Kenya in line with Vision 2030. Mining Engineering is crucial to the development of the mining sector. It is an engineering discipline which we must expeditiously develop.

This issue of Engineering in Kenya magazine is devoted to Mining Engineering. We hope that you will be well informed, educated and entertained by the issue. We welcome your feedback.

Picture: Courtesy

Message from the President



Eng. Shammah Kiteme, CE, FIEK

This issue of Engineering in Kenya magazine will focus on mining engineering. Mining is not particularly a vibrant sector in Kenya. Partly because the extractives industry grows exponentially in economies with vast mineral wealth. The contribution of mining to Kenya's GDP is a paltry 120 B annually. The focus on mining however must not only look at the past but also the potential that Kenya has in the sector.

Mining of soda ash has been carried out in Lake Magadi for more than 100 years. Mining in Kwale has produced zircon, rutile and ilmenite. Limestone mining has also been carried out in the country. It is closely associated with cement manufacturing. Kenya also has fluorspar reserves that can be economically extracted though currently not. Gold mining at artisanal level continues in the western part of the country. There is also a potential to extract manganese. Many of the other mineral deposits are either in small quantities or low grade. These include Niobium, Lignite, Copper, Chromite and iron ore. Diatomite, vermiculite, bentonite, graphite also presents some deposits. Kenya has a coal deposit whose mining has not been carried out. Oil deposits were discovered in Turkana and in January this year, Kenya announced discovery of the valuable Coltan mineral.

The state department of mining under the Ministry of Mining, Blue economy and Maritime affairs is tasked with developing policies to govern the mining industry. The mining Act of 2016 and the Mining and Minerals Policy, 2016 are available instruments governing the industry currently. An important inclusion in the act was the introduction of the Artisanal Mining Permit which allows activity within the sector even at a smaller scale.

Like in so many other economic sectors, engineering plays a critical role in extracting minerals from the ground. Prospecting and extraction, processing and exporting all involve engineering input in one way or the other. Engineers design safe and efficient ways for mineral extraction. They are intricately involved in processing of the minerals to the acceptable final state that they can be commercially applied.

In our tertiary institutions, training in Mining Engineering is offered by Jomo Kenyatta University of Agriculture and Technology, Taita Taveta University. Technical University of Kenya also offers training in Mining.

Kenya's mining potential will continue to unravel with time. It is important that Engineers in Kenya stay ahead of the game in understanding the industry well and participating in growing the local industry's potential to manage the industry. A number of regional countries are well endowed with bigger mineral deposits and the mining industries are well developed there. Exchange programs for training opportunities will be helpful in engendering knowledge of the sector by Kenyan Engineers. IEK will be at the forefront to achieve this.

IEK will further play the role of ensuring that registered professionals are available to mentor those who want to grow in the industry. Through platforms like WFEO and FAEO we have networks that can ensure that the required resources are available to mentor Kenyan engineers to be able to grow in this sector.

A strong drive is necessary from the private sector to be able to realise full exploitation of the mineral wealth. For instance, the known deposits need to be exploited and the exploration to continue. The discovery of coltan this year is a clear indicator that there is a need to continue efforts in exploration. It is also important that the country invests in development of finished products instead of exporting raw. This will be a way of creating more employment opportunities by building more industries.

A number of countries have invested in industries that rely on importing the raw products. This is an indicator that the mining industry can also be fully established in Kenya. However, the downstream utility of the mining needs to be guaranteed. This will spur the demand and guarantee the need to sustain the industry.

A number of factors need to be considered to make exploitation possible. One is full community involvement. This is particularly important when it comes to community buy-in which is required to allow exploitation of minerals. Communities living within the areas where minerals are found need to be fully involved and engaged to buy in. The involvement of county governments should also address the issue of royalties which is key to the local governments.

Environmental sustainability has also become a key issue not only in the mining sector but in all other sectors. Extraction of minerals affect the environment significantly. Open cast mining for instance leaves deep excavations once the minerals are exploited fully. It is important to do land restoration and rehabilitation to ensure the mines are not left open to become breeding ground of disease vectors and expose communities to other dangers like risk of falls and injuries. The environmental and social governance considerations need to be factored by the players in the sector to ensure that sustainability is a key focus for the industry.

The mining industry is generally a heavy capital investment sector. The funding needs may pose a challenge to the growth of the sector. Investment by private sector should in particular guarantee returns that would encourage significant investments. It is important that aggressive publicity is carried out to showcase the potential of the sector. This should be used to demonstrate to the prospective investors that there are opportunities to invest gainfully.

The role of Engineers in this conversation is very important and it is my joy to invite our readers to interact with this issue of Engineering in Kenya magazine.

PICTORIAL

The IEK Council courtesy call to the Principal Secretary, State Department for Roads, Eng. Joseph Mungai Mbugua, CBS.

The IEK Council courtesy call to the National Irrigation Authority.

The IEK Council visited Eng. Charles Mutinda Muasya, CEO of the National Irrigation Authority, to strengthen ties and highlight the Authority's role in enhancing Kenya's food security through key irrigation projects like Thiba Dam. Eng. Mutinda emphasized their impact on socio-economic growth and the importance of hands-on internships for engineering students. IEK President Eng. Shammah Kiteme reiterated the Council's dedication to advocacy, professional development, and training in emerging fields, aligning with the institution's mission to advance the engineering profession and promote sustainable development.

The IEK Council courtesy call to the National Irrigation Authority.

Message from the Honorary Secretary

Eng. Jacton. A. Mwembe, PE, MIEK

This is a subject worth giving attention by professionals from all sectors but most importantly, the engineering community. Mining has long been an essential undertaking of modern societies and engineers have been at the centre of the mining operations. The nature of labour and calibre of skill required to ensure labourers navigate to the depths of earth and come out in one piece requires a high level of safety training and compliance not only to a specific type of people, but for every single one involved in this operation at any level.

To put it simply, mining involves the extraction of essential resources from the earth, thus providing the raw materials necessary for infrastructure, technological advancements, and economic development globally. Due to the demand of these deep-seated resources for economic revolution and evolution, mining has been a crucial discipline in the engineering community. Kenya as a nation has also not lagged in this regard and aims to position itself as a regional hub for mining. It is therefore crucial to examine the sector's potential, its challenges, and pathways toward sustainable growth.

Mining in Kenya is not only a source of mineral wealth but also an avenue for job creation, industrialization, and significant contributions to the nation's Gross Domestic Product (GDP). With more than 400 mineral occurrences established, the sector holds immense promise. In recent years, government initiatives, particularly the enactment of the Mining Act of 2016, have aimed to catalyse growth and attract both local and foreign investments. This framework is intended to position mining as a driver of economic progress, with the goal of contributing at least 10% to the GDP by 2030, as envisioned in Kenya's national development agenda.

Mining laws have been revised, creating a foundation for the growth of the sector. However, much work remains to fully unlock Kenya's mineral potential. Kenya has already attracted significant attention from global investors, with recent reports indicating that Kenya has drawn over $1 billion in mining investments. These developments are encouraging, and they signal that the mining sector is on the cusp of becoming a vital component of Kenya's economy.

Moreover, Kenya's 2010 Constitution, which established devolved governance, has empowered counties to actively participate in resource mapping and mobilization. Each county's unique topography, drainage, ecology, and mineral resources offer tailored opportunities for local development. This decentralization not only strengthens the mining industry but also ensures that its benefits are distributed more equitably across the country.

Kenya's mining sector has experienced considerable growth and has been identified as a key component in achieving the country's industrialization goals. The discovery of oil in Turkana and the exploitation of other minerals like fluorspar, soda ash, titanium, and diatomite, the mining industry plays a central role in contributing to national development.

As Kenya continues to develop its mineral wealth, there is a growing focus on how mining can address unemployment, particularly among the country's youth. In many mineral-rich regions such as Turkana, West Pokot, Baringo, and Isiolo, mining offers opportunities for direct and indirect job creation. According to industry experts, mining could generate over two million jobs in the coming years. These jobs would span various fields, including mining operations, logistics, energy, and infrastructure development.

The industry's potential extends beyond job creation; it also contributes to economic diversification. Mining provides essential raw materials that support other industries, such as construction, manufacturing, and energy, to name a few. By harnessing mineral resources, Kenya can strengthen its industrial base, reduce its reliance on imports, and become a key player in the global mineral supply chain. This can be a possible achievement for the nation if not only engineers of our country, but also other key stakeholders come together in harmony to ensure favourable policies are put in place. There is much to be garnered from this sector than technology has unlocked and with the wealth of knowledge that we have in this nation, we can exploit the sector to the betterment of our country.

IEK urges all the stalk holders in the mining sector to continue the support of the agenda and transformation under mining exploration with a strong focus on youth engagement. The Ministry of Mining should be at the forefront in engaging with engineering institutions, industry players, and other professionals such as the Mining Engineers Society of Kenya (MESK) and the Geology Society of Kenya (GSK). Stakeholders should also implement robust initiatives that collectively create teamwork amongst the mining engineers, geologists, and mapping specialists. This continuous approach would ensure that the professionals in the mining sector are equipped with the skills and up to date knowledge, to drive the sector forward and ensure that Kenya's mineral wealth is utilized for the benefit of all its citizens.

As Kenya's mining sector expands, it is important to consider the safety of all involved in the value chain. IEK

therefore calls upon industry players, government bodies, and academic institutions to prioritize worker safety and environmental sustainability as fundamental principles for the industry's long-term success.

IEK is looking forward to foster collaborative efforts with higher educational institutions, as these research centres remain to be key to driving research and development (R&D) Through partnership with research institutions, the industry players in the mining sector are able to navigate a series of activities that boosts innovative ideas in the sector .This innovations ensures that the mining practices evolve responsibly while contributing to Kenya's economic growth. The IEK Collaborative Spirit between universities, industry, and government is essential to ensure that Kenya's mining sector remains competitive on the global stage.

As Kenya's mining sector continues to evolve, IEK takes this opportunity to advise the various stake holders in the mining sector to revisit some of the country's key mining sites, including the Fluorspar Mines, Magadi Soda, Base Titanium, the discovery of oil by Tullow Oil and diatomite mining in Nakuru. These sites have played a central role in the development of Kenya's mining industry, and they continue to offer valuable insights into the challenges and opportunities facing the sector.

This edition sought to provide insightful knowledge about engineering matters, which cut across all industry sectors. Kenya has the potential to build the mining sector that not only drives economic growth but also safeguards the environment and uplifts its citizens.

I call upon our readers to enjoy the readings captured herein, gain valuable knowledge, and we look forward to seeing you at our upcoming Convention, set to take place at Pride Inn, Mombasa, from 29th October to 1st November 2024, under the theme "Industrialization for Economic Transformation and Employment Creation." See you there!

Picture: Courtesy

Leveraging Mining Engineers for Kenya's Sustainable Growth

Cyrus Njonde
Treasurer, Mining Engineers Society of Kenya

How does the Mining Engineers Society of Kenya define its role in the advancement in mining engineering in Kenya?

The Mining Engineers Society of Kenya (MESK) is a non-profit professional organisation established in 2014 to represent Mining and Mineral Processing Engineers in Kenya. The mining and mineral processing engineering programme is currently offered in Jomo Kenyatta University of Agriculture and Technology (JKUAT) and Taita Taveta University (TTU), having started in the year 2006 in JKUAT.

MESK is committed to advancing the professional interests of its members while providing a framework for extractive development in the country and internationally; through enhancing Professional Development by organising networking opportunities for mining engineers with stakeholders, the society offers an authentic skilled workforce of mining engineers, advocacy, and stakeholder engagement in the country's mining activities, Currently, the society boasts of at least 500 mining professions locally working for mining and manufacturing industries in the country and about 50 working overseas in reputable mining organisations as well as research and academia. MESK ensures its members are up-to-date with the latest industry practices and technologies. The society also advocates for the interests of mining engineers by engaging with the national government and its agencies, to influence policies that promote sustainable mining practices and uphold professional standards.

Furthermore, the society has actively fostered high ethical standards and professional conduct among its members by expanding the leadership of a committee dedicated to ensuring adherence to its constitution and code of conduct. MESK plays a vital role in both the professional development of engineers and the sustainable advancement of Kenya's mining sector, aiming to increase the industry's contribution to the national GDP from the current <1% to 10%.

What is the current membership base of the Mining Engineering Society of Kenya and how is it growing? How do you engage with your members and ensure their active participation?

Since its registration, MESK has experienced steady growth from 30 members in 2022 to 150 registered professionals currently, the total number of mining engineering graduates stands at 513, among the number include at least 300 seasoned mining engineers, 200 young graduates and 208 students aspiring to join the industry, the society has also received interest from affiliates such as geologists and civil engineers, the number continues to rise as the extractive frontiers in the country continue to draw traction from both local and international investors. The society has been experiencing steady growth as it continues attracting new members drawn by its commitment to professional development, advocacy, and the promotion of best practices in the mining sector. This growth is fuelled by MESK's efforts to broaden its reach through strategic partnerships with academic institutions, mining industry stakeholders, and government agencies, as well as through initiatives that appeal to younger professionals and students, such as mentorship programs and networking opportunities.

MESK actively engages its members through a variety of channels, including regular meetings and webinars. The society also leverages digital platforms such as social media, and an online members' portal which it plans to launch later this year to facilitate communication, share industry news, and update members on upcoming events and opportunities. To ensure active participation, MESK encourages members to contribute to research and publications, take part in community outreach programs, and join specialized committees that focus on different aspects of mining engineering. By creating an inclusive and collaborative environment, MESK fosters a sense of belonging and motivates members to actively participate in advancing the goals of the society.

How does society support professional development and continuing education for mining engineers?

The Mining Engineers Society of Kenya (MESK) is dedicated to supporting the professional development and continuing education of mining engineers through a range of programs and initiatives. The society actively encourages its members to register with key engineering bodies, including the Institute of Engineers of Kenya and the Engineering Board of Kenya. Currently, MESK proudly boasts at least 60 registered graduate engineers with the EBK, with five members in the process of obtaining their professional engineer registration. Additionally, MESK organizes internal training sessions covering topics such as engineering mine design, emerging mining technologies, safety standards, environmental, ESG management, and the use of various mining engineering software. These sessions are conducted by industry experts, ensuring members receive valuable insights and practical knowledge.

MESK actively collaborates with institutions of higher learning, such as JKUAT and TTU. This partnership aims to enrich the academic experience and better prepare students for successful careers in mining engineering. The society is also committed to establishing a chapter with the EBK to strengthen the mining engineering profession in the country. In addition, MESK seeks to collaborate with mining industry stakeholders to enhance industry knowledge and compliance.

Furthermore, MESK has implemented at least five mentorship programs that connect young professionals with experienced engineers, facilitating knowledge transfer and providing guidance for career advancement through targeted career talks for mining students.

To enhance continuing education, the society actively encourages its members to engage in research activities and publish their findings in reputable industry journals. Currently, MESK supports at least 30 mining researchers and academics both locally and internationally. Additionally, the society is proud to have around 20 PhDs in mining engineering and related fields, many of whom serve as lecturers and consultants in academic institutions locally and globally. By providing these diverse growth opportunities, MESK ensures that its members stay competitive and well-prepared to tackle the evolving challenges of the mining industry.

What role does MESK play in advocating for policy changes or improvements in the mining sector?

The Mining Engineers Society of Kenya (MESK) plays a crucial role in advocating for policy changes at both institutional level as well as career levels such as the inclusion of mining professionals in every mining venture in the country as well as presenting memoranda on crucial mining bills and mining regulations during public participation, this they do by actively engaging with government agencies, regulatory bodies, and other industry stakeholders. One remarkable engagement has been the recent Meeting with the permanent secretary for the State Department for Mining where the Director of the State Department for Mining, the CEO and Chairperson of the National Mining Corporation, and the Chairperson Mineral Rights Board were in attendance.

In this engagement, MESK advocated for job creation for mining engineers not only in government but also in the mining sector through policy changes. The society has also committed to creating a mining CODE, and safety training materials which will ensure health and safety in all mining and mineral processing operations are adhered to, further making the extractive industry an attractive and safe area to work in.

How do you measure your impact on the mining industry and its members? Highlight any significant achievements or milestones that the society has reached in recent years.

Through various key performance indicators, including membership growth currently rose by 70% in the last 2 months, the membership is now at 150 and likely geared to 400 members by the end of 2024.

The quality and frequency of professional development programs undertaken have been some of the indicators of the society's growth, so far MESK has conducted at least 30 surveys and feedback sessions with its members to assess the effectiveness of its activities and identify areas for improvement. Lastly, the society also tracks its involvement in policy advocacy, monitoring how its contributions have shaped regulatory changes and practices within the mining sector.

A key achievement area is MESK has been on its effort to bring together at least 40 diaspora members (mining engineers) who are working and others studying overseas, this is an important area where opportunities, ideas and collaborations can be harnessed through such members who are exposed to more ideas out of the country.

In recent years, MESK has achieved several significant milestones that underscore its impact. The society has successfully advocated for the inclusion of mining engineers in key decision-making bodies such as the State Department for Mining and currently, there have been at least 98 new additions to the ministry who will serve as mines and explosives inspectors, this human resource will greatly contribute to the development of national mining regulations that promote safety, environmental sustainability, and ethical practices in our industry.

Lastly, MESK expanded its membership base and enhanced its membership to include professionals in mining-related fields such as geologists and civil engineers. It is such a great collaboration with the industry players, researchers, and academia, leading to innovative projects and initiatives that support the growth and modernization of Kenya's mining industry.

Joseph Komu *- Chairman, MESK*

Julia Muriuki *- Secretary, MESK*

Professional Development at Mining Engineers Society of Kenya

ENGINEERS BOARD OF KENYA
Enhancing Professionalism

KEY ACHIEVEMENTS OF THE ENGINEERS BOARD OF KENYA IN THE FINANCIAL YEAR 2023/2024

1 | Registration of Engineers in All Categories

10,000
Professional Engineers
To be registered in the next 5 years

474 Professional Engineers
Registered in FY 2023/24

* The highest number of PEs ever

800 Professional Engineers
To be **Registered** in FY 2024/25

	2019/20	2020/21	2021/22	2022/23	2023/24	Total @June 2024	5YR Target
Graduate Engineer	2561	1576	1674	1664	2607	22,434	33,000
Professional Engineers	110	235	354	343	474	3,116	10,000
Consulting Engineers	9	56	36	43	42	582	1,000
Consulting Firms	19	17	17	16	20	190	300
Accredited Checker	-	-	-	18	1	18	100
TOTAL	2,712	1,901	2089	2,066	3,143	23,322	44,000

The Board conducted an audit on the registration of Foreign Engineers and found low levels of registration (approximately 10%). This FY, the Board will collaborate with the Directorate of Immigration to ensure that all Foreign Engineers register with the Board.

2 | Graduate Engineers Internship Program (GEIP)

420 No. of Graduate Engineers Provided With Mentorships and Valuable Work Experience, Since GEIP inception

GEIP has Effectively Secured Engineering Positions for Many within both the Public and Private Sectors.

Total Trained in FY 2023/24

200 EBK GEIP Model • **452** Agency Based Model • **70** Academic Based Model

3 | Recognition of Engineering Programs

36 **Independent Reviews** Done in last 2 Financial Years

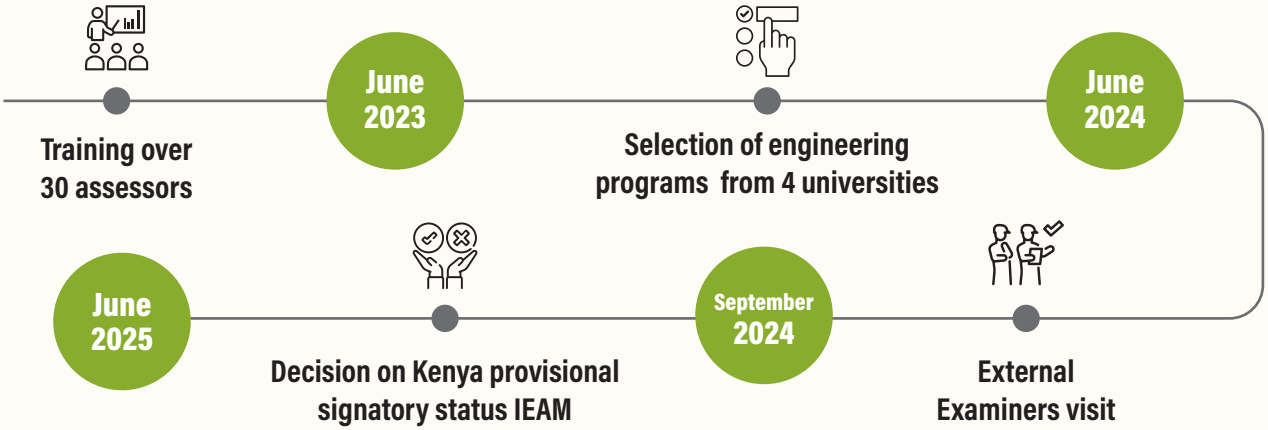
66 **Recognized Programs**

A list of Recognized Programs is available on:-
https://ebk.go.ke/accredited-engineering-programs-in-kenya/

Collaboration with Council of Engineering Deans and Principals (CoEDP) to ensure all Engineering Programs are recognized by Board is appreciated.

4| Acceding to the Washington Accord

Key Milestones



5 | Compliance and Enforcement

Engineers Projects Registration portal was launched in June 2023 by His Excellency President, William Ruto.

127 No. of Registered Projects

+ An additional 4,500 from the NCA Online Project Registration System.

42 Site Inspections

Towns & Counties include:-

- Kirinyaga
- Narok
- Murang'a
- Old Juja Road Estate
- Pangani
- Ngong Road
- Jamuhuri Estate
- Ruaka
- Kayole in
- Nairobi
- Nakuru
- Kajiado
- Bungoma
- Nyamira

16 Complaints Received and Resolved

3 Warnings Issued

3 Engineers Suspended

1 Engineer absolved

6 | Professional Development

Over **9,000** Participants Attended CPD Events - FY 2023/24

Developed instruments for Kenya School of Engineering (KSE) awaiting clearance.

Specialized Training Programs to be Rolled-out in FY 2024/25

7 | Strategic Plan Developed

Hon. Kipchumba Murkomen, CS, Ministry of Roads and Transport, launched the EBK's 2023/2024 - 2027/2028 Strategic Plan EPC 2024 at DeKUT, Nyeri County.

