Royal Academy of Engineering

Engineers for Africa 2025

Challenges and solutions to building engineering capacity in sub-Saharan Africa

Royal Academy of Engineering

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Foreword

As President of the World Federation of Engineering Organizations (WFEO) and an African, I commend the effort of the Royal Academy of Engineering for developing this report as well as thank them for inviting me to write a foreword to it. It is indeed an honour and privilege. Engineering is increasingly being recognised as playing a crucial role in improving countries' economies, despite the challenges of limited available resources, severe environmental concerns, and extraordinary climate change experienced globally and in Africa in particular.

The Global Sustainable Development Report (GSDR) 2023 highlights the link between engineering and achieving all 17 Sustainable Development Goals (SDGs). It shows that engineering is more than just an applied science, it is also a vital tool for tackling global issues as well as a powerful lever for achieving the SDGs at the community, national, continental, and global levels.

At global level, the political declaration of the 2023 UN High-level Political Forum on Sustainable Development (HLPF) under the auspices of the UN General Assembly states that "the achievement of the SDGs is in peril". Furthermore, according to António Guterres, the UN Secretary General at the HLPF, in July 2023: "The world is crying out for high-level political action. Action to make the Sustainable Development Goals a reality — for everyone, everywhere. Without it, the 2030 promise is in danger of slipping away." However, the situation is even more dire in Africa.

Looking at Africa on average, the SDG Index score for African countries has increased by +2.5 points since 2015, bringing it to 56.7 out of 100 in 2022. However, the average score for African countries is 10 points lower than the global level score (66.7) and more than 20 points lower than that of OECD countries (77.8).

With the above realities staring directly at the continent, concerted efforts are needed in Africa more than any other region to reverse the trend and make progress towards achieving the SDGs. As highlighted previously, increasing the engineering capacity in Africa will greatly help this direction. This report highlights the status of engineering capacity in the continent within limits of available and authentic data. It highlights some of the progress that has been made to improve the situation, while highlighting the remaining challenges, as well as some suggestions or ways forward in the future.

It should be noted that engineering capacity in any country includes, but is not limited to, the number of institutions offering engineering training (curriculum, laboratory equipment, teaching staff, industrial training); the number of people graduating from universities/ polytechnics and practising; practical experience in the workplace; and the number and quality of consulting and construction firms actively serving that country. This has highlighted the urgent need for continental (Federation of African Engineering Organizations, FAEO) and global (WFEO) engineering organisations to come up with comprehensive and reliable data on these items to comprehensively analyse the situation in the future, as well as measure progress.

The report also mentions some efforts and interventions by some countries and international organisations, like the Royal Academy of Engineering and World Bank, to improve the situation. While such interventions are welcome and should be supported, it must also be recognised that realistically, they are not sufficient, given the scale of the challenge. Their most important contribution is in demonstrating examples of effective solutions. Real progress can only be made when African governments develop relevant policies, make optimal use of available in-country expertise, and work with all partners to scale successful solutions.

Looking forward with optimism, Africa has the youngest population in the world with more than 400 million young people between the ages of 15 and 35. If the recommendations listed in the report are implemented, Africa will go very far in bridging the engineering capacity gap, thereby bringing us close to achieving the SDGs by 2030.

The report is written in a very comprehensive format for easy reading by students, researchers, government policymakers and legislators (at national, continental and global levels), international organisations, professional engineering institutions, and regulatory bodies at national and international levels, as well as the public.

I therefore recommend it to all.

Engr. Mustafa B Shehu
President, WFEO


Supplied

Executive summary

Engineering is crucial to the sustainable socioeconomic growth of sub-Saharan Africa. Engineers play a vital role in infrastructure development, providing access to essential services like healthcare, water, sanitation, electricity, and food. They contribute to innovation and growth, which are critical for meeting the UN Sustainable Development Goals (SDGs). Global and regional challenges, such as climate change and urbanisation, will further accelerate the demand for skilled engineers in the region.