Accessed Link:

https://shorturl.at/Cyqc2

Which Way Kenya's Mining Industry: Time is Ripe for Mining Investments

Arthur Ndegwa
Mining Engineer

1 The Geological Potential of Kenya and the Contribution to the GPD by the Mining Sector

The geology of Kenya indicates that the country has a great potential for mineral resources occurrence. Despite this potential and additional evidence from the current substantial mineral production by the neighbouring countries sharing similar geological terrain, Kenya's mineral potential has remained largely untapped since independence. The contribution of the mining sector to the economy has been dismal, ranging between 0.2% to just below 1% of GDP over this period. Furthermore, the GDP contribution was for many years borne mainly by two minerals, namely soda ash and fluorspar. Worse, the Kenya Vision 2030 targeted an increase of the contribution to 10% of the country's GDP by 2030. This appears untenable considering that the sector has not even crossed the 1% GDP mark with only six years to 2030. This means that the government must, therefore, undertake some very drastic measures to unlock the potential of this sector which all agree has potential to bring in large revenues to the Exchequer based on the performance of the Kwale based mineral sands miner, Base Titanium Ltd.

Table 1.1 - Mineral Production 1980-2020

ITEM	UNITS	1980	1985	1990	1995	2000	2005	2010	2015	2020	2023
GDP	%	0.3	0.2	0.3	0.2	0.2	0.5	0.7	0.9	0.7	0.7
Soda Ash	Tonnes	203,768	227,760	231,900	223,000	238,190	360,160	473,689	295,417	254,579	240,784
Fluorspar	Tonnes	93,378	57,949	80,529	83,000	100,102	109,394	40,750	70,096	0	0
Gold	Kg	-	-	-	-	-	-	2.0	0.3	149.9	410
Gemstones (Cut)	'000 Carats	-	-	-	-	-	-	-	-	5,186.7	6,944.2
Gemstones (Rough)	Tonnes	-	-	-	-	-	-	168	442	441.9	428.7
Carbon Dioxide	Carbon Dioxide	-	-	-	-	-	-	16,345	19,750	16,256.5	0
Diatomite	Tonnes	-	-	-	-	-	-	224	1,090	928.1	0
Titanium Ore Minerals	Tonnes	-	-	-	-	-	-	-	550,897	439,960	280,698

Source: Extracted from Economic Surveys 1985 to 2024

According to Table 1.1 above, the mining sector GDP contribution was almost constant at between 2-3% for the twenty years 1980-2000. It increased over the next twenty years up to 2020 first on account of increase in production tonnages and better market prices of the two anchor minerals between 2005-2010, secondly on account of a new complement of minerals produced thereafter including gold, gemstones, carbon dioxide and diatomite. There is a significant jump to 0.9% of GDP in 2015 because production of titanium ore minerals (Ilmenite, Rutile and Zircon) had commenced late 2013 into early 2014 at the Kwale mine. Nevertheless the GDP contribution declined to 0.7% because the mine producing fluorspar ceased operations in 2016 and any figures indicated thereafter must be from stockpiles produced before the closure. Despite the heavy contribution to the GDP by the titanium mining since 2014, the GDP contribution in 2023 is at 0.7% because the mine has come to the end of its lifespan and production had been reducing. The mine will close in December 2024.

The foregoing notwithstanding, Kenya is endowed with a wide range of minerals, both metallic and industrial minerals. These include gold, silver, lead, manganese, zinc, copper, nickel, chromite, niobium, rare earths, phosphate, iron ores, graphite, trona (soda ash), fluorspar, diatomite, gypsum, vermiculite, magnesite, magnesium, kyanite, wollastonite, barytes, clays (kaolin, bentonite), heavy mineral sands (ilmenite, rutile, zircon), silica sand, talc, salt, limestones, dimension stones, natural carbon dioxide, coal, and a wide range of gemstones including ruby, tsavorite (a green grossular garnet found only in Kenya and Tanzania) and other garnets (green, red, spessartite, rhodolite, pyrope), sapphires (blue, yellow, fancy), tourmalines (green, chrome, yellow), and zoisites, among others.

2 Kenya Vision 2030 and the Development of Mineral Resources

Kenya Vision 2030 (KV2030) is the country's long-term development blueprint. It was launched in 2008 and is being implemented in a series of 5-year medium-term plans, namely: First Medium-Term Plan (MTP I) 2008-2012, Second Medium-Term Plan (MTP II) 2013-2017, Third Medium-Term Plan (MTP III) 2018-2022 and the current Fourth Medium-Term Plan (MTP IV) 2023-2027. The MTP I was focused on laying the groundwork for the KV2030 in key sectors of the economy. Unfortunately, the mining sector clearly did not catch the eye of the country's economic planners, presumably due to its paltry GDP contribution. Agriculture Sector, for example, was contributing over 20% to the GDP during same periods and would definitely be on the planners' radar. It may be safe to speculate that the sensational discovery of oil in the Lokichar Sub-Basin of Turkana County in March 2012 and the first ever gas strike 85 km offshore within the Lamu Basin in September 2012 could be the two events that sparked off the interest of the economic planners in the mining sector. This, presumably, led to the sector's inclusion in the subsequent Second Medium-Plan 2013-2017 as the seventh priority sector of the Economic Pillar. A standalone Ministry of Mining was established in April 2013 which then proceeded to make drastic changes to propel this emerging sector to the forefront of the economic development of Kenya. The MTP II envisaged the contribution of the Mining Sector to Kenya's GDP to increase from 1% to 3% by 2017 and to 10% GDP by 2030. There was great hope in achieving this when the Kwale Mine of Base Resources Ltd commenced mining in October 2013 started adding close to 1% to the country's GDP annually. The Ministry of Mining aggressively embarked on a series of reforms for the mining sector, produced the Mining and Minerals Policy of 2016, the Mining Act No. 12 of 2016, and a series of its Regulations in 2017, among many subsequent reform measures.

3 Government Reforms to the Mining Sector

The Constitution of Kenya 2010

For governance of the extractive industry, the Constitution of Kenya 2010 is the umbrella law from which all sectoral laws of mining, oil and gas draw their principles. For the Mining Sector, the Constitution starts by declaring at Article 62(1)(f) that all minerals and mineral oils as defined by law are Public Land. This provision removed one of the greatest impediments to mining in the repealed Constitution which provided for compulsory acquisition of private land only for a "public purpose". The definition of "public purpose" in the then applicable Compulsory Land Acquisition Act Cap 295 failed to capture "mining" as one of the public purposes. The Mining Act Cap 306 of 1940, now repealed, also prescribed that a mining lease can only be granted over public land. This became a big challenge for mining investors to obtain a mining lease on private land as it was always argued that mining to be undertaken by such investors on private land is not a public purpose hence government cannot compulsorily acquire the land. In the case of Tiomin Resources Inc of Canada (Tiomin), the original owners of the Kwale Mineral Sands Project later taken over by Base Titanium Ltd, the investor was forced to buy all the land and sell to government in a peppercorn arrangement for the land to become public. The process took over five (5) years. However, this provision in the Constitution of Kenya 2010 is yet to be tested as there has not been another major investment in the mining sector since the Tiomin case.

The Mining and Minerals Policy 2016 and the Mining Act No. 12 of 2016

The Mining and Minerals Policy 2016 comprehensively addressed the gaps that existed in the mining sector and provided a basis for reviewing the legal framework and regulations. It has aligned Kenya's mining sector with the provisions of the Constitution of Kenya (2010), with the aspirations of Kenyans as captured in the Kenya Vision 2030, and the African Union's African Mining Vision (2009). The implementation of the Mining and Minerals Policy 2016 has greatly reformed the Mining Sector through the following:

The Mining Act No.12 of 2016 was enacted by Parliament and came into effect on 27th May 2016, replacing the outdated Mining Act Cap 306 (of 1940), the Trading in Unwrought Precious Metals Act Cap 309 and the Diamond Industry Protection Act Cap 310; a series of regulations have been made under the Mining Act to provide for use of local goods and services (LN No. 81), Employment and Training of Kenyans (LN No. 82), state participation in mining projects (LN No.84), mining licences and permits (LN No. 87), dealing in minerals (LN No. 88), mining community development agreements (LN No. 148), strategic minerals (LN No. 149), a national mining corporation (LN No. 150), and award of mineral rights by tender (LN No. 153), among other subsidiary legislation; an Online Transactional Mining Cadastre Portal has been set up to facilitate online applications for mineral rights without human interface thus enhancing transparency and simplicity in issuance of these rights; execution of a nationwide airborne geophysical survey by the government completed in August 2023, and which is due to be followed by ground truthing ending in a drilling campaign for the more prospective anomalies; a Geo-Data Bank is being set up to host all previously acquired geological data and information, in addition to those from the recent airborne survey and subsequent ground truthing, and is to be availed to the public and other potential investors; easing of access to land for prospecting and mining purposes by investors while still protecting the rights of land owners and prompt compensation yet, in case of disputes, provides for mediation and arbitration (Part IX of Mining Act); ensuring sustainable management of the environmental during mining operations, including placing environmental protection bond(Sections 176, 180, and 181); introduction of a Ninth Schedule to the Income Tax Act Cap 470 for the taxation of mining, petroleum and geothermal resources (extractive industries); providing for equitable sharing of royalties from minerals between the national government (70%), county government (20%) and the community (10%) (Section 183); providing for government to hold 10% free carried interest shareholding in all large-scale mining operations ([Section 48(1)]) through its mining investments arm, the National Mining Corporation (Section 22(1)), in order to ensure greater benefit from mining ventures; providing for mining companies with a prescribed capital expenditure threshhold to list at least 20% of its equity on a local stock exchange within three years of commencing mineral production (Section 49(2)); establishment of a directorate of mineral promotion and value addition to promote the marketing of investment opportunities in mining and promote value addition of minerals (Section 17(4)).

4 Why Are the Reforms in the Mining Sector Not Translating to Increased GDP Contribution?

It is clear that despite the extensive reforms to the sector, the GDP contribution by the mining sector hardly moved from where it was before the reforms when it averaged 0.3% - 0.5% (excluding the contribution by the production of titanium). It is to be noted that the Kwale mine commenced mining in October 2013 and is, technically speaking, not a fruit of these reforms as it had come on-stream prior to the reforms. At any rate the Kwale mine which buoyed up the GDP to increase to between 0.7% - 0.9% has come to the end of its life, having exhausted the mineable mineral sand reserves. This means we are staring at possible decline to 0.5%-0.7% of GDP for the 2024 mineral production.

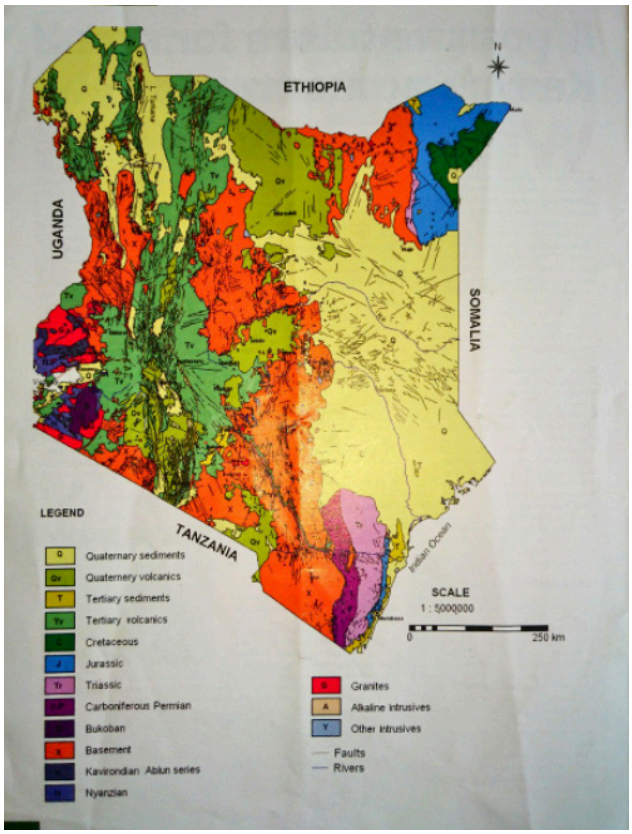
The Mining Act was said to be the most progressive in the region when it came into effect in May 2016. This may still be the case and, accordingly, the reasons for stagnation of the mining sector could be lying elsewhere. The taxation of mining as contained in the Ninth Schedule of the Income Tax Act Cap 470 is also not unfavourable for mining. Mining investments require large capital outlays exposed to relatively much higher risks over long periods than most other industries. The exploration phase of a mineral project could take 5 -10 years and mine development another 2-8 years depending on the type of deposit. For example, the gold exploration project in the Kakamega-Siaya area has been going on for well over 10 years. Furthermore, the probability of discovering an economic deposit in most jurisdictions is very low, typically between 1-2%. It is for the foregoing reasons that most investors in the mining sector are often foreign.

The following could be likely reasons why no investors are rushing to Kenya to capitalize on the attractive mining reforms:

Lack of Serious Mining Investment Promotions by Government appears to be the major reason Kenya has not been able to attract any significant mining investment since the reforms. Even investment promotions done locally in recent years have been through processes driven by parties other than the government. The truth is that Kenya is still a green grass mineral investment destination and more needs to be done by government to draw attention to Kenya's geological potential. Before the ground truthing to follow the completed airborne geophysical survey is done, which will take years, the available geological information could be packaged appropriately and marketed to investors at major mining conferences in the capitals of traditionally mining countries. Negative Publicity on the Kenyan mining sector could be the second reason for lack of attraction of mineral investments into Kenya by would-be foreign investors. Notwithstanding the factual basis of the messages coming from Kenya Government officials, the overall perception overseas is that there is no security of tenure of a mining licence in this country because the press reports quoting government officials are consistently talking of either suspension of licences, cancellation of licences, or a moratorium against issuance of new mining licences or renewal of existing licences.. No investor will put risk funds where the security tenure of a licence is unpredictable. The treatment of investors who are already in the country may also not help sell Kenya abroad; the mining world is very closely networked so bad news travels quickly and is not reversible for many years. Lastly, Repression of Technocrats in MDAs by their political superiors could be another reason for failure of the reforms to translate into investments. The superiors seem to always be on a war path against the technocrats under them. Sometimes the top echelon of technocrats with years of experience are all removed from the Ministry at once whenever there is a new leadership team, leaving no proper institutional memory to run the Ministry smoothly while on the other hand often leading to distress among the industry players. Other times the technocrats are so terrified by the leadership that it is safer to just silently sit tight to avoid misunderstandings, even when things are not proceeding as they should.

5 Conclusion

The geology of Kenya indicates Kenya has a great potential for mineral occurrences. This potential can only be proven by enhanced mineral exploration, culminating in a vigorous drilling campaign to confirm existence or not of economic mineral deposits in the areas of the anomalies revealed by the nationwide airborne geophysical survey completed in August 2023. Kenya completely overhauled its policy, legislative and institutional framework governing the mineral resources sector between 2013 and 2017. However, despite the reforms expected to attract mining investments and propel the mining sector's contribution to GDP from below 1% to 10% by 2030, there have been no significant new mining investments and the GDP contribution by the mining sector remains below 1%. It may be prudent, therefore, that the government embarks on a vigorous mining investment promotion drive to draw the attention of mining investors to Kenya's potential. Of the two long term mineral production anchors to GDP contribution, government should finalise its ongoing arrangements to get the fluorspar mine in Kerio Valley reopened and also encourage production of soda ash at Lake Magadi to at least be doubled. This lake contains the world's third largest reserves of natural trona in the world, which is also self-replenishing, but is greatly underutilized.



Interview With Mr. Enoch Kipseba, Director, Geological Survey Under State Department For Mining.

Mr. Enoch Kipseba
Director, Geological Survey
State Department for Mining

What is the Primary role of the Directorate of Geological Survey?

We are here to translate the geological structure and resources of the earth and guide decision making on exploration and utilization of the mineral resources, and conservation of the environments. We look for the areas containing mineral resources and the feasible areas for extraction of these resources and make sure that the country's resources are being harnessed sustainably.

In addition, we sometimes work with environmental scientists in order to estimate the possible negative effects of extracting natural resources and measures towards preventing them. We also monitor and report on the aspect of disaster management especially risk comprehension with relation to natural occurrences such as landslides, earthquakes, and volcanic activities.

What are some of the most significant discoveries from recent surveys conducted?

Over the last few years, geological reconnaissance through the airborne geophysical survey has revealed the existence of numerous mineral anomalies, which point to potential mineral deposits in Kenya. These include Rare Earth Elements, which are especially found in the coastal areas and are critical in the production of electronic gadgets like smart phones, batteries and renewable energy technologies. There have also been significant find of deposits of industrial minerals, gold and gemstones in different regions of the country thus pointing out that Kenya has the potential to be a mining nation.

Another region of interest which is managed by our sister departments of Energy and Petroleum and has received exploration focus has been the Lokichar Basin, and demonstrating potential, oil deposits have been established in the Turkana County. Further, surveys have added on extent of geothermal resource in the rift valley region which is very fundamental to the development of Kenya's renewable energy platform. Additionally, exploration for water resources in areas of low precipitation such as north eastern region of Kenya has revealed vast underground water reservoirs, which can solve some of the difficulties witnessed in water supply.

Besides, the exploration of geothermal energy is also in progress as part of government overall aim of embracing sustainable energy sources.

In what ways do you ensure that the environmental and social issues are considered during your operations?

Environmental and social sensitivity is highly observed. One of our primary goals as the Directorate of Geological Survey of the country is to ensure a sustainable exploration and exploitation of the mineral resources within the region. For every process of the global operations, we ensure social and environmental impact assessment (ESIA) is conducted. Any preferred exploration or extraction activity is only preceded by undertaking an environment impact analysis to determine the vision that must be taken if any on the general environment, water and soil, and biological life forms. This assists us to implement measures, which reduce the impact on the environment and adherence to national and international environmental standards.

Social issues are solved in collaboration with local peoples by inclusion of them in our operational regions. These include making them aware of the coming activities, seeking their consents and taking them through more of activities to be done. We are also equally determined to see that the fruits of Resource discoveries are felt by local communities especially through employment, infrastructure development, and training. In addition, we follow strict measures of rehabilitation and restoration of the area after the extraction to enable the area to regain its natural state.

What methods have you incorporated into your practice that are more contemporary? Are there any future prospectus of increasing the geological survey activities in Kenya?

The Directorate has used many of the modern methods and equipment in conducting geological surveys. Some of these include:

Geophysical Surveys: Explorations with electromagnetic, gravity and seismic sciences to find deposits of mineral and structures of the earth. These techniques enable us to make fast coverage of large areas with little or no impact on the existing environment.

Remote Sensing and Satellite Imaging: In addition, to geologic imaging we employ satellite imagery to analyse changes in surface material and types of cover, and the structures of the Earth's surface. This is especially so where physical access is not feasible on ground for example in remote regions.

Geographical Information Systems (GIS): As we can see GIS tools are informative in storing archiving and visualizing huge amounts of geological data that we gather. They assist in preparing accurate geological maps and other models that are useful in the process of searching for minerals and land-use planning.

Drilling and Core Sampling: Sophisticated instrumentation and drilling methods enable better obtaining of cores from the subsurface, and in order to study the characteristics of the subsurface better, analyse those samples.

Deposit Modelling softwares: these softwares are used to do modelling of the mineral deposits by inputting the exploration field data of the areas in question. The result gives the form of the deposit, size and shape of the deposit.

In the future we would like to intensify the prospecting exploration in some parts of Kenya especially in the northern and coastal regions. We are also in the process of preparing to incorporate artificial intelligence and machine learning to facilitate a better and faster analysis on the geological information to estimate deposits on resources.

Why don't we explore uranium deposits for mining in Kenya even though it has economic face value?

There are both technical as well as policy reasons that have stagnated exploration of uranium.

First of all, we have not identified potential deposits of uranium in the country. The ongoing airborne geophysical survey has identified some radiometric deposits, which are yet to be confirmed what it actually is.

It is important to note that uranium is a very sensitive mineral in the global view, and used in among others uses in the production of nuclear weapons. It therefore plays an important role in global geo-politics.

Secondly, there are environment factors as the reason for poor financial performance of the enterprise. Uranium mining can generate large amounts of radioactive wastes which, if not well handled, poses a major threat to land and water sources. This is a major task especially in developing countries where the environmental laws are still being developed and where there is growing concern on how to ensure adherence to safety standards which are also in the process of being established in the country.

Lastly, from a policy perspective, Kenya's emphasis has been on the creation of more accessible and environment friendly resources including; renewable energy resources including; geothermal, wind and solar resources.

The Directorate is furthering its exploration and hopes to complete confirmation of the mineral anomalies, which would lead to more discoveries of mineral resources.

Picture: Courtesy

Innovative Energy Solutions for Clinker Manufacturing: A Pathway to Industrialization and Economic Transformation

Eugine Ojala (P.Eng.Tech)

1 Introduction

Industrialization is among the most central forces behind economic development and employment generation, particularly in the emerging world. The cement industry, with the manufacturing of clinker at its heart, is an important industry that supports infrastructure and industrialization (World Bank, 2019). Nonetheless, being an energy-intensive industry, clinker production has two main drawbacks: high operational costs and excessive emissions of greenhouse gases. According to the research undertaken in this paper, the opportunities for energy rationalization in clinker production processes have been explored and analyzed.

2 The Clinker Manufacturing Process

The production of clinker is derived through the calcination of limestone, clay, and other raw materials in a rotary kiln at temperatures of about 1,750 °C. The process is energy-directed, contributing about 30–40% of the total energy use in cement production. The first highlights the energy sources, such as coal, natural gas, and other alternative energy sources. Satisfying the energy needs and the following environmental effects of this process is essential when it comes to the industrialization process.

3 Energy Solutions for Clinker Manufacturing

3.1. Waste Heat Recovery Systems

Waste heat recovery (WHR) systems work by taking heat lost by the kiln and the preheater and using the heat to generate power or heat raw material. Applying WHR can bring 30% savings in energy, a decrease in operation costs, and a reduction in greenhouse emissions (International Energy Agency, 2021). Also, it can contribute to creating employment in the specific country in developing and setting up these plants and their maintenance.

3.2. Alternative Fuels and Raw Materials

Biomass, municipal waste, or industrial products can be used as energy sources, thus helping to minimize the use of conventional fossil fuels. This helps to cut fuel expenses and positively impacts any company that decreases its carbon footprint (International Energy Agency, 2021). It is also possible to boost the energy intensity of clinker-making by utilizing alternative raw materials, including fly ash and slag. Implementing these practices can result in new supply chains and employment in waste management and logistics industries.

3.3. Energy-Efficient Technologies

Advanced technologies, which include vertical roller mills for raw materials and high-efficiency kilns, ensure a drastic reduction of energy usage in the clinker manufacturing process. The digital tools in the envelope of predictive service and process optimization can be used to complement energy effectiveness and operating dependability (International Energy Agency, 2021). Staffing and training persons with relevant knowledge and skills in managing such technologies open new employment in high-technology fields.

3.4. Carbon Capture and Storage (CCS)

CCS technologies involve using structures to encase carbon dioxide emissions from clinker plants in underground storage or as inputs in production processes. CCS technology is relatively new to clinker manufacturing plants but can substantially reduce the plants' environmental footprint. Some experts have argued that introducing and implementing CCS technologies can create employment opportunities in research and engineering, along with the establishment of plant management systems.

4 Economic Impact of Energy Optimization on Clinker Manufacturing

4.1. Cost Reduction and Competitiveness

By saving energy and money on their operation, clinker plants can increase their effectiveness in the global environment. Sometimes, this can result in increased production capability, improved profitability, and capacity for reinvestment in plant development and renewal.

4.2. Job Creation and Skills Development

The application of energy solutions can only be envisioned to be carried out effectively with competent personnel to perform installation, operation, and maintenance. This generates employment chances in the clinker manufacturing industry and other industries supporting it. Also, programs that will help the existing workforce acquire more skills will improve productivity and satisfaction at work.

4.3. Contribution to Economic Transformation

The efficiency of energy use in the production of clinker must be improved to be in line with the broader social economy as it can lower the cost of construction materials, hence making the development of infrastructure more achievable and attracting foreign investment. This, in turn, may lead to enhanced economic growth, structural change, and poverty slashing.

5 Challenges and Recommendations

5.1. Challenges

Cost burden: The amount of capital required to realize these advanced energy solutions is not insignificant and, as such, can be a barrier for many plants.

Technological adaptation: Encouraging new technologies on current plants poses the most significant difficulty regarding ICT skills.

Policy and Regulatory Comparatively Energy Use and Emission Restrictions: Lack of a coherent national or worldwide guideline on energy use and emissions could limit the execution of a new, innovative solution.

5.2. Recommendations

Government Incentives: Offering tax rebates, subsidies, and grants for energy-efficient projects can help stimulate investment in new and exciting solutions.

Public-Private Partnerships: Governments, industry, and research organizations could work together to help develop and deploy advanced technologies.

Capacity building: Setting up training programs to build a cadre of experts in energy management and advanced manufacturing technologies.

6 Conclusion

Implementing highly innovative energy solutions within cement clinker manufacturing is a prerequisite for sustainable industrialization, economic transformation, and employment generation. This will contribute to reducing the ecological footprint of the clinker industry on earth and improving the competitiveness of this sector in production and distribution while continuing to support the process of sustainable socio-economic progression. To do this, policymakers and stakeholders must work together to identify the challenges preventing these solutions from being fully utilized.

7 References

1. International Energy Agency. (2021). Cement Technology Roadmap: Pathways to a Low-Carbon Transition.

2. United Nations Industrial Development Organization (UNIDO). (2020). Industrial Energy Efficiency for Sustainable Development.

3. World Bank. (2019). The Role of the Cement Industry in Economic Development.

Picture: Courtesy

Picture: Courtesy

Unlocking Kenya's Petroleum Potential: Exploring New Frontiers in Oil and Gas.

Eng. Selemia Opap, PE, MIEK

Fossil fuel is a hydrocarbon-containing material, and examples are coal, oil and natural gas among others, whose formation occurs naturally within the Earth's crust. Reservoirs of such compound mixtures can be extracted and processed for human activities requiring energy. The major drawback of this kind of fuel is that its combustion emits carbon dioxide, a greenhouse gas, which is a primary source of pollution contributing to global warming. The natural reservoirs of fossil fuel are finite thus may be depleted in future if the world continues to consume it at present high rates. It is appropriate to turn to reliance on other sources like solar energy, wind, geothermal, hydropower and bioenergy.

Kenya has a crude oil Refinery which was incorporate in 1960 and was then referred to as East African Oil Refineries Limited. The shareholders were Shell and BP, but the Government of Kenya acquired 50% shareholding in 1971. The refinery consisted of crude distillation, catalytic reforming, hydro treating and reforming units. Grease production unit was introduced in 1974. Bitumen was also a product of this process. This refinery served the East Africa market supplemented with other imported refined products from overseas.

In 1983 the company acquired the present name; Kenya Petroleum Refineries Limited (KPRL). However, the Government of Kenya stopped the crude refining activity in September2013 and KPRL is currently operating as a storage and distribution deport for petroleum products. In October 2023, KPRL was acquired by Kenya Pipeline Company (KPC) as a subsidiary.

The Kenya Crude Oil

Crude oil exploration in Kenya began in the 1950s. It was not until 2012 when the first commercially viable discovery was made in Lokichar, Turkana County, by the British Oil prospecting firm called Tullow PLC. These crude oil reserves were extracted and transported by road to KPRL for storage under a pilot project dubbed Early Oil Pilot Scheme (EOPS) which aimed to produce and export some crude oil to test the market. Sufficient stock was received at KPRL and Kenya exported her first crude oil batch on 26th August 2019 securing a place for Kenya among the world Oil producers. As the world moves away from fossil fuels due to environmental issues, Kenya may consider other sources of energy like Biofuel and any other renewable ones.

Eliminating all work-related injuries and adverse health effects.

KPRL has a robust Health Safety Security (HSSE) policy. It ranks HSSE matters on equal terms with other strategic business objectives. The policy is anchored on the premise that all company activities will be carried out taking utmost account of health and safety of employees, contractors, customers and the community while paying proper regard to the environment. The policy is implemented through a comprehensive Health, Safety and Environment management system certified to ISO 14001;2015 Standards. Reasonable steps are taken to protect and preserve the environment by identifying and controlling hazards that are inherent in KPRL's operations.

Among the safety tools contained in the policy include:

- Health, safety and environment procedures including but not limited to Incident investigation and reporting procedures, Job Safety Analysis for all project and maintenance work to identify/assess the hazards and put in place control/mitigation measures prior to commencing work.
- 'Permit To Work' system which details system on work done and keeping in mind the safety of all persons performing the job.
- Health, Safety and Environment Golden Rules of 'COMPLY' with all KPRL Procedures and Regulations, 'INTERVENE' when colleagues are not complying and 'RESPECT' to internal and external neighbours.
- Conducting 'Safety at Work Always'(SAWA) Audits and reporting of Near Misses to generate learning points.
- Conducting weekly 'Safety Standstills' (a 15-minute safety talk on topical issues) which are normally for communicating safety messages site-wide.

KPRL continues to comply with applicable laws. It is done through carrying out statutory audits and inspections including annual environmental, occupational health and safety, fire safety, ambient air measurements, noise survey, medical examinations among others. Statutory First Aid training as part of capacity building to both members of staff and contractors is also KPRL priority.

As part of the environmental sustainability programs, improvement of biodiversity and in line with the Presidential directive on tree restoration drive which aims at restoring over 10 million hectares of degraded land countrywide, KPRL staff and contractors continue to participate in tree planting exercises and hundreds of trees have been planted on site and in the host community.

Opportunities for growth in Kenya's Oil and Gas sector

Kenya discovered oil in Turkana in March 2012. Additionally, there exists natural gas deposits in the coastal Lamu basin. The energy transition from fossil fuels to renewable energy will place natural gas as a transition bridge. Natural gas is a flexible lower carbon fuel in comparison with carbon coal and crude oil. Going forward, natural gas may attract more investor interest and capital. Getting commercial value remains an idea to be explored. Under the Ministry of Energy and Petroleum, Kenya may commercialise her crude oil through exports by pipeline via Lamu under the LAPSSET corridor project.

Challenges of the Turkana oil Delivery

KPRL was the only refinery in East Africa. The last major investment was undertaken in 1974 when the second refining train was commissioned. Since then, there has been many changes in technology, product specifications which included unleaded for gasoline and sulphur levels reduction in diesel. KPRL was thus unable to compete with modern complex refineries in Asia and Middle East leading to eventual closure of the refinery. KPRL is however strategically located and has expertise in handling Liquefied Petroleum Gas (LPG). The government plans to develop an LPG storage and distribution terminal which will enhance LPG penetration and consumption. The location and the storage facilities also position KPRL as an ideal location for a petroleum trading hub in the region. Additionally, KPRL may invest in cleaner fuels like bio-diesel refining.

The EOPS project necessitated engineering the crude oil infrastructure at KPRL to allow for exports via the Kipevu Oil Terminal. Accumulating sufficient volumes of crude oil for export (Vessel payload) required very long periods for transport by road. Some parts of the road network were prone to vagaries of the weather at times halting delivery altogether. Transport to Lamu port via pipeline could be timely but requires effective infrastructural security and sustenance, considering the security volatility in the region.

Eng. Selemia N. Opap is Electrical Engineer at Kenya Petroleum Refineries Limited (KPRL)

He writes on topical issues in Engineering Sector. His contact is Selemia, opap@kprl.co.ke

He wishes to acknowledge the following for their valuable contribution for the production of this article:

1. *Eng. Michael Kariuki – Engineering Manager at KPRL*
2. *Nathaniel Omom – Head of Administration and Welfare at KPRL*
3. *Diana Nthiwa – Health, Safety and Environment Officer.*

Picture: Courtesy

Connecting Africa's Future: Leveraging Space Technology and Emerging Innovations for Inclusive Digital Prosperity

Umar Sani Abdullahi[1], Tasi'u Sa'ad Gidaari Wudil[2], Margret Oguntala[3]
[1] National Space Research and Development Agency, P.O.Box 593 Abuja, Nigeria
[2,3] Nigerian Society of Engineers (NSE), P.O.Box Abuja, Nigeria
Email: umarsani@gmail.com

Introduction

The African continent is experiencing a profound transformation in the digital landscape. With a growing population, immense economic potential, and an increasing appetite for connectivity, Africa stands at the forefront of the global digital revolution. However, unlocking the full potential of this transformation necessitates a strategic approach that integrates space technology and emerging innovations.

Broadband has now become an essential utility for economic development and facilitating the achievement of the Sustainable Development Goals (SGDs), e.g., through better access to education and healthcare, climate change mitigation, promotion of peace and international cooperation, reduced inequality and poverty etc. A recent study found that in developing countries, a 10% increase in mobile penetration increases Total Factor of Productivity, a measure of an economy's long-term technological dynamism, by 4.2 percentage points in the long run (source: Deloitte/GSMA). Furthermore, the World Bank estimates that there is a 1.38 rise in economic growth for low and middle-income economies for every 10% rise in broadband penetration as shown in Figure 1 [1]. Hence, the continuous rollout of faster, more resilient and reliant networks is sure to continue across the world.

The African Digital Landscape

Africa's digital growth is marred by a series of formidable challenges:

- Infrastructure Deficit: Many regions in Africa lack adequate terrestrial networks, making it challenging to extend digital services to underserved areas. Even where fibre is available at landing points, connecting to other parts within nations is a herculean task.
- Regulatory Bottlenecks: The telecommunications and space sectors are governed by complex regulatory frameworks, hampering innovation and expansion in Africa. Multiple taxes and fees, loop-holes in spectrum management practices, right-of-way bureaucracies etc. are hampering operators' ability to deploy and expand needed telecommunication infrastructure.
- Limited Access to Financing: Startups and entrepreneurs often struggle to access capital, hindering technological advancements. Operators are equally facing hurdles accessing forex and needed financing for network expansion and importing needed equipment.
- Low Consumer Income: A significant portion of the population falls below the poverty line, limiting their access to digital services and products.
- Staggering Digital Divides: Rural and remote areas suffer from a significant lack of digital access, creating a digital divide that worsens existing inequalities.

Currently, the GSMA estimates that there are about 400 million people globally (5% of world's population) still living in areas without mobile broadband coverage, with Sub-Saharan Africa representing the region with highest margin (15%) as shown in Fig. 1 where such communities are predominantly rural, poor and sparsely populated, and the most challenging to reach.

Deploying fibre cables is complex and expensive, and operators are hesitant to expand for not only technical, but largely economic reasons. It is also evident that lack of affordability of smart phones is largely the challenge due to uptake of mobile broadband even where connections are available.

The coverage gap is simply defined as the lack of supply of mobile broadband services, while the usage gap, which stands at about 59% in sub-Saharan Africa (680 million people), represents those who live within the footprint of a mobile broadband network but do not use mobile internet services [2]. This may be due to poor digital literacy, high cost of mobile devices or services, lack of sufficient local content etc.

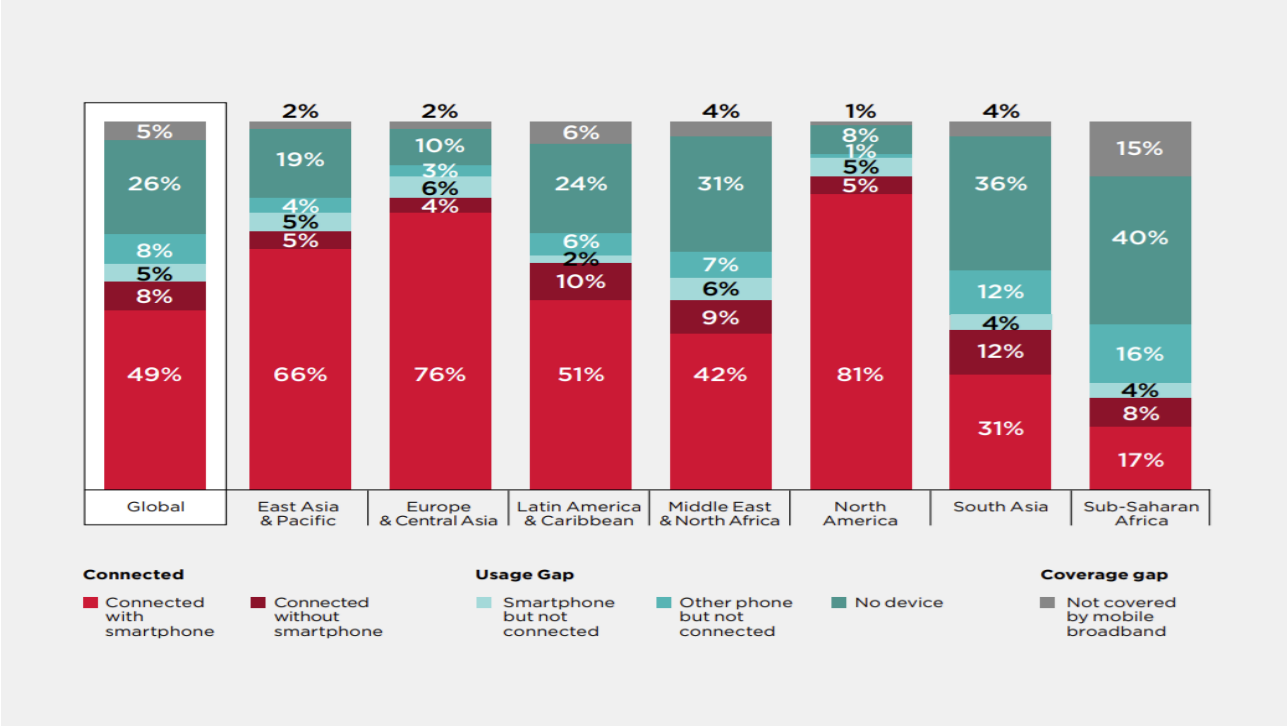


Fig. 1: State of connectivity by region, with connectivity and usage gap by device type, 2022 [2]

The Role of Space Technologies

Space technology presents a unique opportunity to overcome these challenges due to its distinct features and benefits which include – ubiquitous coverage, multicast/broadcast capabilities, scalability and resilience, increasing reliability and remote monitoring and observations. Recent advances in the space sector across the entire value-chain is breaking barriers and ushering new business cases and opportunities via advances in miniaturization with low-cost, but capable small and nanosatellites often deployed in constellations, advent of High Throughput Satellites (HTS), reusable launchers, improved sensors and battery technology, enhanced materials and additive manufacturing, propulsion systems, flexible and smart payload configurations etc. [4].

Leveraging satellite technology can help bridge the digital divide and extend connectivity to remote regions. Key aspects include:

- Broad Connectivity: Satellite technology can provide connectivity in remote and underserved areas, bridging the digital divide and ensuring that even marginalized communities have access to high-speed internet.

- Earth Observation: Satellite-based earth observation systems aid in agriculture, disaster management, and environmental monitoring.
- Navigation Services: Global Navigation Satellite Systems (GNSS), like GPS and Galileo, enable precise location-based services.
- Space Exploration: African nations are increasingly investing in space exploration, fostering technological innovation.

Emerging Innovations

Complementary to space technology, emerging innovations play a vital role in Africa's digital transformation:

- 5G networks: These are expanding across Africa, enabling faster internet speeds and supporting advanced applications, facilitating IoT connectivity, enhanced mobile experiences, and low-latency communication, driving innovation in sectors like healthcare, agriculture, and manufacturing.
- Artificial Intelligence: AI-driven applications can address healthcare, agriculture, and education challenges.
- Internet-of-Things (IoT): IoT is being used in smart agriculture to monitor soil conditions and crop health, in healthcare to enable remote patient monitoring and efficient resource management and applied to optimize energy consumption in smart cities.
- Renewable Energy: Off-grid and renewable energy solutions are vital for powering digital infrastructure in remote areas.
- Blockchain: Implementing blockchain technology can improve transparency and reduce fraud.
- E-Government: Digitizing government services enhances efficiency and accessibility for citizens.
- Financial Inclusion: Satellite technology can support mobile banking and digital financial services, ensuring that underserved populations have access to banking and economic opportunities.

The Integrated Approach: Bridging the Digital Divide

The integration of satellite technology and emerging innovations in Africa holds the promise of significant benefits, with the overarching objective of achieving equitable access, minimizing inequalities, and bridging digital divides. The Author's work in [4] presented a model for hybrid satellite 5G deployment in sub-Saharan Africa, highlighting the challenges and providing technical and regulatory solutions.

- Equal Connectivity: Satellite-based internet can extend its reach even to the remotest regions. Coupled with mobile technologies, this fosters equal access for all, reducing the digital divide.
- Agricultural Transformation: The integration of space technology allows for precision agriculture, making use of satellite data for optimal resource management and crop production. This empowers rural farmers and contributes to food security.
- Educational Advancement: Online learning platforms powered by satellite internet and e-learning applications contribute to equitable access to education. This is especially vital for children in underserved areas.
- Healthcare Accessibility: Telemedicine and mobile health applications ensure remote communities have access to quality healthcare services.
- Environmental Monitoring and Disaster Management: Satellites provide real-time data that, when integrated with AI and IoT, can help enable real-time monitoring of climate change as well as predict and manage natural disasters, saving lives and reducing economic losses.
- Digital Inclusion: Initiatives to increase digital literacy and ensure the participation of disadvantaged groups, such as women and those with disabilities, in the digital ecosystem reduce inequalities.
- Job Creation: The integrated approach fuels innovation and entrepreneurship, offering employment opportunities across various sectors and addressing socioeconomic disparities.
- Empowerment Through Innovation: The use of blockchain for land registration and transparent financial systems empowers marginalized communities by ensuring land ownership rights and financial inclusion.
- Supply Chain Optimization: Combining satellite data with IoT and Blockchain can enhance transparency and traceability in supply chains, reducing waste, fraud, and inefficiency.
- Government Services: E-government platforms enhance public service access, promoting efficiency and accessibility for all citizens, regardless of location.
- Financial Inclusion: Satellite technology can support mobile banking and digital financial services, ensuring that underserved populations have access to banking and economic opportunities.

Insight on Nigerian Space Technology Sector

Nigeria, through the National Space Research and Development Agency (NASRDA), has made significant strides in space technology with impact across various key sectors of the economy as shown in Fig. 2. Notable achievements include launching communication satellites, earth observation satellites for environmental monitoring and management of disasters such as floods, oil spills, and forest fires. The Agency

has also embarked on nanosatellite development and launch, intensive capacity building initiatives and investing in research and development as well as recently launching a high-resolution earth observation satellite for reconnaissance. The agency collaborates with academia, public, private and professional organizations such as the Nigerian Society of Engineers (NSE) through the Nigerian Institution of Space Engineers (NISEng) in advocacy, awareness, knowledge transfer and skill development in the area of space science and engineering.

Fig. 2: Space Technology Contribution to GDP Nigeria

Recommendations

To harness the potential of space technology and emerging innovations for inclusive digital prosperity in Africa, the following key recommendations are hereby made:

- Simplifying regulatory frameworks to encourage innovation and investment, and encourage private sector participation, including in new space sector. Governments must work collaboratively across tiers to streamline regulations across federal, state and local authorities, avoid multiple fees and taxation in the ICT/space technology sector, develop transparent and clear spectrum roadmaps which will include both terrestrial and satellite spectrum.

- Increasing access to financing for startups and entrepreneurs, and accommodate innovative financing models in the ICT sector especially on infrastructure development, including public-private partnerships, lease-to-own models for telecom devices, equipment etc.

- Developing educational and training programs to foster digital literacy.

- Expanding initiatives to connect underserved and remote areas to the digital ecosystem. Government universal service provision funds need to be empowered but given the requisite autonomy to operate with transparency, accountability, focus and efficiency in enhancing connectivity to rural/underserved areas.

- Multi-stake holder collaborations are important to ensure everyone is one the same page regarding ubiquitous, inclusive and equitable digital connectivity is ensured. This may include partnerships to develop use cases in the consumer and enterprise segments, initiatives to bring affordable devices to market, and active network sharing and joint equipment sourcing to drive down deployment costs.