There is a need to increase both the expertise and number of engineers across sub-Saharan Africa to support sustainable socioeconomic growth. Local employers consistently find engineers trained in sub-Saharan Africa do not have the technical or non-technical skills they require and are often unable to invest in training to upskill them. This gap in local skills leads employers to seek skills from other countries or regions, further depriving local engineers of opportunities to acquire practical experience.[1] Although numbers vary considerably across countries and sub-fields,[2] recent publications have identified Africa as the region with the lowest number of engineers per capita in the world and pointed to the shortage of engineers as a critical barrier to socioeconomic progress.[3]

Closing the engineering capacity gap will require resolving key challenges across the engineering career journey:

- **Technical education:** University and technical and vocational training (TVET) courses across sub-Saharan Africa lack sufficient funding, struggle to keep pace with new technologies and include few practical training opportunities. There is also a lack of private sector involvement in engineering education, limiting opportunities for students to acquire work experience.
- **Transition to employment:** many graduates struggle to find jobs because of a mismatch between their skills and employer needs, and little on-the-job training available. Graduate placement programmes are uncommon, and limited standardisation of education and professional registration requirements across countries further constrains the mobility of entry-level engineers.
- **Career progression:** local engineers encounter challenges in progressing within their careers because of: (i) insufficient access to continuing professional development (CPD) opportunities to stay up to date with developments in industry; and (ii) limited opportunities to build skills for more advanced roles or jobs in new sectors. Employers do not invest consistently in upskilling local engineers and often recruit foreign engineers for more senior and specialised positions. Emigration of more experienced African engineers further reduces the pool available to mentor and supervise their junior counterparts. Across the engineering career journey, these challenges disproportionately impact women, compounded by socio-cultural norms and persistent biases.
- **Transition to entrepreneurship:** entrepreneurship offers an alternative route to employment but graduates across sub-Saharan Africa face barriers, including limited real-world experience, financial expertise, and access to resources (including funding and infrastructure). Limited availability of venture capital further constrains efforts to grow and scale entrepreneurial ideas.

1. Dalberg interviews with private sector employers in East and Southern Africa, June & July 2024
2. There is significant variation across the Southern African Development Community (SADC) with 1 engineer for every ~5,500 people in Malawi versus 1 for ~380 people in Botswana. In East Africa, there was 1 registered engineer for every ~8,000 people in Tanzania, ~30,000 in Uganda, and ~825,000 in Burundi in 2021. Sources: Improving competences of engineering graduates through student industrial secondments, STIPRO Tanzania, 2022; SADC Research – SADC Research site for SAICE-PDP, SADC, 2018
3. Engineering for Sustainable Development, UNESCO, 2021; Help Us Engineer a Better Sustainable World, World Federation of Engineering Organizations, Accessed August 2024

RAEng/Kit Oates

Multiple actors, including the Royal Academy of Engineering (the Academy), have demonstrated effective solutions to these challenges. Scaling these will require continued advocacy by non-African development organisations and funders, political engagement of governments and long-term funding.

Examples of promising initiatives include the following:

- **Curriculum reform:** organisations including the Academy and World Bank have supported academic institutions across sub-Saharan Africa to increase industry involvement in curriculum reform, providing soft skills training and facilitating student and lecturer secondments.[4]

- **Graduate placement programmes:** placement programmes that provide job-specific skills training under the supervision of professional engineers have shown promise in improving graduates' employment prospects. They have provided them with practical experience, and the chance to build professional networks and showcase their skills to secure full-time roles.[5]

- **Professional development:** professional engineering bodies (PEBs) have improved CPD offerings by implementing stricter registration renewal requirements and introducing new training events. Additionally, the Academy's Africa Catalyst programme has supported PEBs to deliver staff training, implement policy reforms, and fund innovative initiatives.[6]

- **Entrepreneurial support:** universities have established commercialisation offices and innovation hubs to support graduates in developing entrepreneurial ventures. New competitions and fellowships encourage young engineers to apply their theoretical knowledge to develop innovative engineering solutions and provide resources to turn these into revenue-generating models.[7]


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Looking ahead

The report recommends coordinated action, bringing together governments, professional engineering bodies, intergovernmental bodies, non-African development organisations and funders, the private sector and academia to close the engineering skills gap across sub-Saharan Africa:

1. **Continue to strengthen academia–industry links to better align engineering training with evolving industry needs**
    - Higher education institutions to engage industry experts more in course design and delivery
    - Industry employers to offer more student internship and graduate placement opportunities – with governments and international funders providing financial support to aid this
2. **Standardise education and registration requirements to boost mobility for African engineers within the region and beyond, while broadening the pathways to achieve skill verification**
    - Non-African development organisations and funders to support higher education institutions to obtain regional or international accreditation for their courses
    - Intergovernmental bodies and PEBs to work together to introduce (i) regionwide professional registration requirements and (ii) systems to validate skills acquired through non-traditional learning pathways – with government support to drive policy changes
    - Higher education institutions to engage industry and NGO/CSO partners to expand access to support and funding for entrepreneurial ventures (e.g., commercialisation offices)
3. **Incentivise the hiring and upskilling of local workers on infrastructure projects to help local engineers gain valuable hands-on experience**
    - Governments to enforce local content policies and provide financial incentives (e.g., subsidies, tax benefits) to increase private sector investment in hiring and upskilling local labour
    - International infrastructure funders to prioritise bids from companies with a proven track record in local capacity building and use project-financed technical assistance from development banks to fund skilling initiatives
4. **Convene stakeholders to develop unified national and regional agendas for emerging jobs and priorities, including skill development strategies**
    - Non-African development organisations and funders to bring together stakeholders to develop skill development plans, provide flexible funding for new pilot initiatives, and advocate for scaling proven pilots
5. **Launch and scale initiatives to increase women's participation and progression in engineering**
    - Industry employers and higher education institutions to set targets, create or adapt initiatives, and track key outcomes to increase women's participation and progression
    - National and local governments and non-African development organisations and funders to provide resources and incentives to scale initiatives with a gender focus

Detailed recommendations grouped by stakeholder can be found in the **recommendations section** of this report.

4. For example, the Academy's Higher Education Partnerships in sub-Saharan Africa (HEPSSA) and Transforming Systems Through Partnerships programmes have supported the formation of multistakeholder networks in which industry partners (i) advise curriculum development, (ii) contribute to joint research and (iii) facilitate student and lecturer secondments.
5. Bridging The Gap – building capacity, local content and resilience in Rwanda's engineering sector, Engineers Against Poverty, 2019
6. Africa Catalyst, The Royal Academy of Engineering, Accessed June 2024
7. Toolbox: Improving engineering graduates' employability, The Royal Academy of Engineering, Accessed June 2024

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Background on the Royal Academy of Engineering's work to improve engineering capacity in sub-Saharan Africa

The Royal Academy of Engineering (the Academy) published the 2012 Engineers for Africa report[8] in the context of growing recognition of engineering capacity as a critical driver of sustainable development but with limited action and data available on the topic.

The report came at a time when there had been little progress on most of the Millenium Development Goals (MDGs) in sub-Saharan Africa and the impact of events such as the Arab Spring was being felt across the continent.[10] Concerns about these challenges prompted policymakers to focus more on the importance of investing in engineering and technology, and linking higher education to industrial needs.[11] Three years before the publication of the 2012 report, the Academy and its partners established the 'Africa-UK Engineering for Development Partnership' to promote mutually beneficial links between the engineering communities in sub-Saharan Africa and the UK and strengthen the capacity of the engineering profession across Africa.[12] Those involved in the partnership's programmes were convinced that achieving the MDGs, and subsequently the Sustainable Development Goals (SDGs), required significant investments in building engineering capacity. In partnership with professional engineering bodies (PEBs) and higher education institutions across sub-Saharan Africa, they launched a range of activities aimed at testing approaches.

The 2012 Engineers for Africa report shed light on the severe shortage of engineering capacity across sub-Saharan Africa and informed multiple initiatives by the Academy to address it. Speaking at an event 10 years after publication, Dr Hayaatun Sillem CBE, CEO of the Academy, said that the report had "shined a light on how severe the shortage of engineering skills was across a range of disciplines".[13] She also described how the report had informed the Academy's programmes in sub-Saharan Africa including Africa Catalyst,[14] Higher Education Partnerships in sub-Saharan Africa Programme (HEPSSA)[15] and the Africa Prize for Engineering Innovation.[16] All of these programmes are showcased in this report.

Twelve years on from the 2012 Engineers for Africa report, this report revisits the challenges, takes stock of progress and looks again to the future of engineering across sub-Saharan Africa. The need to build engineering capacity is more widely recognised than it was 12 years ago. This report outlines the challenges to building engineering capacity and provides recommendations for various decision-makers that can help address these to build engineering capacity on national and regional levels.