Conclusion

Africa's digital transformation is a promising journey with significant potential. Leveraging space technology and emerging innovations offers the opportunity to address infrastructure deficits, bridge digital divides, and drive inclusive digital prosperity. With strategic investments and collaborative efforts, Africa can embrace a future where technology empowers all its citizens and fuels economic growth. This paper underscores the importance of these endeavours and presents a path toward a brighter digital future for the African continent.

In conclusion, the integrated approach of space technology and emerging innovations is the catalyst for transforming Africa's digital future. It brings forth the promise of a more equitable, inclusive, and prosperous continent, where access to digital services is no longer a privilege but a fundamental right. As African nations continue to invest in these transformative technologies, they are well on their way to embracing a brighter digital future, ensuring that no one is left behind in the era of the digital revolution.

References

1. C. Qiang, C. Rossotto, and K. Kimura, "Economic impact of broadband, Information and Communication for Development," 2009.

2. GSMA Intelligence: The State of Mobile Internet Connectivity 2023. Available: The-State-of-Mobile-Internet-Connectivity-Report-2023.pdf (gsma.com), Accessed on: Nov. 2023.

3. "5G Report Africa: Making 5G a reality for Africa," A CSIR & Ericsson Collaboration, Available: https://www.ericsson.com/4ac1fd/assets/local/press-releases/africa/2018/5g-africa-report-11-2018.pdf.

4. Abdullahi, U S et al 2021. Hybrid Satellite-5G Network Deployment in Sub-Saharan Africa: Challenges and Prospects. In: 71st International Astronautical Congress (IAC) – The CyberSpace Edition, 12-14 October 2020.

Innovating Beyond Boundaries:
Kenyatta University's Evolution of the School of Engineering and Architecture

Eng. Dr. Isaiah Bosire Omosa

In a rapidly evolving global landscape, higher education institutions are continuously seeking innovative ways to attract and nurture skills. This is what the Associate Dean of the School of Engineering and Architecture, Kenyatta University, had to say regarding the University's efforts in making it the most preferred institution for Engineering Research and Development.

'The School of Engineering and Architecture (SEA) is a result of a merger between the former School of Engineering and Technology (SET) and the former School of Architecture and the Built Environment (SABE). At the time of the merger, the University was undertaking a major re-organization and re-alignment of its processes in a bid to achieve its vision and mission more efficiently and at the same time keep with global best practices in the higher education sector. A closer look at the engineering and architectural and related programs shows that they are very complementary and more or less belong to the same family. By way of example, the University of Nairobi, the oldest university in Kenya, for a long time has had the College of Architecture and Engineering (CAE). Kenyatta University does not embrace the college system but the school system. Therefore, having the architectural and engineering programs under one roof builds a synergy that manifests itself in greater efficiency. Since most of the programs in the school are regulated professionally, the administration of the school and indeed the programs in particular is undertaken by professionally qualified staff in line with the requirements of the professional bodies, notably, EBK and BORAQS. These bodies from time to time visit the school to gain insight on how the delivery of the programs is progressing and if quality control is exercised. The school remains open to improvement and keeps collaborating and networking regionally and internationally to ensure competitiveness.

The civil engineering program, in a special sense, has very close ties with the architectural program. **Structural engineering thematic area of civil engineering, construction management, quantity surveying programs and architectural works go hand in hand.** The architects are always the team leaders in building construction works and have in their team other professionals such as structural engineers, mechanical engineers, electrical engineers, quantity surveyors, and project managers among others. Having the school of engineering and architecture is therefore a boon in many ways and the impact should be positive.

SEA has its professional programs accredited and/or recognized by either the EBK or BORAQS. The boards monitor the delivery of these programs continually. The development of curricula in part is informed by the provisions given by the Academic Qualification Committees of the respective boards. Certain minimum requirements must be met concerning teaching/contact/credit hours, staff numbers and qualifications, lecture spaces and studios, laboratory and workshop areas among others. Additionally, the university through SEA has been in the process of working closely with the EBK on fulfilling the requirements of the Washington Accord in which our engineers shall have worldwide recognition. It is also worth noting that we revise our curricula every 5 years bringing on board emerging trends and future orientations to remain competitive.

Traditionally, the civil engineering program has been premised on the British Standards (BS codes) e.g. BS 8110, CP 110, etc. However, with the adoption of the Eurocodes in member states of the eurozone and elsewhere, Kenya through KEBS is in the process of adopting the Eurocodes and therefore the training institutions must embrace the same in the delivery of their related programs. Kenyatta University has for some time now been developing capacity for the same by sponsoring engineering lecturers to attend training sessions by KEBS and other platforms. Moreover, our revised civil engineering curriculum has migrated to the Eurocodes, especially the structural engineering thematic area.

On the other hand, as an institution committed to research and development, we recognize the vital role that various departments within the School of Engineering and Architecture play in advancing knowledge and innovation. However, there remains a significant gap between academia and industry in our

country. In contrast to systems in many developed countries where universities act as consulting partners to industries, several local industries fail to make use of academic resources available in our universities. This is worrisome, given the fact that most government agencies do not have any formal department that is charged with research and development or innovations, and whenever and wherever available, the departments are usually faced with resource and capacity constraints.

We should, therefore foster and encourage collaboration and linkages with industry and other relevant institutions recognizing that good will from the top leadership of the sector and the country is crucial and/or critical. Universities should aim to generate more than theoretical concepts by translating the same into actionable insights that the industry can adopt. This way, it is possible to bring value to research and generate innovations for the industry, as well as create new processes.

The Chandaria Centre in Kenyatta University, which is an innovation hub, has a critical function. Research projects by final-year students are presented to the Centre and strongly argued. Competitive projects can get funding and proceed to prototyping which gives the students a good view of their creations. It not only helps in discovering youth talent but also in developing functional solutions to a problem. Our overarching goal is to undertake need-driven research. We start by examining the needs of the industry and the concerned community, followed by the identification of knowledge and technology deficiencies. This structured approach has allowed us to address real challenges facing society.

SEA is certainly the first local school to start offering non-traditional courses like Petroleum Engineering, Aerospace Engineering, and Biomedical Engineering among others. We have our petroleum engineering program supported by universities from Nigeria and Benin, while Biomedical engineering is supported by universities from South Africa and Italy. Most importantly, Iowa State University from the USA has been developing our capacity in most of our engineering programs. In addition to this, SEA boasts of senior and notable academicians as well as practitioners such as Eng. Prof. Francis Gichaga and Arch. Prof. Paul Mwangi Maringa and others as adjunct professors. These academic and professional stalwarts give SEA the much-needed edge and stability.

Tilt angle optimization of Grid tied solar PV system: A case study of 600 kWp Grid tied solar PV system.

Emmanuel Ayora[1], **Mathew Munji**[2], **Keren Kaberere**[3], **Jilian K. Ouko**[4]

[1]Department of Energy, Gas and Petroleum Engineering, P. O. Box 43844 – 00100 Nairobi, Kenya

[2]Department of Physics, Kenyatta University, P. O. Box 43844 – 00100 Nairobi, Kenya

[3]Department of Electrical and Electronics Engineering, Jomo Kenyatta University of Agriculture and Technology P.O. Box 62000 – 00200 NAIROBI, KENYA

[4]Kenya Power, P.O Box 30099-0100 Nairobi

*Correspondence: ayoraemmy@gmail.com

1. Introduction

The investigation into the performance of the 600 kWp grid tied solar Photovoltaic plant at Strathmore University and the establishment of optimal configurations for electricity supply have the potential to alleviate strain on the national grid and generate substantial savings on electricity bills. Such studies have not been done extensively in Kenya, so monitoring these systems' performance is imperative. The angle of tilt of a solar PV module refers to the angle at which the panel is inclined with the horizontal. When determining the optimum tilt angle, the mounting techniques, climatic conditions of the location, and topography are crucial aspects to consider. Sun tracking is considered in a situation where the solar panel is made to move continuously relative sun's position. Dual and single axis tracking mechanisms are crucial for enhancing the performance of solar PV systems. Single axis sun tracking mechanism entails the rotation of the panel in one axis while following the sun's position. The dual axis sun tracking mechanism ensures that the solar panel rotates in two axes as it follows the sun. The single axis tracker follows the sun from east to west during the day whereas the dual axis tracker follows the sun daily as the single axis tracker, but also tracks the suns position from north to south across all the seasons of the year. The solar PV module angle of tilt determines the levels of solar irradiation reaching the horizontal surface. It is globally accepted to set the solar PV panel at inclination angle same as the altitude as concluded by Babatunde *et al*. (2018). The solar photovoltaic modules inclined at a lower tilt angle exhibits better power performance during summer seasons whereas the solar PV systems inclined at higher tilt angles perform better during winter seasons. Figures 1 and 2 illustrates the seasonal tilt angle of the solar panels and solar panel orientation respectively.

Figure 1: seasonal tilt angles for solar PV system

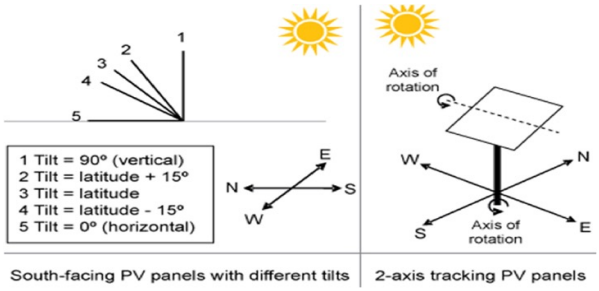


Figure 2: The orientation of a solar panel

Orientation refers to the direction and position of the solar panel relative to the sun's position and measures the direction of the solar panel relative to a reference point which is either north or south. Solar PV systems in the southern hemisphere and northern hemisphere should be oriented northwards and southwards respectively for maximum power output. Salih *et al*. (2014) asserted that for grid tied solar PV system where they are attached to permanent structures, the PV modules should be installed at tilt angles equal to the location's latitude to optimize power being generated throughout the year. A study done by these researchers on the effect of the tilt angle and orientation on the photovoltaic module performance showed that the tilt angle and orientation have crucial impact on the output. Khoo did a study on the optimized tilt angle and orientation for maximizing the solar irradiation for Singapore solar PV systems applications and established that the solar PV modules performance is affected by the panel's angle of tilt and orientation since these factors influence the levels of solar irradiation received by the modules in a given region. The results showed that PV system tilted at an angle of 10^0 facing eastwards realized a high yield and performance ratio that is close to the other locations. Dominic carried out tilt angle optimization using PV Syst for biannually adjusted Solar PV system based on the Perez transposition model. This model generates yearly global solar Irradiation incident with tilt angles varying from 0^0 to 46^0. The optimized tilt angle for winter season was 25.46^0 whereas the optimized tilt angle for summer season was 0^0. The results further indicated that the annual fixed optimal tilt angle was 7.16^0 with an annual transposition factor of 1.01 for the fixed

system whereas 1.05 for the solar PV systems which are adjusted seasonally. This paper aimed at obtaining optimized tilt angle for Strathmore University 600 kWp solar PV system. This, in turn, will contribute to an increased power supply to the grid and significant reductions in electricity bills for both the institution and the wider community. The findings have practical implications for other institutions within the country, as well as off-grid areas. These findings offer a feasible solution for power generation, highlighting the viability and potential benefits of implementing similar solar energy systems. The results contribute to the broader goal of promoting sustainable and clean energy sources, facilitating a more environmentally friendly and economically viable approach to power generation across the country.

2. Methodology

2.1 Tilt Angle Optimization Software

In this study, PV Syst software version 7.2.3 was used to perform tilt angle optimization. In various studies and experiments, different scholars have used different software to carry out the tilt angle optimization analysis. The PV Syst software has been widely used to perform optimization simulation studies.

2.1.1 Geographical Site of case study

Strathmore University is located approximately 5.5 km away from the Nairobi City Centre. The solar PV system is located at latitude and longitude of S01^0 18.621' and E036^{0}48.918', respectively, and an altitude of 1794 m above sea level. Figure 3 shows the geographical location point of the Strathmore University solar PV project (Google Earth, 2022).

Figure 3: Geographical location of Strathmore University (Google Earth, 2022)

The location latitude and longitude were used for establishing the ambient temperature and solar radiation data from the PV Syst NASA-SSE database.

PV system specification

To carry out optimization simulation, the solar PV module type was selected as a standard module type, polycrystalline cell technology, tilted roof-mounting disposition and free air circulation ventilation property as shown in figure 4.

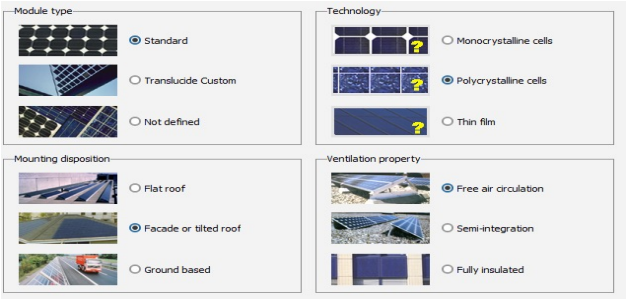


Figure 4: Module type specification

Optimization simulation procedure

In the PV Syst software, the location coordinates were entered which aided in the extraction of the meteorological data for Strathmore University from the NASA-SSE database. The module type specification was selected and system array specification parameters were entered in the *PV Syst* software as shown in figures 3.7 and 3.8. The orientation parameters i.e., Azimuth and tilt angle and main simulation parameters were set as shown in figures 3.8 and 3.9 respectively. The Azimuth was fixed at 0^0 while the tilt angles were changed from 0^0 to 15^0 at intervals of 1^0. In each step, the annual energy output value (MWh/Yr) and Global Horizontal Irradiation (kWh/m^2) was captured. To determine the optimal tilt angle, an optimization tool within the PV syst software was used where 15 steps of optimization simulations were done. Figure 5 shows the optimization tool used for obtaining optimized tilt angle.

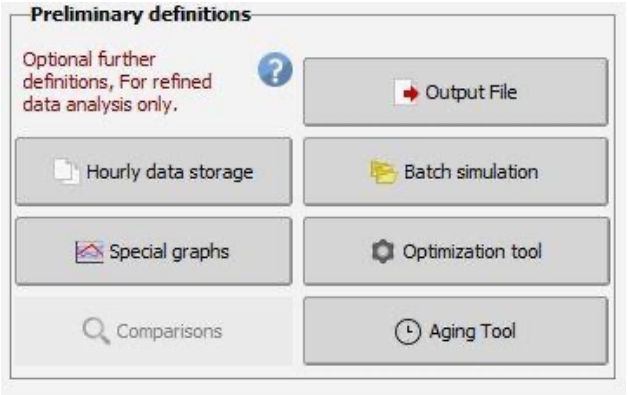


Figure 5: Tilt angle optimization tool

Experimental validation

Experiment location details

An experiment was set up at Kenyatta University Energy Laboratory roof top to further validate the optimization simulation results for Strathmore University Solar photovoltaic system as shown in figure 3.11. The location for this set up was S01^{0}10.758'E036^{0}55.543' and 5,164 feet above the sea level. The solar panels were set facing True North to match the orientation for the one of the installations in Strathmore University. Since the experimental site location was different from the Strathmore university simulation setting location, a simulation for Kenyatta university site location was done. The simulation at the energy technology building roof top of Kenyatta University used weather data input as sourced from NASA-SSE meteo database. The simulation was done as detailed

for the Strathmore University site with the location's coordinates used to retrieve meteo data from the NASA-SSE data base.

Technical details of the system

The experimental set up consisted of six polycrystalline panels installed on the rooftop. Table 3.4 shows the PV module specifications:

Table 1: Solar Module specifications

System Parameters	PV specifications
Solar Module type	Polycrystalline 20 W
Maximum Power (P_{max})	20 W
Open circuit voltage (V_{oc})	21.56 V
Short Circuit Current (I_{sc})	1.23 A
Voltage at Pmax (I_{mp})	17.55 V
Current at Pmax (Imp)	1.14 A

Experimental Set up

Figure 6 shows the experimental set up that was carried out for a period of 3 weeks i.e., from 23/03/2022 to 14/04/2022. The data was collected from 09:00 AM to 4:00 PM daily. The six panels were positioned into 3 pairs with each pair set at 4^0, 11^0 and 15^0. The choice of these tilt angles for experimental analysis was because of the following rationale:

4^0 tilt angles: This angle was chosen since it was within the optimal range i.e., between 1^0 and 5^0 from the simulations done as shown in figure 7.

11^0 tilt angles: Chosen to mimic the installation tilt angle for the solar PV panels in one of the roof top buildings at Strathmore University.

15^0 tilt angles: This tilt angle was chosen for analysis since it is considered as the industry best practice installation angle by most companies in Kenya to allow self-cleaning.

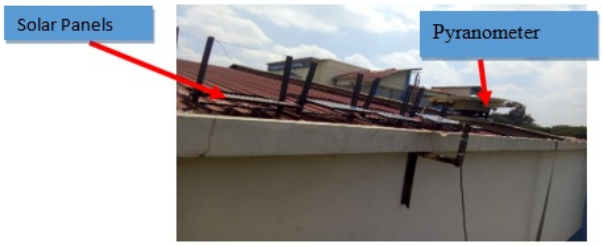


Figure 6: Experimental set up at Kenyatta University Energy Laboratory Rooftop

Data logging was done using the Rigol M300 data logger and the Arduino Microcontroller based data logger at 5 seconds intervals. The Arduino Microcontroller based data logger was designed and programmed to collect short circuit current and open circuit voltage. The data collected by this data logger was displayed on LCD display in real time and stored on the embedded SD card. The microcontroller-based data logger was designed with voltage and current sensors thus measuring data.

The Rigol M300 data logger was configured to collect and store solar irradiation data, ambient temperature and the temperature of the back surface of the panel. The K type thermocouple temperature sensors attached at the back surface of the solar panel measured the temperature. The data logger recorded irradiation data measured by a pyranometer attached at the rooftop. The readings were recorded at intervals of 5 seconds, which gave an accurate account of the environmental behavior and their impact on the power performance characteristics of the panels. A Laptop computer was used to retrieve the data logged on the Rigol and microcontroller-based data logger. Figure 7 shows the complete data logging set up.

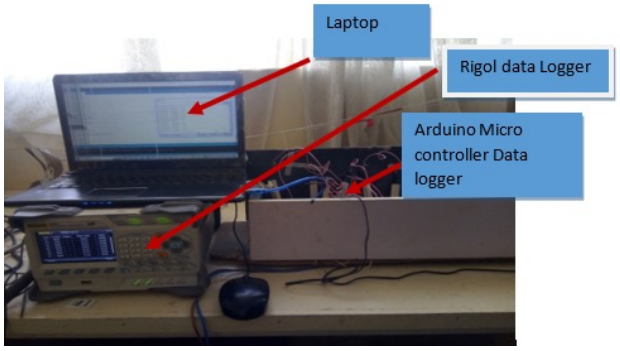


Figure 7: Data logger equipment set up

Results and Discussion

3.1 Tilt Angle optimization

3.1.1 Optimized tilt angle for Strathmore University Grid tied roof top PV system

Figure 8 shows a graph of simulations results for 0^0 to 15^0 tilt angles for the Strathmore University's 600 kWp plant throughout the year.

Figure 8: Simulations results for 0^0 to 15^0 tilt angles

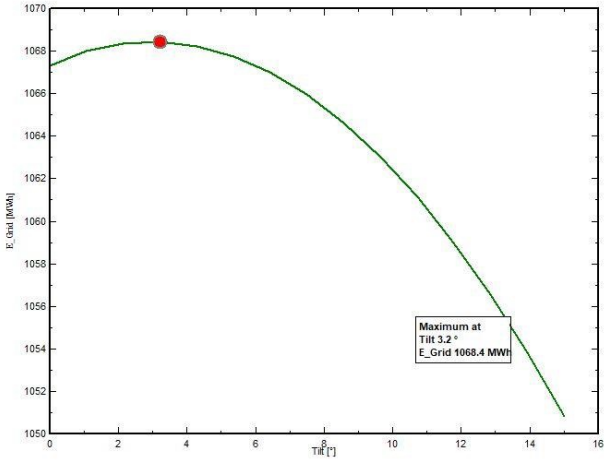


Figure 9: Simulated Strathmore University Solar PV system annual optimized tilt angle

As seen in figure 8, the energy yield values for this system at azimuth 0^0 with tilt angles ranging between 0^0 and 15^0 varies from 1051 MWh/Yr to 1068 MWh/Yr. The annual global horizontal irradiation ranged between 2136 to 2168 kWh/m^2. The annual optimized tilt angle for this Solar PV system was estimated at 3.2^0 as shown in figure 9. At this optimum angle, the annual energy tied is 1068.4 MWh/year. These results agree with findings from other studies. The variance is due to the different latitude locations. For instance, Sugirianta *et al.* (2020) carried out research on tilt angle optimization of 300 Wp solar panel at

Bukit Jimbaran area of Bali with a latitude of -8.805' and found out that the tilt angle with highest energy value for the fixed solar photovoltaic systems was 12^0 to 18^0. Numerous studies done on optimizing the tilt angle for solar photovoltaic systems installed in a given region shows that optimized tilt angles are close to the location's latitude (Dominic, 2017; Hailu and Fung, 2019; Kumar, 2011). Therefore, the optimization simulation findings for Strathmore University system agree with other scholars.

3.2 Experimental Results

3.2.1 Experimental Validation

The experimental analysis was done to validate the 600 kWp grid tied solar PV system optimal tilt angle simulation analysis. The simulation depicted an optimal tilt angle of 3.2^0. The simulated results for 600 kWp solar PV system were scaled down to match the experimental model of 20 Wp solar PV module under investigation between 0900hrs and 1600hrs. The estimated simulated total energy output for 20W solar PV system for 4^0, 11^0 and 15^0 tilt angles were 97.5, 96.89 and 95.98 Wh respectively. The experimental energy yielded by the 20 W panel at a tilt angle of 4^0,11^0 and 15^0 was 108.26, 110.91 and 103.18 Wh respectively. Although the optimized tilt angle under simulations reported 3.2^0 as the most optimal, the variation between 3.2^0 tilted solar Panel and 11^0 tilted solar PV panel under the simulation depicted a percentage variation of 0.695 %. This percentage variation is very small and therefore justifies the experimental findings of 11^0 tilted solar PV panel as the optimal tilt angle. These experimental results are comparable to the simulation results with the small variation justified by the varying environmental conditions in the outdoor settings. The RMSE values for the measured and simulated values for 4^0,11^0 and 15^0 tilted panels was 0.01076, 0.01402 and 0.0072 respectively. These values are very close to zero i.e., within acceptable range of $0 < RMSE \leq 0.3$ and thus shows high correlation and accuracy between the experimental and simulated results. This variation was caused by the impact of the fluctuating external environmental factors as compared to the standard conditions in the simulation setting. In addition, the Mean Absolute Error for the observations obtained for 4^0,11^0 and 15^0 tilted panels was 0.01076, 0.01402 and 0.0072 respectively. These values are within the acceptable range of $0 < MAE \leq 0.1$.

Table 2: Validation results

	4 Degrees	11 degrees	15 Degrees
Annual Energy yield (MWh/Yr)	1068	1061	1051
Global on collector Plane (kWh/m2)	2168	2155	2136
Simulated Energy Yield (kWh)	0.0975	0.0969	0.0960
Experimental Energy yield (kWh)	0.1083	0.1109	0.1032
Mean Absolute Error	0.01076	0.01402	0.0072
RMSE	0.01076	0.01402	0.0072

From the experimental validation done, solar panel at 11^0 tilt angle was the most optimal with highest energy yield of 110.91 Wh for the specified duration (0900hrs-1600hrs). The small variation from the simulated energy output values was attributed to other external environmental factors in the experimental location.

Conclusion

The Strathmore University's 600 kWp Grid tied solar PV system tilt angle optimization analysis was done. Although the simulation results reported an optimal tilt angle of 3.2^0, the experimental validation analysis found that 11^0 tilted Solar PV module was the most optimal with energy yield of 110.91 Wh. Therefore, it was concluded that 11^0 tilted solar modules will exhibit optimal power performance. It was concluded that by increasing tilt angle by 4^0 i.e., from 11 to 15 degrees, the energy yield drops by 6.97%. The variance between the simulated and experimental analysis was due to other environmental variations which were not fully accounted for in the simulations. The salient finding on the Strathmore University solar photovoltaic system's overall performance optimization analysis done provided a feasible solution for optimal power generation for other institutions in the country and off-grid areas.

Acknowledgments

The authors express gratitude to Strathmore University for authorizing access to their grid-tied system, the Energy Technology department for technical support, and the Germany BMZ for the DAAD scholarship granted to Emmanuel Ayora.

References

1. Babatunde, A. A., Abbasoglu, S., & Senol, M. (2018). Analysis of the impact of dust, tilt angle, and orientation on the performance of PV Plants. *Renewable and Sustainable Energy Reviews*, *90*, 1017–1026. https://doi.org/10.1016/j.rser.2018.03.102

2. Dominic Ekanem, O. (2017). Determination of Optimal Tilt Angle for Biannual Seasonally Adjusted Flat-Plate Photovoltaic Modules Based on Perez Transposition Model. *American Journal of Software Engineering and Applications*, *6*(3), 85. https://doi.org/10.11648/j.ajsea.20170603.15

3. *GoogleEarth*.(2022). https://earth.google.com/web/data=MjIKMAouChwxVlFYc2hWdmNDRzAySXhpRWdGRUc5TnVabTNjEgwKCjNINmYwNTAxXzAgAg?authuser=0

4. Hailu & Fung. (2019). Optimum Tilt Angle and Orientation of Photovoltaic Thermal System for Application in Greater Toronto Area, Canada. *Sustainability*, *11*(22), 6443. https://doi.org/10.3390/su11226443

5. Khasawneh, Q. A., Damra, Q. A., & Bany Salman, O. H. (2015). Determining the Optimum Tilt Angle for Solar Applications in Northern Jordan. *Jordan Journal of Mechanical & Industrial Engineering*, *9*(3).

6. Khoo, Y. S., Nobre, A., Malhotra, R., Yang, D., Rüther, R., Reindl, T., & Aberle, A. G. (2013). Optimal orientation and tilt angle for maximizing in-plane solar irradiation for PV applications in Singapore. *IEEE Journal of photovoltaics*, *4*(2), 647-653.

7. Kumar, A., & Thakur, N. S. (2011). OPTIMIZATION OF TILT ANGLE FOR PHOTOVOLTAIC ARRAY. *International Journal of Engineering Science and Technology*, *3*(4), 9

8. Prasad, B. K. K., Reddy, K. P., Rajesh, K., & Reddy, P. V. (2020). Design and simulation analysis of 12.4 kWp grid connected photovoltaic system by using PVsyst software. *International Journal of Recent Technology and Engineering*, *8*(5), 2859-2864.

9. Salih, S. M., & Kadim, L. A. (2014). Effect of tilt angle orientation on photovoltaic module performance. *ISESCO Journal of Science and Technology*, *10*(17), 19-25.

10. Sugirianta, I. B. K., Sunaya, I. G. A. M., & D Saputra, I. G. N. A. (2020). Optimization of tilt angle on-grid 300Wp PV plant model at Bukit Jimbaran Bali. *Journal of Physics: Conference Series*, *1450*, 012135. https://doi.org/10.1088/1742-6596/1450/1/012135

PICTORIAL

Rt. Hon. Raila Odinga met with the IEK Council, led by President Eng. Shammah Kiteme, to discuss key matters on the welfare of the engineering community and professional development. The council also highlighted the growing representation of women in engineering.

Rt. Hon. Raila Odinga met with the IEK Council, led by President Eng. Shammah Kiteme, to discuss vital issues concerning the welfare and professional development of the engineering community. The council also celebrated the increasing representation of women in engineering, showcasing a more diverse and inclusive leadership.

The IEK Council courtesy call to the Engineers Board of Kenya (EBK). The joint meeting marked a significant step in strengthening regulatory frameworks, training opportunities, and a unified scheme of service for engineers. This collaboration reinforces on the shared commitment to advancing integrity and excellence in the engineering profession.

IEK Council members recently met with Dr. Eng. John Mativo, MBS, MD of KETRACO, to strengthen their partnership. IEK President Eng. Shammah Kiteme thanked Dr. Mativo for his mentorship at the Future Leaders Dinner. Discussions focused on the 31st IEK International Convention theme, "Industrialization for Economic Transformation," with key insights on affordable power, green energy, and the blue economy. Dr. Mativo emphasized engineers' role in supporting Kenya's industrial growth through innovative strategies to enhance power efficiency and unlock new opportunities.

The IEK Council recently visited the Geothermal Development Company (GDC), reinforcing their partnership that has boosted engineer registration at GDC. Recognized for its sustainable energy leadership, GDC's innovations in slim hole drilling technology highlight its pivotal role in geothermal power.

Balancing Safety and Sustainability in Mining

By EiK Correspondent

Mining is vital for modern society, supplying essential materials for infrastructure and technology. However, the industry must address the challenges of ensuring worker safety while minimizing environmental impact. This article examines how mining can balance these priorities effectively.

Ensuring Worker Safety

Mining remains one of the most hazardous professions globally, characterized by risks such as exposure to harmful substances, heavy machinery accidents, and unstable geological conditions. Historically, the industry's safety record has been marred by numerous incidents, highlighting the urgent need for enhanced protection measures.

To address these risks, mining companies are increasingly adopting advanced safety technologies and practices. The introduction of autonomous machinery and remote-controlled equipment is a significant advancement, reducing the need for workers to operate directly in perilous conditions. These technologies not only protect workers but also enhance operational efficiency.

Additionally, modern mining operations implement rigorous safety protocols, including regular training programs and comprehensive safety audits. Innovations such as real-time air quality monitoring and advanced ventilation systems help manage environmental hazards, ensuring that conditions remain safe for miners.

Environmental Sustainability in Mining

The environmental footprint of mining is substantial, with concerns ranging from deforestation and habitat destruction to water pollution and soil erosion. Addressing these issues requires a commitment to sustainable practices that minimize ecological disruption.

One effective strategy involves reducing the environmental impact of mining operations through precise planning and land management. This includes minimizing the extent of land disturbance and implementing effective reclamation practices to restore affected areas. Reclamation efforts often involve reforestation, soil rehabilitation, and the restoration of water systems, helping to reverse some of the damage caused by mining activities.

Moreover, mining companies are increasingly focused on reducing their consumption of water and energy. Technologies such as dry stacking for tailings management and the use of renewable energy sources are becoming standard practices. These measures not only decrease the environmental impact but also contribute to the overall efficiency of mining operations.

Harmonizing Safety and Sustainability

Achieving a balance between worker safety and environmental sustainability requires a comprehensive approach. Technology plays a pivotal role in this endeavor, offering solutions that address both concerns simultaneously.

For example, real-time data analytics and monitoring systems can provide valuable insights into environmental conditions and potential hazards. By utilizing this data, mining companies can implement proactive measures to prevent accidents and mitigate environmental damage. Predictive maintenance technologies further enhance safety by identifying and addressing potential equipment failures before they result in incidents.

Cultivating a culture of safety and environmental stewardship is also essential. Engaging workers in safety and sustainability initiatives fosters a shared sense of responsibility. When employees understand the impact of their actions on both their well-being and the environment, they are more likely to contribute to achieving the company's safety and sustainability goals.

Examples from the Industry

Several mining companies exemplify successful integration of safety and sustainability. For instance, Rio Tinto's "Mine of the Future" program highlights the use of autonomous trucks and drones. These technologies reduce human exposure to dangerous conditions while minimizing environmental disturbance through precise and efficient operations.

Newmont Corporation's approach to tailings management and reclamation serves as another noteworthy example. By investing in advanced tailings storage techniques and emphasizing long-term stability, Newmont enhances both worker safety and environmental protection. Their commitment to innovative practices demonstrates how mining can evolve to meet contemporary safety and sustainability standards.

Conclusion

The pursuit of a balance between safety and sustainability in mining presents a complex but crucial challenge. By embracing technological advancements, implementing sustainable practices, and fostering a culture of responsibility, the industry can make significant strides. The path forward involves a continuous commitment to both the protection of workers and the preservation of the environment, ensuring that mining remains a valuable and responsible contributor to society's needs.

Shaping the Future of Mining Engineering: Insights and Innovation From Taita Taveta University (TTU), the Home of Ideas

Dr. Alunda Bernard Ouma (Ph.D)
Dean, School of Mines and Engineering
Taita Taveta University

What unique approaches is Taita Taveta University employing to enhance the Mining and Mineral Processing Engineering curriculum?

Taita Taveta University (TTU) has taken a more multidisciplinary approach to enhancing its curriculum for Mining and Mineral Processing Engineering. It has been nearly 17 years since the introduction of this programme, during which time it has undergone significant refinement to suit the industrial demands.

At the programme's inception, the university brought in professionals from around the world to provide a more enriched learning experience for the students. Today, we have a first generation of lecturers, many of whom have accessed their education from abroad (Korea, Australia, Germany, Japan, China, South Africa and the USA), bringing world-class knowledge and experience to our lecture halls.

We review our curriculum periodically to align it to the industry's demands. These reviews incorporate inputs from different stakeholders, including the Engineering Board of Kenya (EBK) and alumni who work in diverse sectors both locally and internationally. They all provide invaluable input towards creating a more robust and up-to-date curriculum.

Moreover, some of our course units are co-taught by local and international partners from Germany, Ghana, India, the United Kingdom and Zambia, whose input has given our curriculum a more global perspective. One of our partnering German universities with whom we co-teach, TU Bergakademie Freiberg, is one of the oldest mining universities in the world having been founded over 250 years ago. Employers within the Mining and Mineral Processing sector also provide crucial inputs particularly when it comes to addressing any gaps arising due to technological advancements and world trends in natural resources management.

Our program is anchored strongly in emerging technologies and trends. Current course offerings include Artificial Intelligence (AI), Machine Learning (ML), computer application and sustainability in mining. Our partners have played a major role in providing some of the hardware and software needed for computer application learning and instruction.

Can you share some of the key innovations or research projects currently being developed within the School of Mines and Engineering?

The Department of Mining and Mineral Processing Engineering (MMPE) is working on a "lithium extraction project" geared toward innovative extraction and processing of locally available lithium deposits. To address the shortage and overreliance on imported copper, we are developing a copper extraction plant to extract and process copper deposits. These projects bring academia and industrial partners together to innovatively exploit local ore deposits

Several of our students' innovations have, in fact, been patented, including a technology that utilises radio waves to facilitate industrial operations. Prolonged exposure to certain mining processes and direct interaction with machinery may pose safety risks, and it is in this context that the technology proves invaluable, enhancing both worker safety and machine efficiency.

The intelligent connected quarry system innovation, utilizes sensors to optimize operations like loading and allows for remote monitoring of processes. Load cells are used to measure conveyor loads, temperature sensors detect potential bearing failures, and a controller measures variations in resistance to determine the system's actual power factor. The collected data is then processed to provide valuable insights to managers, helping to prevent theft and mismanagement of the quarry.

Another innovation is the truck auto-loading system, using conveyors and weighbridges which greatly improves efficiency, safety, and accuracy in quarry operations. It reduces emissions, maintenance, and human error while enhancing accountability and minimizing theft. With data collection for monitoring and optimization, the system also cuts costs by boosting efficiency and lowering labor expenses.

In collaboration with our German university partner, TU Bergakademie Freiberg, our doctoral students have developed several disruptive innovations, namely:

Creation of a new 3D constitutive model for evaluating the factor of safety and extraction ratios in mines;

Development of the first integrated, regional-scale, and multisector mine planning model – a scalable and replicable dynamic simulation model and multicriteria spatial decision support system focused on strategy and policy design for long-term sustainability in the mining sector, branded the Taita-Taveta Integrated Mine Planning Model (TIMPM);

Development of concrete products capable of absorbing carbon dioxide while enhancing strength; and the invention of a device that utilises diatomite to remove heavy metals from mine water

The University is developing a cost-effective gemmological microscope to support artisanal and small-scale miners, alongside an advanced Atomic Force Microscope (AFM) for precise analysis of mineral crystal structures. The AFM will enable the identification of optimal processing and refining techniques at the nanoscale level.

How does the university ensure that its graduates are well-prepared to meet the challenges of the rapidly evolving mining industry in Kenya and beyond?

Through student exchange programmes in collaboration with our German and Canadian partners, we have facilitated our students to international academic networking events, world-class teaching facilities and research hubs. Our students participate in mining competitions such as mining bootcamps to sharpen their skills and exchange new knowledge. Moreover, students work closely with our staff in preparation and participation in conferences and our bimonthly seminars which draw industry practitioners and academia worldwide for knowledge-sharing opportunities. Under a robust attachment policy, TTU encourages rigorous experimentation during industrial attachment. This has resulted in innovation and creativity that have developed practical skills. Many students often secure job offers from companies where they intern, enhancing their transition from academic life to professional work.

Students participate in industrial research projects in areas like mine safety, environmental sustainability, resource optimization, or new mining technologies. In most cases, they have access to operational mines, field data, and case studies, enriching the university's research and helping students conduct more practical and impactful research projects. Engaging in this kind of research enhances students' analytical skills and contributes to innovation in the sector.

What role does industry collaboration play in the education and training of mining engineering students at Taita Taveta University?

Industry collaboration is the cornerstone of our training that bridges the gap between academic learning and the practical realities of the mining sector. Our mining industry partners such as Base Titanium Limited (BTL), Classic Gems East Africa Limited, African Diatomite Industries Limited (ADIL), Voi Gemstone Value Addition and Marketing Centre, Mombasa Cement, Karsan Ramji & Sons Limited, Homa Lime Company Limited, and Kenya Chamber of Mines (KCM) corporate members, have given our students tangible internship opportunities to gain industrial experience and shape our training. Our collaboration incorporates student and staff exchange, industrial attachment and joint research. It is through university and industrial collaborations that led to the Artisanal and Small-Scale Miners (ASM) from Taita Taveta County to travel to Germany for benchmarking and exchange of knowledge in the world-known Munich Show and Idar-Oberstein gemstone trade fair. The trip provided them access to the latest technologies, market for their products and network connections. TTU regularly invites professionals from the mining industry to deliver guest lectures (under the bimonthly postgraduate seminar series) and conduct workshops. These sessions expose students to the latest trends, challenges, and innovations in the field, providing them with experiences that go beyond theoretical learning.

How is the University integrating sustainability and environmental stewardship into its mining engineering programs?

Sustainability is deeply integrated into our training through interdisciplinary learning which incorporates subjects from environmental engineering. The students gain a comprehensive understanding of how mining activities affect ecosystems and communities. We have developed an outreach program to promote awareness of sustainable mining practices and to understand the social impacts of mining activities, fostering a sense of responsibility among Artisanal and Small-Scale Miners(ASM) and also our students.

A new and modern unit, Sustainability in Mining, has since 2022 been offered under the revised mining engineering curriculum to acquaint our students with sustainability concepts and principles and with environmental stewardship imperatives in the mining sector. This novel unit was a product of collaborative research and lessons from a joint field project involving artisanal and small-scale miners in Taita Taveta, led by Taita Taveta University and the University of Nottingham (UK). This project, in conjunction with the County Government of Taita Taveta, developed the Taita Taveta Sustainable Mining Action Plan 2021-2025.

Our mining programme emphasizes data analytics for sustainability where geospatial technologies (GIS) help students analyse environmental data, assess impacts, and develop solutions that promote sustainable mining. Currently, we have advanced our research areas to incorporate Artificial Intelligence (AI) and deep learning that helps analyse mining environmental data. These techniques have been applied to understand and minimise blasting vibrations and rockburst. Our curriculum emphasizes the industry best practices for reducing emissions, managing waste, and rehabilitating mining sites post-extraction. Our staff and students are conducting research on silicon powder and graphene oxide as innovative, eco-friendly reagents for mineral processing, and exploring bio-materials as sustainable alternatives to timber for support structures in mining. These efforts aim to advance sustainable practices and reduce the ecological footprint of the industry.

Could you discuss the importance of practical, hands-on experience for students in the field of mining engineering, and how the university facilitates this?

TTU has maintained close relationships with mining companies where our students undertake industrial excursions and internships. These activities allow mining students to observe real-life mining operations, understand the workflow, and interact with experienced mining professionals. To embrace a competency-based approach to education, TTU has provided laboratories and workshops to ensure students are assessed not only on their theoretical knowledge but also on their

practical skills and ability to handle real-world challenges. This ensures that graduates are job-ready and can meet the practical demands of the mining industry. Furthermore, TTU has collaborated with the German Academic Exchange Service (DAAD) under the Kenyan German Centre for Mining, Environmental Engineering and Resource Management (CEMEREM) project that has sponsored students to access state-of-the-art laboratories at TU Bergakademie Freiberg (TUBAF), Germany. As a university specialising in mining science, TUBAF operates its own research and teaching mine.

Our School of Mines and Engineering (SME) has a well-trained staff who are involved in local and international research and development projects. These projects often include fieldwork and experimentation, giving students a chance to develop innovative mining technologies or sustainable practices that could be implemented in the industry.

How can Taita Taveta University collaborate with the Engineers Board of Kenya (EBK) and the Institution of Engineers of Kenya (IEK) to foster quality engineering education and advance the mining engineering profession?

TTU has initiated collaboration with EBK to ensure the mining engineering programme is accredited by EBK. Further collaboration with IEK will ensure our graduates smoothly transition to professional engineers (PEs) in a well-recognized structure. This improves the credibility of the professional engineers and ensures they meet the requirements of being a member of a professional body during any hiring process.

By collaborating with IEK and EBK, TTU will enhance the mining curriculum to align with local and international standards of engineering education, thereby enhancing the credibility of the mining engineering programs. Furthermore, IEK can help integrate mining industry-relevant skills and emerging technologies into the programmes.

Our collaboration will encourage industry-academic forums, where industry players and academia will discuss opportunities and challenges. This fosters stronger relationships and ensures that TTU remains responsive to industry needs.

EBK and IEK will guide the mining students and graduates on the engineering ethics and regulations landscape. This will ensure they adhere to the highest ethical standards in mining and engineering practices. They will be well prepared to ensure safety compliance, environmental protection, and community engagement.

It takes a lot of resources from the Kenyan government to train a single mining engineer to an international standard. The EBK and IEK should advocate for world-class working conditions for engineers in the Kenyan market. This would help cushion the country against the excessive outflow of engineers to the international market while maintaining quality infrastructure that accelerates economic growth. Through research and development, engineers will develop locally tailored technologies to solve the ever-evolving challenges.

SME Teaching and Research Facilities: Foundry Workshop

CEMEREM: Geomatics & Surveying Equipment

Pipe laser: precise alignments/partitioning

Automatic level: H, slope measurements

SME Teaching and Research Facilities:

Summer School, Dresden, Germany, 2023

CEMEREM: Digitalization – South Africa E-Learning Development Training at Nelson Mandela University

Picture: Courtesy

Mining Equipment and Maintenance: An Analysis of Optimization for Efficiency

By EiK Correspondent

In the demanding mining industry, operational efficiency hinges on the performanceand maintenance of equipment. Proper maintenance and optimization are key to boosting productivity, minimizing downtime, and ensuring safety. This article discusses various mining equipment, their maintenance needs, and strategies for achieving operational efficiency.

1 Overview of Mining Equipment

Mining operations utilize a wide array of equipment, each designed for specific tasks.Key types of mining equipment include:

a. **Excavators and Shovels**: These are used for digging and moving material. Excavators are versatile and can be used in various mining environments, while shovels are typically used in surface mining to handle large volumes of material.

b. **Haul Trucks**: Essential for transporting ore and waste materials from the mining site to processing facilities or waste dumps. They come in various sizes, from smaller trucks for narrow operations to massive haul trucks for large-scale mining.

c. **Drills**: Used for creating holes in the rock to place explosives for breaking up the ore. Drills can be rotary or percussion, depending on the hardness of the rock and the specifics of the mining operation.

d. **Loaders**: These machines load material into trucks or onto conveyors. Loaders arecrucial in both underground and surface mining to ensure efficient materialhandling.

e. **Crushers and Mills**: Crushers break down large rocks into smaller pieces, while mills further reduce the size of ore to prepare it for processing. These are critical for ore preparation and extraction.

2 Maintenance of Mining Equipment

Effective maintenance is key to extending the life of mining equipment and ensuringreliable performance. Maintenance strategies generally fall into one of three categories:

i. **Preventive Maintenance**: This involves regular, scheduled maintenance activities designed to prevent equipment failures before they occur. It includes routine inspections, lubrication, and parts replacement. For example, scheduled oil changes and filter replacements are standard preventive measures for haul trucks.

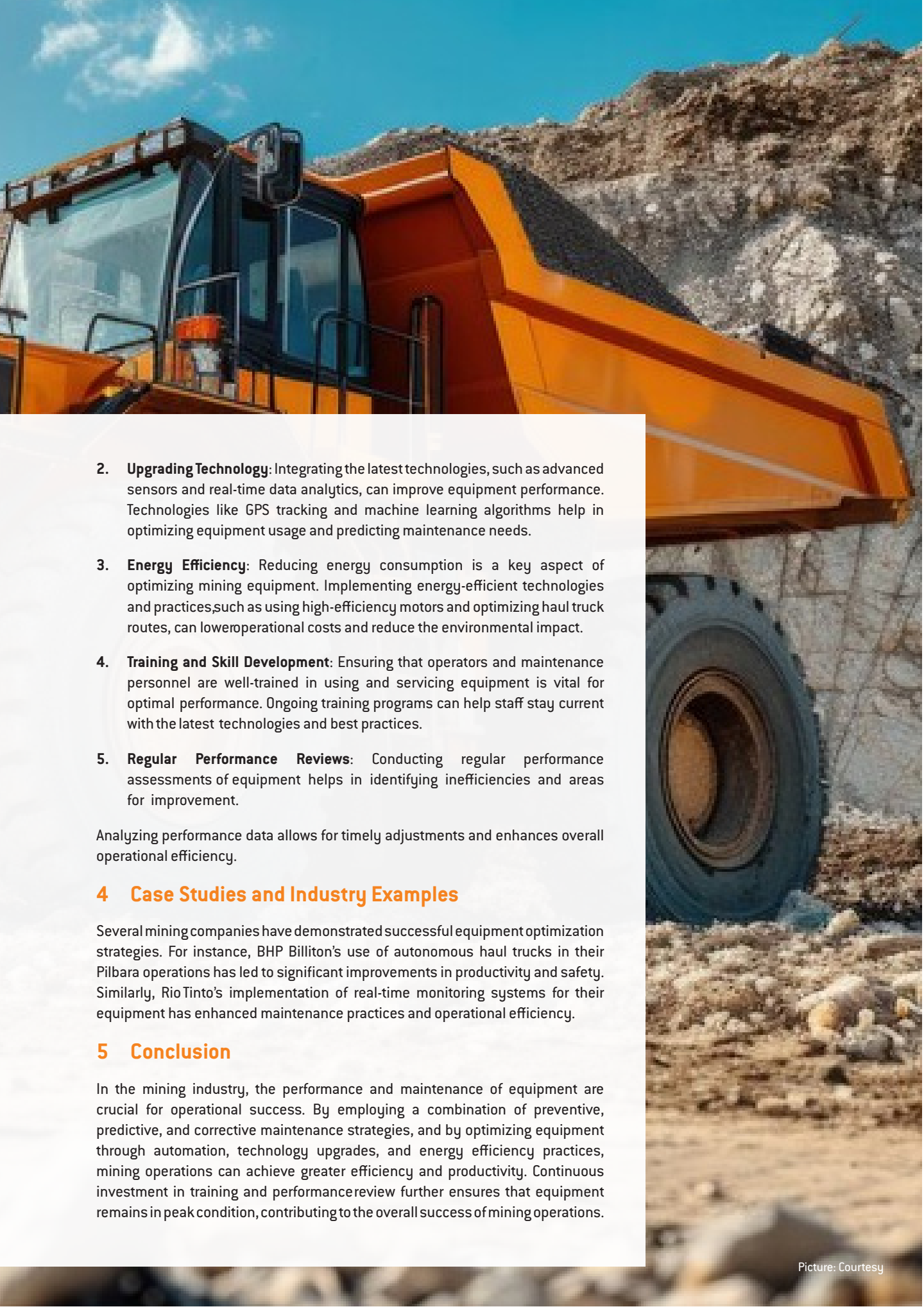
ii. **Predictive Maintenance**: Using data and technology to predict when equipment will need maintenance before a failure happens. Techniques such as vibration analysis, thermography, and oil analysis help in identifying potential issues. Predictive maintenance can reduce unexpected breakdowns and extend the operational life of equipment.

iii. **Corrective Maintenance**: This type of maintenance is performed after equipmenthas failed. While necessary, corrective maintenance can lead to costly downtimes and unplanned expenses. It's generally less desirable than preventive or predictive maintenance because it disrupts operations.

3 Optimization for Efficient Operations

Optimizing mining equipment involves several strategies to enhance performance, increase efficiency, and reduce operational costs:

1. **Automation**: The use of automated systems, such as autonomous trucks and remote-controlled drills, can significantly improve efficiency and safety. Automation reduces human error, enhances precision, and allows for continuous operation even in hazardous conditions.



2. **Upgrading Technology**: Integrating the latest technologies, such as advanced sensors and real-time data analytics, can improve equipment performance. Technologies like GPS tracking and machine learning algorithms help in optimizing equipment usage and predicting maintenance needs.

3. **Energy Efficiency**: Reducing energy consumption is a key aspect of optimizing mining equipment. Implementing energy-efficient technologies and practices,such as using high-efficiency motors and optimizing haul truck routes, can loweroperational costs and reduce the environmental impact.

4. **Training and Skill Development**: Ensuring that operators and maintenance personnel are well-trained in using and servicing equipment is vital for optimal performance. Ongoing training programs can help staff stay current with the latest technologies and best practices.

5. **Regular Performance Reviews**: Conducting regular performance assessments of equipment helps in identifying inefficiencies and areas for improvement.

Analyzing performance data allows for timely adjustments and enhances overall operational efficiency.

4 Case Studies and Industry Examples

Several mining companies have demonstrated successful equipment optimization strategies. For instance, BHP Billiton's use of autonomous haul trucks in their Pilbara operations has led to significant improvements in productivity and safety. Similarly, Rio Tinto's implementation of real-time monitoring systems for their equipment has enhanced maintenance practices and operational efficiency.

5 Conclusion

In the mining industry, the performance and maintenance of equipment are crucial for operational success. By employing a combination of preventive, predictive, and corrective maintenance strategies, and by optimizing equipment through automation, technology upgrades, and energy efficiency practices, mining operations can achieve greater efficiency and productivity. Continuous investment in training and performancereview further ensures that equipment remains in peak condition, contributing to the overall success of mining operations.

Picture: Courtesy

Resource Management and Optimization in Mining: Techniques for Managing and Optimizing Mineral Resources in Kenya

By EiK Correspondent

Picture: Courtesy

Mining is one of Kenya's most important sectors, contributing significantly to the national economy. Our country is endowed with a wide range of mineral resources such as gold, titanium, limestone, soda ash, and rare earth elements. However, as global awareness grows about the environmental and social impacts of mining, the mining sector faces increased pressure to adopt more sustainable practices. Effective resource management and optimization techniques can not only maximize recovery rates of minerals but also minimize waste, environmental damage, and operational costs.

These are some key techniques for managing and optimizing mineral resources that if effectively employed, will result in profound economic and environmental benefits.

Geological Survey and Mapping

Before any mining activity can commence, a comprehensive understanding of the geological features of a mining site is essential. Geological surveys and mapping help identify the concentration, grade, and distribution of minerals.

In Kenya, the use of advanced geophysical and geochemical survey techniques is becoming increasingly common. These methods provide more precise data on mineral deposits, helping mining companies target their efforts more effectively.

Modern mapping technologies, such as Geographic Information Systems (GIS), are particularly helpful in creating detailed maps that integrate various data sources.

By ensuring a more accurate identification of mineral-rich zones, these techniques allow mining operations to focus on high-yield areas, reducing unnecessary excavation and minimizing the environmental footprint of the mining process.

Selective Mining and Grade Control

Selective mining is an essential technique for optimizing mineral recovery while minimizing waste. It involves extracting only high-grade portions of a mineral deposit while leaving behind less valuable material.

This approach can significantly enhance the efficiency of mining operations, ensuring that companies extract as much useful material as possible from a given site.

In Kenya, especially in gold and gemstone mining, selective mining is critical. Grade control, which involves regular sampling and testing of ore, allows mining operations to adjust their extraction methods dynamically.

Accurately identifying the grade of ore in real time helps mining companies avoid processing large volumes of low-grade material, thereby reducing operational costs and waste.

In-situ Leaching (ISL)

In-situ leaching (ISL) is an innovative method used in some mining operations to minimize waste and reduce environmental disruption. ISL involves injecting a solution into the ground to dissolve valuable minerals without the need for extensive surface excavation. The solution, containing the dissolved minerals, is then pumped to the surface for recovery. This method is particularly effective for extracting minerals like uranium and copper.

Though ISL has yet to gain widespread adoption in Kenya, its potential for reducing the environmental impact of mining operations cannot be overlooked.

This avoiding of large open-pit mines through ISL can help conserve natural landscapes, reduce waste, and lower energy consumption during extraction, making ISL adoption a step toward more sustainable practices, particularly as the demand for copper and other minerals grows.

Tailings Management and Recycling

One of the major challenges in mining is managing tailings, the waste material left over after the desired mineral has been extracted from the ore. Tailings often contain toxic substances such as heavy metals, which can pose serious environmental risks if not properly managed. In Kenya, where gold mining and soda ash extraction are prominent, tailings management is a critical concern.

The introduction of more sophisticated techniques such as dry stacking, thickened tailings, and tailings reprocessing can greatly reduce environmental hazards. Dry stacking, for instance, involves removing most of the water from tailings before stacking them in a stable configuration, reducing the risk of dam failures. Tailings reprocessing, on the other hand, involves retreating tailings to extract additional minerals that may have been left behind during the initial processing.

In many cases, tailings still contain a considerable amount of valuable minerals. Reprocessing tailings will result in mining companies recovering more minerals, thereby improving resource utilization and reducing the overall waste generated by their operations, therefore mitigating some of the environmental concerns associated with mining.

Water Resource Management

Mining operations often require large amounts of water for mineral processing, dust suppression, and equipment cooling. However, inefficient water use can lead to shortages, especially in regions where water is scarce. In Kenya, managing water resources is a key challenge for the mining industry, particularly in arid regions like Turkana and Kitui where water is already a limited resource.

One approach to optimizing water use is the implementation of closed-loop water systems. These systems recycle water used in mining operations, reducing the overall consumption and minimizing wastewater discharge. Additionally, the treatment of wastewater for reuse can significantly reduce the environmental impact of mining operations.

The adoption of water-saving technologies and strategies is particularly important for Kenyan mining companies, especially as water scarcity becomes an increasingly pressing issue due to climate change. Proper water management not only reduces operational costs but also helps mining companies comply with environmental regulations and maintain a social license to operate.

Energy Efficiency and Renewable Energy Integration

Energy is one of the largest operating costs in mining, and reducing energy consumption is critical for both economic and environmental sustainability. Optimizing energy use through more efficient equipment, automation, and process control systems can significantly lower operational costs.

Kenya's energy mix includes geothermal, hydroelectric, and solar power, thus, integrating renewable energy into mining operations can provide a dual benefit: reducing carbon emissions and lowering electricity costs. Renewable energy solutions such as solar-powered crushers or geothermal-powered processing plants could play a crucial role in making Kenyan mining operations more sustainable.

Some mining companies are already exploring the use of hybrid power systems that combine renewable energy with traditional power sources. These systems not only enhance energy efficiency but also improve the reliability of power supply in remote mining areas.

Mine Rehabilitation and Reclamation

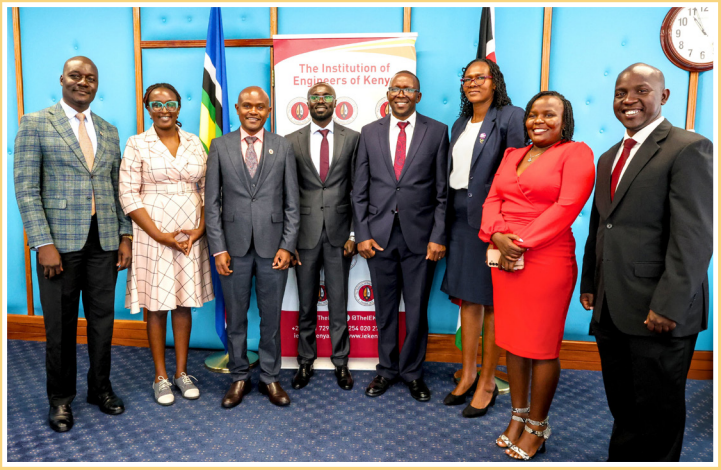
After a mining site has been exhausted, proper rehabilitation and reclamation are essential to mitigate long-term environmental damage. This involves restoring the land to its natural or economically usable state. In Kenya, where mining operations often take place in ecologically sensitive areas, such as the Taita-Taveta gemstone mines or titanium-rich Kwale region, post-mining rehabilitation is crucial for environmental sustainability.

Reclamation techniques include re-vegetation, soil restoration, and water management. These practices can help prevent soil erosion, promote biodiversity, and reduce the impact on local communities.

Conclusion

The future of mining in Kenya hinges on the ability of the industry to adopt sustainable and efficient resource management techniques. Through advanced geological surveying, selective mining, innovative waste management solutions, and energy-efficient technologies, Kenya can maximize its mineral recovery while minimizing waste and environmental impact.

PICTORIAL



The Institution of Engineers of Kenya (IEK) Council, led by President Eng. Shammah Kiteme, met with Cabinet Secretary for Water, Sanitation, and Irrigation, Eng. Eric Mugaa, to discuss the urgent need for increased investment in Kenya's water sector and modernization of sewer systems. Eng. Kiteme emphasized the importance of local engineers in Public-Private Partnerships (PPPs), called for amendments to the Water Act to ensure qualified engineers hold key leadership roles, and both parties committed to strengthening collaboration for sustainable water solutions.

IEK President,Eng. Shammah Kiteme presents the latest edition of the African Journal of Engineering Research and Innovation (AJERI) to Permanent Secretary for the State Department for Investment Promotion, under the Ministry of Investment, Trade, and Industry, Ps. Abubakar Hassan Abubakar.

The IEK Council recently met with Eng. Maurice Akech, Executive Director of the National Construction Authority (NCA), to discuss partnerships aimed at enhancing safety, quality, and capacity building in Kenya's construction industry. Eng. Akech acknowledged the critical advocacy role of IEK in promoting engineers and emphasized the need for collaboration between NCA and stakeholders like IEK to improve safety and quality standards.

Eng. Akech also highlighted ongoing initiatives to strengthen the regulatory framework for performance-rated tools to tackle non-performing contractors. He announced NCA's plans to develop new inspection manuals and handbooks, supported by IEK, and stressed the importance of professional associations in raising awareness of the upcoming Building Code, set for implementation in March 2025. IEK President, Eng. Shammah Kiteme, reaffirmed the commitment to ensuring Kenyan engineers lead national infrastructure projects and emphasized that partnerships, such as with NCA, are crucial for their active involvement.

Role of Mining in Kenya's Economy, Employment and GDP.

By EiK Correspondent

Kenya evaluated its potential in mineral resources and came up with a working paper in the year nineteen ninety-nine, where more than 400 mineral occurrences were established. The government enacted laws to catalyze this sector. It is impossible to mention Kenya's economic progress without mentioning this industry. Growth in this area is anticipated will help in the creation of employment opportunities, increase in earnings of the employees, and the GDP of the country. The 2010 Constitution established Counties and endowed them with the power to formulate and implement their development plans. This recent development is compelling Counties to do resource mapping and resource mobilization for local development. The resources differ from County to County and are relative to the topography, drainage, ecology, and weather of the County.

Kenya has been particular about its mining laws and in doing so, the laws on mining were revised in the year twenty sixteen due to the Mining Act which was viewed as a breakthrough new young law that looked forward to transforming the mining sector. This has enhanced the growth prospects of the mining sector in Kenya which is projected to be the primary driver of industrial growth.

At the start of this year, the Kenya Chamber of Mines Chairman, Kanyoro Patrick, wrote an open letter to President William Ruto. In it, he said ending the moratorium and starting the Mineral Rights Board would help process applications for various mineral rights.

"When we issue prospecting and mining licenses and permits on time, we'll attract both local and foreign investors. This will change the sector. We're sure our industry can boost its contribution to Kenya's GDP to 10%, over $10 billion (Sh1.6 trillion) well before 2030," Kanyoro explained. He also thanked the Kenya National Chamber of Commerce and Industry for leading efforts to revive Kenya's mining sector. Their partnership, he said, would benefit both local and international markets. Kanyoro further added that the Kenya Chamber of Mines continues to push for favorable conditions to develop the mining sector.

Recently, President William Ruto reported that Kenya has drawn Sh157.4 billion ($1 billion) in investments after it made changes to its mining sector to make it a key part of economic growth. Also, mining has helped Kenya reach its wider goals for the industry by giving key raw materials to many businesses. This grows the economy and helps build up infrastructure and other areas. The mining sector in Kenya could create many jobs and boost industry. New findings show it might create over two million jobs, both in mining work itself and in related fields like moving goods and energy. As more young people in Kenya can't find work, talks have started on social media on X (once called Twitter) where young folks have pointed out what mining could do.

Topics like *"Minerals in Kenya that Don't Belong to Kenyans"* and *"Is Kenya Poor by Choice or by Design?"* have caught young people's interest showing mining as a way to free up the economy.

"Youths in Mining" has become a strong idea showing a generation ready to use the country's mineral wealth to bring unity and fairness. Many of Kenya's areas rich in minerals, like Turkana, West Pokot, Baringo, Moyale, and Isiolo to name a few, face tough weather and hard-to-reach places. Our nation's huge wealth needs teamwork across all ages to provide the needed resources and skills. Young experts such as mining engineers, geologists, and mapping specialists, have formed groups like the Mining Engineers Society of Kenya (MESK) and the Geology Society of Kenya (GSK). They stand ready to use their know-how to boost the country's economy through mineral use. Jobs remain a big issue in Kenya, but new youthful trained generation of skills bring key skills and a professional approach to the mining sector.

The vast unexploited mineral resources in Kenya present a major opportunity for economic development and job creation. Nonetheless, the environmental impacts of mining in the region cannot be neglected. Mineral extraction processes require a well-adjusted approach that considers both sustainability and economic returns. The mining industry and government stakeholders must adopt sustainable technologies while prioritizing responsible mining practices. All-inclusive and collaborative steps are necessary for harnessing Kenya's potential mineral wealth while protecting the delicate balance of its environment

Revisiting Kenya's Key Mining Sites: Updates on Fluorspar Mines, Magadi Soda, Base Titanium, and Diatomite Mining in Nakuru

By EiK Correspondent

Although not one of the top producers of minerals in the continent, Kenya still features among the mineral-rich countries in Africa. From fluorspar and magadi soda to diatomite and ilmenite, the country's mining sector has always been a mega booster of the economy. It doesn't just end there; this sector also attracts heavy foreign investment which in turn brings in foreign exchange. This explains the seriousness with which the Kenyan government takes this industry, which manifests in the extensive investments in the exploration of mineral sites.

A good place to start exploring Kenya's mining sites would be the fluorspar mines. Fluorspar was discovered at Kerio Valley sometime in the 1960s. Initially, it was mined by a government-owned company, the Fluorspar Company of Kenya. Later in the mid-90s, a Canadian investor got into a 20-year lease deal with the Kenyan government that was to the effect that the investor would exploit the mines, then yield it to the government upon expiry of the lease. The plant was returned to the government upon the lapse of the lease period, and no fluorspar mining has taken place since, as reported by Stephen Rutto in a The Standard article entitled *"UK Firm Invests Sh. 4.8B To Extract Fluorspar in Elgeyo Marakwet."*

Thankfully, fluorspar mining is to be revived shortly, following the close of a deal with an investor who intends to inject Ksh. 4.8 billion into the project, as reported in a Daily Nation article titled "*Kenya Inks Sh. 4.8 Bn Deal To Revive Fluorspar Mining In Kerio Valley*" by Barnabas Bii. According to the deal, the mining activities would take place in Kerio Valley, particularly at Kimwarer, in the Elgeyo Marakwet County. This would mark the end of a 6-year hiatus in fluorspar mining in the area. This deal is projected to generate a boatload of revenue for both the national and county governments.

Picture: Courtesy

Magadi soda is yet another serious player in the Kenya's mining scene. Magadi soda, or soda ash as it is often otherwise referred to, is mined at Lake Magadi in the Rift Valley. Its uses range from making detergents and paper to manufacturing glass and chemicals. As of now, Kenya is home to the largest magadi soda mine in Africa. A Statista report published by Madhumitha Jaganmohan titled *"Global Natural Sodium Carbonate Production 2023, by Country"* reveals that in 2023, Kenya exported a staggering 280,000 metric tons of Magadi soda, making it one of the largest producers of soda ash globally.

As much as Kenya currently enjoys revenue in form of foreign exchange brought in by exporting Magadi soda, we may be set to lose some of those privileges. Since around 2020, experts have been warning that Lake Magadi, the only Magadi soda source in Kenya, may be no more by 2025, as stated in a The Standard article with the title "*Magadi May Die in Five Years, Warn Experts*" by Robert Kiplagat.

According to report by the Kenya National Highways Authority titled *"Geological Study, Feasibility Study, Environmental and Social Impact Study, Preliminary and*

Detailed Engineering Design of Suswa-Mai Mahiu (B7) Road Section" the upper catchment areas of the lake are positioned in such a way that they pose a siltation hazard to it due to soil deposits getting carried into the lake by the surrounding drainage system. If we do not act and arrest the siltation problem as soon as possible, then we might lose one of our most significant foreign exchange earners.

Any discussion about mining in Kenya would not be complete sans the mention of diatomite. Diatomite mining also places Kenya on the map as far as the global diatomite market is concerned. This mineral is primarily mined in the Rift Valley, particularly in the Kokitoin, Kariandusi, and Gilgil areas. With a wide range of uses, including manufacture of fertilizers, filtration devices, and industrial absorbents, diatomite makes a significant contribution to Kenya's mining sector and the economy.

In February 2024, the African Diatomite Industries Limited (ADIL) announced its partnership with Showa Chemical Industry Co. Ltd, a Japanese mining company, via a press statement released by the Kenya National Chamber of Commerce and Industry titled *"Partnership Announcement Between African Diatomite Industries Limited and Showa Chemical Industry Co. Ltd."* This partnership is aimed at boosting Kenya's diatomite production, hence strengthening its position in the global market. Furthermore, this partnership would likely create more opportunities in Nakuru County which houses ADIL's primary mining site.

Equally worth noting in the mining industry are the activities of Base Titanium Limited Company. For over 10 years, this company was mining ilmenite, zircon and rutile in Msambweni Constituency, Kwale County. However, in late 2023, the company announced its intention to close up shop by the end of 2024, according to a Daily Nation article authored by Siago Cece with the title *"Kwale Bids Farewell to Mines as Base Titanium Prepares for Exit."*

This came after a series of exploration activities that revealed lower-grade minerals in the area, a clear indication that the mines had outlived their usefulness. The news of Base Titanium's departure dealt a heavy blow to Msambweni residents, who had heavily benefited from the presence of the Australian company in the area.

As part of its CSR, the company had developed communication centers, water projects, hospitals, and schools, among other social amenities. Additionally, its departure means all the locals employed at the mine would lose their jobs. Despite this profound loss, Base Titanium will be remembered for being environmentally responsible, in that the company has taken it upon itself to rehabilitate the mined areas to restore their usefulness and make them available for other economic activities.

As far as mineral resources go, Kenya is quite rich. Currently, the country has over 900 identified minerals worth billions of dollars, as Mercy Simiyu reports in a Daily Nation article titled *"Survey Reveals Kenya Has Some 970 Minerals."* With adequate regulation and transparency, we could enjoy much higher revenue, both local and foreign, from the mining sector. It is imperative that we push for policies that will ensure we get the most out of our mining sites without over exhausting them.

Picture: Courtesy

The Tullow Oil Saga in Turkana: Delays, Impacts and the Future of Oil Exploration in Northern Kenya

By EiK Correspondent

When Kenya announced that it had discovered oil in Turkana back in 2012, lots of foreign companies were drawn to the possibility of exploration. Big players in the oil and gas industry, such as Total, Exxon, Shell, BP and Chevron only managed to find traces of oil, but Tullow Oil strongly believed there was more than just negligible amounts of it. With this belief, the company injected its resources into extracting oil from the reserves in the hopes that there will be great returns from it.

However, by 2020, it became apparent that the amount of investment Tullow Oil had injected into the venture was not proportionate to the prospect of making money out of it. For starters, the global drop in crude oil prices at that time hit the company so hard that it led to an unprecedented shake-up of the company's top leadership. The shake-up was followed by a Ksh.180.6 billion loss of paper wealth by shareholders of the company. Unfortunately, the ripple effect of the shake-up and the subsequent loss would be company-wide staff cuts that were projected affect up to 300 people, including the employees in Tullow Kenya, to the company's Kenyan subsidiary.

12 years since the initial announcement of oil discovery in Turkana, Tullow Oil does not have much to show as regards its involvement with the mineral in the area, yet. So far, the company has exported two batches of oil under the Early Oil Pilot Scheme (EOPS), whose value was approximated at Ksh. 498.5 million. The EOPS began in June 2018 and ran for two years before it was ended.

Experts in the sector have posited that the company may lack both the infrastructural and financial wherewithal to make good on their promise to mine oil in the area. George Wachira, a Petroleum Consultant, is of the idea that it could be stranded asset that awaits either a write-off or a strategic buyer who will take it off the hands of Tullow Oil. An equally popular belief is that Tullow Oil may not have much success in finding any other strategic investors since the investment dynamics in the oil and gas industry have shifted, such that investors are more interested in marine offshore projects than new onshore projects.

As far as its impacts go, Turkana residents do not have many good things to say about Tullow Oil. In fact, earlier this year, 43 residents of Turkana County sued the company for what they phrased as "environmental violence." Through their petition filed at the Environment and Land Court in Lodwar, the petitioners accused the company of destroying their environment by using


Picture: Courtesy

hazardous means of oil exploration in the area. They also sought compensation for the loss of their animals, which they argue was occasioned by said animals consuming waste dumped by the company post-exploration.

This is not a very flattering look on Tullow Oil, given that it comes after the local community accused the company of failing to involve them in their operations back in 2023. Following these accusations, members of the Senate Committee on Energy visited the exploration site in a bid to find answers to why the company had failed to involve the community in its activities. The committee also pushed to have the locals benefit from the water that the company uses in exploring oil deposits in the area.

The company's current position regarding oil mining in Turkana is that it plans to make its first commercial oil export in 2028. This is according to Tullow Oil's Field Development Plan (FDP) which the company submitted to the Energy and Petroleum Regulatory Authority (EPRA). However, the realization of this dream heavily relies on whether or not the company will be able to engage a strategic partner that would provide additional financial muscle for the project. This comes after Africa Oil and TotalEnergies withdrew their participation from the project in May 2023.

Since its entry into the Turkana oil scene in 2012, Tullow Oil has certainly not lived up to the petrodollars it so confidently promised. There is a good chance that aside from Turkana, there are other areas in Northern Kenya that are silently hosting yet-to-be-discovered oil deposits. However, any companies whose interest could be piqued by such prospects would have to not only make well calculated moves as regards investment in the exploration, but also involve the local communities in their activities both pre and post exploration.

Identifying and Mitigating Mining Hazards: Strengthening Risk Assessment and Management in Kenya's Mining Sector.

By Kigen K. Leonard

What is Mining Safety?

Mining safety entails all the regulations and practices that prevent accidents and protect miners' health throughout the mining process. By enforcing these measures, mining companies reduces risk, protect the environment, and ensure the well-being of their workforce.

Sustainable mining on the other hand ensures for resourceful extraction, improves social, economic, and environmental outcomes.

Therefore, to elevate safety stakeholders must adopt essential practices that promote compliance, efficiency, and sustainability in mining operations.

Importance of Mining Safety Considerations

Mining provides value to industries by supplying essential raw materials for manufacturing, energy, and infrastructure. However, its risks must be managed for the following reasons:

- **Reduces accident risks** – The State Department of Labour and Skills Development, through its Directorate of Occupational Safety & Health Services (DOSHS), plays a key role in ensuring workplace safety. In the last five years, the DOSHS filed nearly 3,500 reports of mining-related accidents. Hence, the extent of safety measures pointed out by DOSHS is crucial in mitigating the number of deaths, cutting the costs of workers' compensation and legal risks in the mining industry.
- **Boosts operational efficiency** – Safety-conscious employees can work on tasks without much worry hence decreasing the time that they take off from work due to injuries.
- **Ensures sustainability** – A safety management system provides protection to the workers, the community, and the environment as well as the company's image and its future.

Picture: Courtesy

Common Mining Hazards

Despite improvements in safety standards, mining continues to be dangerous. Key risks include:

- **Cave-ins and Roof Falls** – Underground mining can cause structural collapses, leading to serious accidents and fatalities.
- **Explosives and Blasting** – Blasting operations are dangerous since they may cause premature explosions, fly rocks, and toxic gases.
- **Fires and Explosions** – Flammable gases like Methane can ignite, causing deadly incidents, such as coal mine explosions.
- **Respiratory Hazards** – Dust, gases and fumes that are associated the mining process pose risks to the respiratory system of the workers.

- **Haulage and Transportation** – The use of large vehicles and heavy equipment in congested areas leads to accidents caused by poor visibility and human mistakes.
- **Falls from Heights** – Working on elevated surfaces puts miners at risk of falling due to unexpected movements or unstable equipment.
- **Noise and Vibrations** – Prolonged exposure to loud noises and vibrations can cause hearing loss and musculoskeletal issues.
- **Environmental Pollution** – Some of the chemicals used in mining operations are toxic including cyanide and sulfuric acid which have adverse impacts on the health of workers and the community in general.

Strategies for Ensuring Worker Safety in Mines

Mining is generally a high-risk business, and safety is a major concern in mines than in other industries. Many companies achieve near zero fatalities cumulative average over a specified period by following these strategies:

Tailored Training and Education

- Preventive training from certified professionals enables the workers to appreciate risks and develop ways of handling risks in case of an occurrence.
- Continued learning, periodic skills reactivation, and safety briefs ensure that safety skills are well-enhanced and current.

Hands-on Simulations

- Realistic simulations help workers practice safety procedures in controlled settings.

Use of Safety Equipment

- Personal Protective Equipment (PPE) is vital in safeguarding miners from hazards, and providing the right equipment is essential.

Top Safety Practices in Mining

- That personal protective equipment should fit properly to afford the most protection.
- Inspect PPE for signs of wear, signs of damage, or defects more often than in everyday use.
- Educate the miners on how to use the required PPE and at the same time explain the working limits of the equipment.

Risk Assessment and Management in Mining Operations

Proactively managing risks is crucial to prevent accidents. The key steps are identifying hazards, assessing risks, solving problems, and evaluating outcomes. Common strategies include:

- Use digital inspection templates for thorough hazard identification.
- Perform routine maintenance and calibration of monitoring equipment.
- Standardize the reporting and investigation process.
- Employ advanced sensor technology for accurate data collection.
- Develop protocols for addressing deviations promptly.
- Store reports in a secure, centralized system for transparency.
- Encourage workers to report hazards or violations without fear of retaliation.
- Regularly update risk assessments to reflect changing conditions.
- Involve safety managers, workers, and community stakeholders in the assessment process.

Conclusion

The act of balancing safety and sustainability is one continuous evolving practice that remains relevant to its purpose and goals. The two are inter-twined for overall economic sustainability with human lives and environmental protection

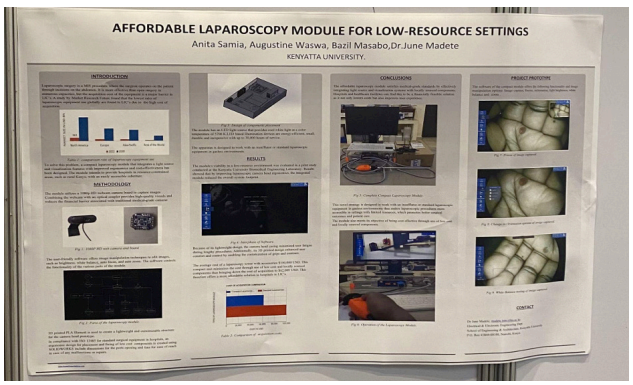

Picture: Courtesy

Kenyatta University Wins Best Poster Award at the 3rd International Congress in Innovations for Global Surgery (ICIGS 2024)

By Dr. Kenneth Iloka
Ag. Chairman,
Electrical and Electronics Engineering Department
School of Engineering & Architecture,
Kenyatta University

The 3rd International Congress in Innovations for Global Surgery 2024, held from May 6-7 at the Lagoon Beach Hotel in Cape Town, South Africa, was a landmark event in the field of medical science and engineering. This congress brought together leading surgeons, biomedical engineers, healthcare professionals, and innovators from around the world to discuss and explore advancements under the theme "Value-Based Innovation in Global Surgery.

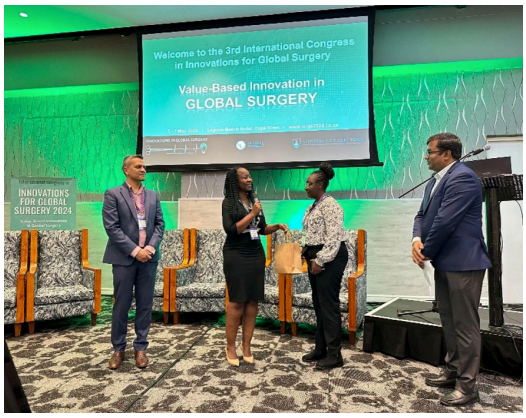
Our project from Kenyatta University's Biomedical Engineering Department titled, *"Affordable Laparoscopy Module for Low-Resource Settings"* was presented under Poster presentation category. The presentation was made by one of the team members, Ms Anita Samia, who was granted a bursary by the organising scientific committee of the congress.



Project Presentation and Recognition

The poster presentation attracted significant interest from a diverse group of professionals, including biomedical engineers and surgeons. Many attendees were eager to discuss potential collaborations and exchange ideas on how to further develop and implement such innovations. The keen interest from the medical community underscored the relevance and potential impact of our project.

Out of the 18 poster presentations made at the congress, our project was honoured with the Best Poster Presentation award. This prestigious recognition not only highlighted the quality and significance of our work but also granted us an exclusive invitation to present at the next International Congress in Innovations for Global Surgery, scheduled to be held in Malawi in 2025.



Path Forward

The recognition and interest garnered at the congress have opened exciting new avenues for collaboration. Notably, Prof. Pankaj Jani, a renowned Kenyan surgeon with extensive experience in laparoscopic surgery, expressed a strong interest in our project. Prof. Jani has a similar initiative and has proposed a meeting to explore how our efforts can be synergized to advance laparoscopic solutions for low-resource settings.

The congress has provided a robust platform for networking, learning, and showcasing our work. The Best Poster Presentation award and the subsequent invitation to the next congress are testaments to the dedication and innovation of our team. We are excited about the future prospects of our project and the potential collaborations that will help us achieve greater impact in global surgical practices.

Acknowledgments

We extend our heartfelt gratitude to the scientific committee for their support and the bursary grant, which made our participation possible. We also thank all the professionals who engaged with us and showed interest in our project.

The Way Forward

As we prepare for the next congress in Malawi in 2025, we are committed to further refining our project and fostering the collaborations initiated at this event. We are optimistic that our continued efforts will lead to substantial advancements in making laparoscopic surgery accessible to underserved communities worldwide.

Picture: Courtesy

Overcoming the Difficulties and Maximizing the Benefits of Artisanal Mining in Kenya's Border Areas

By EiK Correspondent

The importance of artisanal mining to Kenya and the mining sector was recognized in the Mining Act (2016). The government has also made an admission that needed to make progress and in 2019, placed a moratorium on new mining licences. This resulted in a halt to the issuance of new permits, including for artisanal mining while cleaning up and mapping out mineral resources as well.

But, like its predecessor Mr. Salim Mvurya (now Cabinet Secretary, Investments, Trade and Industry), the former Mining docket holder last year declared Cobalt, Copper, Lithium, Niobium, Coltan, Tantalum, and Tin Tsavorite as strategic minerals when he gazetted other Rare Earth in addition to Thorium, Uranium among others. The result was the government moving towards partially reopening a forest in one of the again, disputed territories.

Artisanal mining in Kenya's border regions presents a mix of both challenges and opportunities. This sector, which includes small-scale, often informal mining activities, is crucial for the livelihoods of many Kenyans, especially in remote areas.

Opportunities

Economic Contribution: Artisanal mining is a worthwhile economic activity in Kenya by creating jobs and job opportunities for society. Eight or nine out of ten people working in mining are mainly those engaged in small-scale or illegal mining. Artisanal mining, particularly in rural Kenya and around its borders, is one of the largest employers after agriculture and retail in many developing countries. Development minerals that support construction and infrastructure in terms of construction materials, industrial minerals, and semi-precious stones are high in demand which makes artisanal miners a valuable asset for such mining. *"Mining is a bedrock for Kenya's economy. If well managed, this resource can clear our debts and revenues can be generated to catalyze the growth of the country,"* these were the words of the Cabinet Secretary for Mining Blue Economy and Maritime Affairs in an interview at a recent date in Kenya.

Formalization and Support: Addressing the issue of informal activity cannot itself resolve the problem of creating these sectors. A paradigm shift is more pronounced within the sector whereby governments are making attempts to treat the artisanal miners justly and appropriate measures are in place to protect the area in which they operate. It has also required political commitments, and legislative and policy strategies aimed at changing the position of the African artisanal and small-scale miners from being peripheral actors to economically

Picture: Courtesy

active stakeholders within the industry. The nations with such interference from artisanal miners are also seeking to implement management practices that are artisanal miner-focused, to help better their lives.

Community Development: Whereas artisanal mining is regulated and free from abuse, it has been noted that it has benefits that accrue to the surrounding areas including establishing local social structures and developments. During a recent visit to Kisumu, new Cabinet Secretary Hassan Joho was equally clear that when and how investors engage with people, and how the people and the community accept those investors must be placed before any of the investor's licenses is granted. He said that people have to be at the center of such investments.

Challenges

Regulation and Legal Matters: Artisanal mining is largely extracting operations work outside the law of a given country. Although this is portrayed as a complex problem, most of the issues before the sector are superficial. For national governments, the sheer size of this sector means they want to be able to control and tax all aspects of it even more than buyers need minerals or workers need jobs. That is why most artisanal mining works operate without proper permits, leading to illegal activities and conflicts with authorities.

Team Safety: The real challenges in this arena are the risks associated with this sector that make it necessary to come up with plenty of safety features for worker protection. Comprehensive safety protocols need to be followed as well as risk assessments. Some of the most common risks are exposure to hazardous chemicals, accidents with equipment and machinery, heat stress due to UV explosions and fires, emissions of gases that trigger respiratory problems, excessively high temperatures, electrical hazards, body stress especially via manual operations, extreme exposures for unprotected skin and noise-induced hearing loss.

Environmental Impact: Unregulated mining remains intense and invasive, and its operations often leave large environmental impacts on the local surroundings as well as wider implications for the environmental health of the planet. In as much as the mining of further resources is required to support the growing global population, it is important to allow for the creation of green infrastructure and renewable energy generation. Governments and artisanal miners should innovate to create clean mining technologies with strict environmental regulations which will pave the way for a sustainable and hopeful future.

Economic Exploitation: Regions with artisanal miners continue to exhibit low levels of development and poor standards of living. This has been attributed to various factors including exploitative multinational corporations, lack of expertise and corruption, and negotiation of unfavorable mining development agreements. Artisanal miners frequently receive poor prices for their minerals due to a lack of market access and exploitation by middlemen. The Africa Mining Vision is expected to address most of these challenges if not all. But even with this Vision document, most of the miners still struggle with making the mineral resources work for them.

Way Forward

Dealing with these issues and taking advantage of the available opportunities necessitates a multi-pronged approach, including regulation, help to the miners themselves, and conscientious approaches. This will be crucial in making sure that artisanal miners realize maximum potential.

Picture: Courtesy

Low-Cost Oxygen Concentrator for LRS

By Dr. Kenneth Iloka
Ag. Chairman,
Electrical and Electronics Engineering Department
School of Engineering & Architecture,
Kenyatta University

Introduction

In many parts of the world, particularly in resource-constrained areas, access to essential medical equipment remains a significant challenge. The oxygen concentrator, a critical device that provides supplemental oxygen to patients with respiratory issues, is often out of reach for many healthcare facilities in Kenya due to budget limitations. Recognizing this pressing need, a collaborative team of faculty and students from the biomedical engineering department has embarked on an innovative project to develop a low-cost oxygen concentrator. This initiative aims to bridge the gap between the vital oxygen therapy needs and the financial constraints many Kenyan healthcare facilities face. Our team leverages diverse skills and knowledge, combining experienced faculty members' expertise with enthusiastic students' fresh perspectives. Our focus is on creating a cost-effective solution without compromising quality and reliability, with the ultimate goal of significantly improving access to oxygen therapy in underserved areas.

Problem Statement

Oxygen concentrators provide the cheapest and most consistent source of oxygen in health facilities where power supplies are reliable. Commercial oxygen concentrators are relatively expensive for many healthcare facilities in Kenya. The limited technical expertise available for the maintenance and repair of complex medical equipment in remote areas and inconsistent supply chains for replacement parts and consumables exacerbate the issue. Consequently, many patients with respiratory conditions in these areas lack access to adequate oxygen therapy, potentially leading to increased morbidity and mortality rates.

Proposed Solution

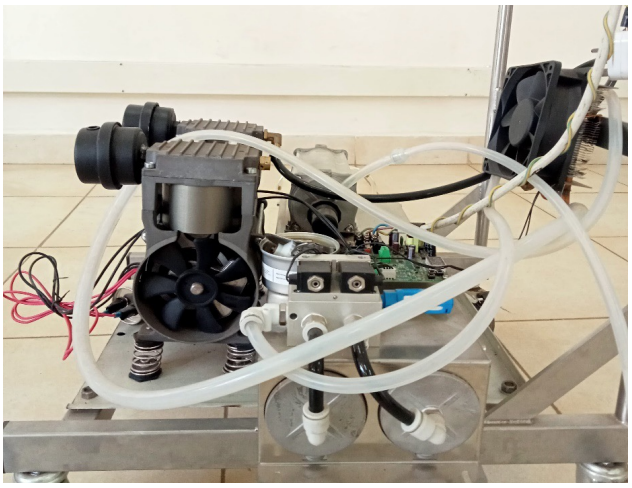
Our proposed solution is the development of a low-cost, robust, and user-friendly oxygen concentrator designed explicitly for resource-constrained healthcare settings in Kenya. We aim to significantly reduce the overall price using cost-effective components and manufacturing processes. To address the challenge of unreliable electricity, we're designing an energy-efficient device with the potential for battery backup or solar power integration. The mechanics and electronics are being simplified to facilitate easier maintenance and repair by local technicians, and we're prioritizing the use of locally available materials where possible to improve sustainability and ease of maintenance. User-friendliness is critical in our design, ensuring that healthcare workers with minimal training can efficiently operate the device. We're also implementing a modular design to allow for easy replacement of individual components, enhancing the long-term viability of the device in challenging environments. Through these features, we aim to create a device that is affordable and suitable for sustained use in the target settings.

Prototype

The current compressor model consists of the following components that are individually sourced locally. The components include a heat exchanger, a compressor with a tank, a fan, a power supply board, air filters, a muffler, and an oxygen sensor.

How it works.

Our low-cost oxygen concentrator efficiently produces medical-grade oxygen using locally sourced components, making it ideal for resource-constrained healthcare settings. The device comprises several vital elements working in harmony to concentrate oxygen from ambient air. At the heart of the system is a compressor with a tank, which draws in and pressurizes air. A heat exchanger then cools this compressed air to improve efficiency and protect downstream components. Air filters remove contaminants, ensuring clean oxygen output and safeguarding internal parts. The clean, pressurized air undergoes pressure swing adsorption, a process that separates nitrogen from the air, leaving oxygen-enriched air. An oxygen sensor continuously monitors the purity of the produced oxygen before it's delivered to the patient. Supporting components enhance the concentrator's performance and usability. A fan prevents overheating by cooling the compressor and other internal parts.



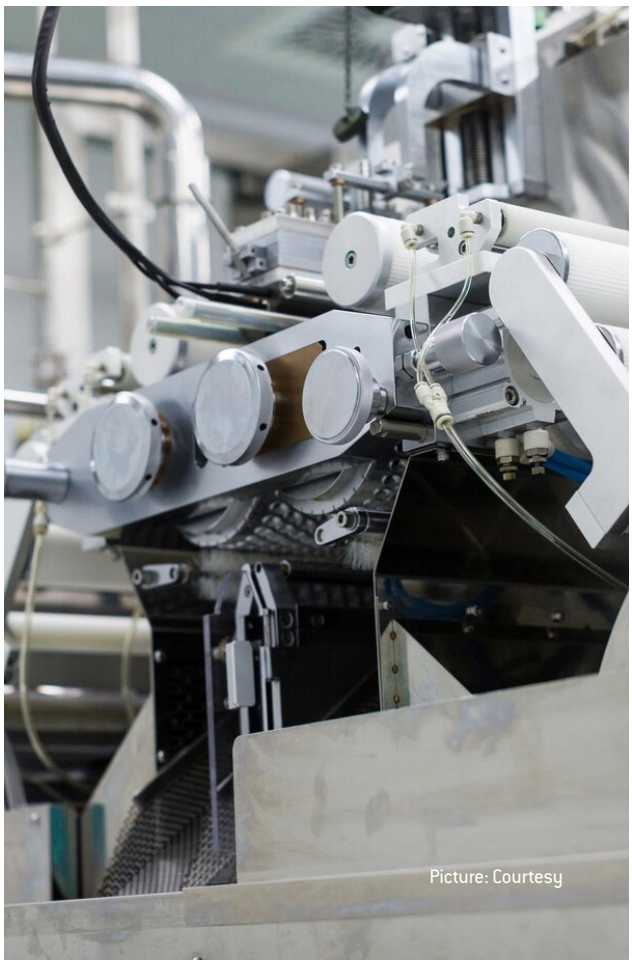
A muffler reduces operational noise, making the device suitable for quiet healthcare environments. The power supply board regulates and distributes electricity to all components, ensuring smooth operation. This design allows our concentrator to produce a steady supply of high-purity oxygen (90% pure) efficiently and quietly, meeting the critical needs of healthcare facilities in challenging environments.

Next Steps and Future Improvements

Our project, currently at the prototype stage, has successfully proven its concept. We are continuously refining the design and improving efficiency. Moving forward, we will finalize the prototype, incorporating feedback from initial testing. Extensive field trials in various Kenyan healthcare settings will follow, allowing us to assess real-world performance and user acceptance. Simultaneously, we'll pursue the necessary certifications and establish partnerships with local manufacturers. We plan to develop training materials, conduct a pilot implementation, and gather data to inform our scaling strategy. Throughout this journey, we remain committed to continuous improvement, aiming to create a widely accessible solution that enhances oxygen therapy in resource-constrained areas across East Africa.

Team Members.

- Faculty: Bazil Masabo and Augustine Waswa.
- Students: June Lindah Adhiambo, Peter Kagwe Kagunyi, Edward Njoroge, Dan Mwirigi, and Cedric Murage



Picture: Courtesy

PICTORIAL

The IEK Editorial Board Courtesy Call to Kenyatta University Ag. Vice Chancellor Prof. Waceke Wanjohi, on Wednesday 4th September 2024

Chairperson of the IEK Editorial Board, Eng. Prof. Lawrence Gumbe, presents the latest volume of the African Journal of Engineering Research and Innovation (AJERI) to Prof. Caroline Thoruwa, Kenyatta University's Deputy Vice-Chancellor for Research, Innovation, and Outreach, representing Acting Vice-Chancellor, Prof. Waceke Wanjohi, during the IEK Editorial Board's courtesy call

IEK Council, led by Eng. Shammah Kiteme, met with KenGen MD Eng. Peter Njenga to strengthen collaboration and promote the role of local engineers in national projects. The meeting emphasized engineering talent development and positioning Kenyan engineers for regional opportunities.

IEK Council, led by President Eng. Shammah Kiteme, visited KURA Director General, Eng. Silas Kinoti, to strengthen collaboration on engineering and urban mobility in Kenya. The meeting highlighted KURA's pivotal role in transforming urban infrastructure and emphasized the need for innovation-driven industrialization. Both institutions committed to advancing the engineering profession and supporting Kenya's economic growth through enhanced infrastructure.

The Institution of Engineers of Kenya (IEK) paid a courtesy call to the Athi Water Works Development Agency (AWWDA) to explore collaboration opportunities and strengthen the relationship between the two Institutions.

AWWDA CEO ,Eng. Joseph Kamau proposed several collaborative efforts to enhance professional development, such as industrial visits to key projects and operations and fostering knowledge dissemination within the water sector.

In response, The IEK President Eng. Shammah Kiteme proposed initiatives focused on advocacy to promote better engineering practices and policies. This visit will enhance the partnership between the two Institutions which is aimed at addressing critical issues within the water sector.

The IEK council courtesy call to GDC

STUDENTS' VOICES

Name: Elizabeth Mbithe Joseph

Age: 22

University: Dedan Kimathi University of Technology

Program: Civil Engineering

Year of Study: 5th year

As a fifth-year civil engineering student, I've discovered that my education provides a solid foundation for a career in mining engineering. The principles of structural integrity, project management and sustainable design are directly applicable to mining projects. My journey has been both challenging and rewarding, underscoring the interdisciplinary nature of these fields

Technological advancements, such as autonomous equipment and real time data analytics, have revolutionized mining operations, much like smart infrastructure in civil engineering. These innovations enhance safety, efficiency and sustainability in both fields.

Kenya's potential as a mining hub is immense and civil engineering expertise is vital for developing the necessary infrastructure. My background in project management and environmental assessment equips me to contribute to this growing sector.

Professional institutions like the Institution of Engineers of Kenya support engineers by promoting best practices and continuous learning. This aligns with global sustainability trends, where responsible engineering practices are essential in mining engineering projects.

In conclusion, my civil engineering skills are proving invaluable in the mining sector, allowing me to significantly impact society and the environment. Aspiring engineers should stay updated with technology, pursue continuous learning, and prioritize sustainability. Addressing resource depletion, environmental concerns, and technological adaptation requires innovation and stringent regulations. Chemical engineers are essential in designing eco-friendly processing techniques and waste management solutions for responsible mining.

Name: Brian Wangari

Age :22 years

University: Dedan Kimathi University of Technology

Year of Study: 4th year

Field of study: Chemical Engineering

The future of mining engineering is set to be transformative, focusing on sustainability and minimizing environmental impact. Innovations in renewable energy-powered operations are becoming standard, promoting safer, eco-friendly practices. Kenya has rich mineral resources. By investing in education and technology Kenya can establish itself as a leader in responsible mining practices.

Collaboration between academia and industry in Kenya can be achieved through joint research initiatives, internships, and industry funded scholarships. This cooperation ensures that academic research is practical and industry relevant.

Aspiring engineers should stay updated with technological advancements, pursue continuous learning, and prioritize sustainability in all endeavors. The biggest challenges today include resource depletion, environmental concerns, and the need for technological adaptation. Addressing these requires innovation, stringent regulations, and a commitment to sustainable practices. Chemical engineers play an important role in ensuring responsible mining by designing eco-friendly processing techniques and waste management solutions.

STUDENTS' VOICES

Name: Ndiritu Muriuki

Age: 20

University: Dedan Kimathi University of Technology

Program: Bachelor of Science in Mechanical Engineering

Year of Study: 4th Year

One major application is in sustainable energy technologies, where advancements in areas like renewable energy systems and energy-efficient transportation can help mitigate climate change and reduce dependence on fossil fuels. Technological advancements such as automation, data analytics, and remote sensing have transformed mining engineering, making operations safer and more efficient.

The future of the field will focus on sustainability, emphasizing practices like mine reclamation, waste reduction, and renewable energy integration, in line with global trends in responsible resource management. The Engineering Board of Kenya serves as a vital resource for students aspiring to excel in mechanical engineering by providing guidance, accreditation, and professional development opportunities.

Name: Philip Mutweleli Mutuku.

Age: 22 Years.

University: Machakos University.

Program: Civil Engineering.

Year of Study: 5th Year.

The noble chance the field offers to envision, design, and construct tangible solutions to real-world problems ignited my inspiration to pursue engineering. Civil engineering focuses on improving the built environment and the opportunity to design impactful structures on the society proved highly rewarding.

One of the challenges I have encountered in my studies is structural design (STUDIO). My strong analytical and problem-solving skills proved invaluable to tackle the assignments.

Engineering is evolving due to technological advancements in the current world. Automation and artificial intelligence will revolutionize the sector, especially the mining industry. These technologies are poised to enhance efficiency and sustainability in the industry and should be highly embraced.

The mining industry is majorly associated with the environment. The implementation of strategies, that reduce environmental degradation such as renewable energy, will foster sustainability and reduce its environmental impact.

In my coursework, a strong foundation in mathematics, critical thinking, communication, teamwork, and problem-solving skills have been of core importance.

My ideal career would integrate Environmental and Structural engineering. The mining industry aligns perfectly and avails opportunities to pioneer sustainable mining methods and environmental conservation practices.

My advice to those considering a career in Engineering, especially the mining discipline, is to develop the zeal for problem-solving and the passion to create a more suitable environment for future generations.

STUDENTS' VOICES

Name: Faith Chepkoech

Age :23 years

University: Machakos University

Program: Civil Engineering

Year of Study: 5th year second semester

The desire to design and build infrastructure that leaves a lasting impact on communities and significantly improves people's lives inspired me to pursue Civil Engineering. I am particularly drawn to transportation engineering because it directly influences society, shaping the efficient and safe movement of people and goods.

Machakos University played a pivotal role in shaping my career by offering rigorous training, inspirational mentorship (including global exchange programs), and practical experience, all of which fueled my passion for Civil Engineering and prepared me to confidently tackle real-world challenges.

Attachments provided valuable hands-on experience, enabling me to apply theoretical knowledge to real-world projects. I gained exposure to Civil 3D for designing actual projects and developed essential soft skills, particularly during my time with the Kenya National Highways Authority (KeNHA).

Civil engineering, especially transportation engineering, is vital in mining for designing infrastructure to move extracted materials efficiently while minimizing environmental impact.

Surface Mining focuses on roads, conveyors, and railways, while underground mining relies on shafts and underground rail systems. Sustainable planning and integrating advanced sensors and IoT are essential for safety and minimizing disruption. Aspiring engineers should explore diverse disciplines, gain hands-on experience, and stay adaptable to new technologies.

Name: Mugalla Lilian Kagai

Age: 24 Years

University: Jomo Kenyatta University of Agriculture and Technology

Major/Program: Bsc. Mining And Mineral Processing Engineering

Current Year of Study: 5th Year

Kenya's mining industry faces challenges such as licensing issues, outdated technology, and limited value addition facilities, leading to raw mineral exports. However, the sector presents significant opportunities for economic growth through local processing and enhanced value addition. Modern mining engineering leverages technologies like AI for predictive maintenance, ore sorting, and resource estimation, alongside carbon capture methods to reduce emissions. Applying these innovations in Kenya could improve operational efficiency and sustainability.

Environmental impacts of mining, including soil disruption and contamination, along with social issues such as community displacement and livelihood loss, can be mitigated through engineering solutions. Wastewater treatment and stockpiling topsoil for land rehabilitation help address environmental concerns, while compensation and strict safety measures support affected communities and ensure safe working conditions.

Mining engineering contributes to economic growth by utilizing Kenya's mineral resources, creating jobs in extraction, processing, and support industries, and enhancing regional infrastructure. Skill development programs linked to mining operations further empower local communities.

STUDENTS' VOICES

Name: Tendo Kiwoi

Age: 24 years

University: Jomo Kenyatta University of Agriculture and Technology

Program: Bachelor of Science Mining and Mineral Processing Engineering

Year of Study: 5th Year Second Semester

The mining industry is a critical sector for Kenya's economic development. However, it currently faces a myriad of challenges amidst a pool of opportunities. Key challenges include labour shortages, underinvestment, and low productivity, while opportunities lie in the rising demand for strategic minerals and technological advancements. The energy transition presents itself as a major opportunity for Kenya to reform its mining industry.

Innovative technologies such as AI, machine learning, and the Internet of Things are revolutionizing modern mining engineering. By adopting innovative technologies, efficiency and sustainability are enhanced through increase in production as well as reduction in environmental pollution. The environmental and social impacts in Kenya are significant, with mining activities contributing to landscape changes, pollution, and loss of biodiversity. Engineering solutions like improved waste management systems and sustainable mining practices can mitigate these effects.

Mining engineering can significantly contribute to Kenya's economic growth by tapping into the country's rich mineral resources, which can increase GDP contributions and create job opportunities.

Engineers play a pivotal role in ensuring the safety and health of workers by adhering to occupational health and safety standards and implementing protective measures. Aligning engineering education with industry needs is crucial for fostering innovation and driving development. This requires updating curricula, promoting industry partnerships, and focusing on practical skills to bridge the skills gap.

In summary, the Kenyan mining industry stands at a crossroads between traditional challenges and modern opportunities. Embracing technological innovation, prioritizing environmental and social responsibilities, and investing in human capital are essential steps towards a sustainable and prosperous mining sector that not only contributes to the nation's economy but also safeguards its workforce and environment.

Name: Brian Kiplangat

Age: 22 yrs

University: Kenyatta University

Program: BSc Petroleum Engineering

Year of Study: 5th

Unlocking Kenya's Petroleum Potential: Integrating Cutting-Edge Mining Equipment, Maintenance Strategies, and Sustainable Practices for Efficient Oil and Gas Exploration

Kenya's petroleum sector is poised for transformation following the discovery of significant oil reserves in Turkana in 2012 by Tullow Oil. To fully realize this potential, the industry must integrate advanced mining equipment, effective maintenance strategies, and sustainable practices. Technologies like seismic imaging and automated drilling rigs are improving operational efficiency, reducing environmental impacts, and ensuring worker safety. By use of Predictive maintenance driven by AI and data analytics, the miming sector is in the approaching its maximum equipment reliability, minimizing costly breakdowns, and improving safety by preventing malfunctions.

Sustainability is at the forefront of Kenya's oil industry as companies adopt energy-efficient technologies to reduce flaring and emissions. Furthermore, post-extraction land restoration efforts and community development initiatives ensure that petroleum extraction benefits both the environment and local populations. Safety measures, such as Advanced Monitoring Systems and Extensive Worker Training, further strengthen industry standards.

Government policies, including the Petroleum Act 2019, have been instrumental in attracting foreign investment and ensuring that oil exploration benefits the nation. Despite challenges like fluctuating oil prices and underdeveloped infrastructure, continued investment in technology and strong public-private collaboration will help Kenya overcome these hurdles. By focusing on responsible development, Kenya's oil sector can drive economic growth while preserving environmental integrity and benefiting future generations.

IEK Membership Report

The IEK membership committee meets every month to consider applications for membership of the various classes received at the secretariat. The IEK council at its 527th and 528th council accepted the following members under various membership categories as shown below;

MEMBERSHIP CLASS	NUMBER ACCEPTED-527TH COUNCIL	NUMBER ACCEPTED-528TH COUNCIL	TOTAL
FELLOW	0	3	3
CORPORATE	10	85	95
GRADUATE	99	56	155
GRADUATE ENGINEERING TECHNOLOGIST	8	5	13
GRADUATE ENGINEERING TECHNICIAN	21	4	25
STUDENT	25	15	40
TOTAL	**163**	**168**	**331**

During the period, we had 3 members who transferred from the class of Corporate to Fellow member and 95 from Graduate to Corporate member. In addition, we had 155 graduates, 13 graduate engineering technologists, 25 graduate engineering technicians and 40 students were accepted as members.

Gender Data

Class	Male	Female	Percentage (Male)	Percentage (Female)
Fellow	3	0	100%	0%
Corporate	73	22	77%	23%
Graduate	125	30	81%	19%
Graduate Engineering Technologist	10	3	77%	23%
Graduate Engineering Technician	23	2	92%	8%
Student	22	18	55%	45%
TOTAL	**256**	**75**	**77%**	**23%**

Summary

Gender	No.	Percentage
Male	256	77%
Female	75	23%
	331	**100%**

527TH APPROVAL

CORPORATE

	NAME	MEMBER NO.
	Anthony Mwangi Maina	M.9104
	Daniel Kimani Ndung'u	M.7349
	Elizabeth Sidi Mrashui	M.6794
	Emily Teresa Nyambati	M.9400
	Eric Murithi Mugaa	M.8963
	Ivan Kimathi Mugambi	M.10324
	Joyce Muguru Wairimu	M.8664
	Patrick Kirimi Kirema	M.7690
	Phidel Ochieng Amayo	M.11709
	Victor Musogah Mambah	M.5808

528TH APPROVAL

FELLOW

	NAME	MEMBER NO.
	Kimari Maina Patrick	F.4735
	Mahboub Mohamed Maalim	F.3145
	Michael Ndirangu Nderitu	F.3563

CORPORATE

S/NO.	NAME	MEMBER NO.
	Adan Noor Hussein	M.7280
	Agabus Odanga Milimu	M.12105
	Alfred Kimeli Kemei	M.3034
	Aloo James Ogutu	M.8162
	Alphaxard Kitheko Mutonga	M.5964
	Annette K Aming'a	M.12163
	Aron Kimutai Rono	M.5099
	Billy Onono Okuto	M.10308
	Boiywo Cheboi Benjamin	M.7633
	Calvin Odhiambo Jagongo	M.5973

S/NO.	NAME	MEMBER NO.
	Caroline Indakwa Makonjio	M.5317
	Caroline Nyawira Ngunyi	M.10620
	Chris Macharia Muriuki	M.6566
	Collins Mawira Ragwa	M.12512
	Cosmas Ngui Kisyoka	M.5838
	Cynthia Mukabana Osundwa	M.6628
	Dan Muchwanju	M.9902
	David Karumu Wanjiru	M.9020
	David Omooria Masara	M.10098
	Denis Kipkorir Bett	M.10153
	Dorcas Sinde Otiato	M.7472
	Doris Murugi Kangangi	M.4582
	Duale Sigat Jilal	M.12056
	Elijah Kithuku Mithanga	M.9214
	Eliud Koome	M.5394
	Emmanuel Mugiira Kinoti	M.10837
	Florence Khaendi Oteba	M.9424
	Frank Ogochi Ombongi	M.2636
	Fredrick Ochieng Ongoro	M.6854
	George Kaaria M'mboroti	M.8796
	George Washington Ogalo Ajwang	M.12566
	Gideon Waweru Mwaura	M.9252
	Gladwell Wanjiku Nganga	M.7019
	Hamisi Chikombe Sudi	M.9142
	Ishmael Maina Makanga	M.10717
	Ivy Chepkosgei Kerich	M.10478
	Jacob Kibe Ngugi	M.7996
	James Kiplagat Kipkoech Barmasai	M.6740
	James Wairia Wangari	M.12870
	Jesca Makena Mbuba	M.12584
	Jesse Waweru Wahome	M.10579
	John Gachinu Thirima	M.6980
	Johnson Kinyua Maina	M.9472
	Joseph Oyamo	M.9932
	Joshua Kibera Gichoya	M.11903
	Joy Kendi Muthuri	M.8733
	Joyce Muthue Munuve	M.7842
	Julius Mosaria Makone	M.7422
	Kennedy Ngala Ouma	M.6643
	Kenneth Oscar Kimani Muthumu	M.9361
	Kigen Kipchirchir	M.6909
	Kiplangat Richard Koskei	M.7468
	Koech Kiptoo Ronald	M.7634
	Lawrence Okoth Ongele	M.10167
	Mary Wambui Gitungo	M.8642
	Michael Otieno Nyang'ango	M.5933
	Mike Okello Okumu	M.6119
	Mohamed Salim Mohammed	M.10037

S/NO.	NAME	MEMBER NO.
	Morris Meta Miriti	M.6978
	Mwangi Mathenge	M.9159
	Nancy Neema Supaki	M.10731
	Ngetich Catherine Chepngeno	M.7006
	Patrick Karanja Njeri	M.11650
	Peter Otieno Ngeso	M.9124
	Prudence Khalumba Lumbasi	M.9440
	Purity Mokeira Nyaberi	M.7333
	Quinter Atieno Onyango	M.8525
	Rahab Wambui Kingori	M.8562
	Richard Eric Ochieng Obumba	M.5140
	Rowlex Kiprono Kororia	M.11441
	Samson Mbora	M.9359
	Samuel Gitonga Mitambo	M.6800
	Samuel Katee Rose	M.9560
	Samwel Kimani Njogu	M.13218
	Samwel Ochieng' Ojenge	M.6275
	Sharon Mwelu Musau	M.7504
	Simon Kabocho Kangethe	M.8044
	Simon Muendo Mateli	M.10067
	Stephen Kiua Muli	M.6712
	Susan Nthamba Masila	M.5882
	Timothy Kimemia Karanu	M.6814
	Timothy Mdawida Mwakazi	M.6859
	Titus Okello Miginjo	M.13546
	Victor Otieno Odhiambo	M.9789
	Wiliams Nyakundi Agayo	M.9487

The council invites Engineers and affiliate firms to apply for membership in the various membership classes, kindly follow the link members.iekenya.org to register or scan the QR Code below to apply for membership;

PICTORIAL

Jomo Kenyatta University of Agriculture and Technology (JKUAT) hosted Techweek 4.0 in October 2024, themed "Future Forward - Engineering for a Sustainable Future." Eng. Maxwell Ngala, Eng. Ignatius Maranga, and Eng. Bentlay Nango, representing the IEK Council and Future Leaders Committee, presented the IEK Magazine to Prof. Dan Sila and Dr. Eng. Charles Kabubo, Dean of the School of Civil Engineering at JKUAT.

Be visible, grow your Brand
Advertise with Us!

Engineering in Kenya magazine is published by the Institution of Engineers of Kenya (IEK).

The magazine has a wide audience among engineering professionals and beyond, including stakeholders and policy makers in both public and private corporate entities. Advertising with us will bring you to the attention of these stakeholders, and give you the opportunity to grow your market. Grab this opportunity in our next issue scheduled to be published in November 2024 and tap into this rich audience. Our print run is 3,000 hard copies and over 100,000 in digital circulation,

bi-monthly. Email editor@iekenya.org.