"The report shined a light on how severe the shortage of engineering skills was across a range of disciplines." [13]

- Dr Hayaatun Sillem CBE, CEO of the Academy

8. Engineers for Africa Report, Royal Academy of Engineering, 2012
9. MDG Report 2012, Economic Commission for Africa (et al) 2012, Accessed August 2024
10. The Arab Spring and its Impact on the Situation in Africa and Russian-U.S. Bilateral Cooperation in the Region, Wilson Center, 2011
11. See for example African Economic Outlook 2012, Africa Development Bank (et al), Accessed August 2024
12. The Africa-UK Engineering for Development Partnership, Engineers Against Poverty, 2018
13. Africa Engineers the Future: Building on 10 years of Africa-UK engineering collaboration, Accessed August 2024
14. Africa Catalyst, The Royal Academy of Engineering, Accessed June 2024
15. HEP SSA, The Royal Academy of Engineering, Accessed June 2024
16. The Africa Prize for Engineering Innovation, The Royal Academy of Engineering, Accessed June 2024

Context

Engineering is vital to the sustainable economic growth of countries worldwide.

Defined as creative thinkers, inventors and builders, engineers bring critical skills in analytical problem-solving, systems thinking, design, and innovation.[17] Engineers contribute greatly to the provision of infrastructure that enables access to healthcare, water and sanitation, electricity, and food, and are a key driver of innovation and growth.[18] Recognising this importance, prominent stakeholders including governments, funders and civil society organisations (CSOs) have prioritised building engineering capacity to accelerate sustainable development worldwide. UNESCO's 2021 report, Engineering for Sustainable Development,[19] underscores engineering's vital role in meeting the UN SDGs and calls for more quality engineers and innovative solutions.

Engineering capacity is vital to socioeconomic development across sub-Saharan Africa and ensuring the region can meet the SDGs.[20] Across sub-Saharan Africa, infrastructure development and economic activity still lag behind other regions, while global and regional trends – crucially climate change and urbanisation – are increasing the importance of infrastructure investment. Several African countries and regional bodies have formulated goals and action plans to develop essential infrastructure and create a more attractive environment for foreign investment. Successful execution of these plans will require a large supply of quality engineering expertise across different geographies, subfields and sectors. The African Union Agenda 2063[21] provides a strategic framework to accelerate the implementation of past and existing continental initiatives, such as the Integrated High-Speed Train Network, Grand Inga Dam project and Continental Free Trade Area (AfCFTA).[22] The Programme for Infrastructure Development in Africa (PIDA) is a collaborative effort to mobilise resources for cross-country projects in the energy, transport, water and ICT sectors.[23] At a country level, several African governments have also launched comprehensive infrastructure development plans, including Kenya's 'Vision 2030'[24] and Nigeria's 'National Integrated Infrastructure Master Plan'.[25]

Within that context, this report discusses current engineering capacity across sub-Saharan Africa, celebrates the progress made, identifies key challenges, and outlines potential opportunities to progress. This study considers engineering capacity in terms of the size and skills base of the local workforce relative to demand but excludes other types of capacity (such as engineering research). It is not a primary piece of research, rather it summarises some of the experience and learning of the Academy and others. It draws from a variety of secondary sources and studies, consultations between staff, Academy Fellows, awardees and stakeholders working in and for Africa, as well as other multinational organisations, supplemented with insights from additional interviews.[26] The analysis is not exhaustive and recognises that the challenges identified vary extensively across the subregions and countries of sub-Saharan Africa. Local and regional examples highlight these nuances where appropriate. However, there are sufficient regional touchpoints and coordination to establish a general context around engineering capacity and present a solid understanding of the most pressing issues and promising solutions. The report aims to stimulate action among regional, national, and local stakeholders, fostering a coordinated approach to enhance engineering capacity and unlock its full growth potential.[27]

17. Thinking like an engineer", The Royal Academy of Engineering, 2014 (referencing Six Engineering Habits of Mind)
18. Engineering to meet the Sustainable Development Goals, The Royal Academy of Engineering, Accessed September 2024
19. Engineering for Sustainable Development, UNESCO, 2021
20. Future of Jobs, World Economic Forum, 2023
21. Agenda 2063: The Africa We Want, African Union, Accessed August 2024
22. Flagship Projects of Agenda 2063', African Union, Accessed August 2024
23. Program for Infrastructure Development in Africa, African Development Bank Group, Accessed August 2024
24. Kenya Vision 2030, Kenya State Department of Economic Planning, Accessed August 2024
25. Reviewed National Integrated Infrastructure Master Plan, Nigeria Federal Ministry of Finance, Budget and National Planning, 2020
26. See section 6.2 in the Annex for more details on the report methodology and information sources.
27. See also the Global Engineering Capability Review (GECR) 2024, which calls for actors across the engineering capacity system, from individuals to industry to governments, to work together to achieve safer engineering outcomes: https://engineeringx.raeng.org.uk/programmes/skills-for-safety/global-engineering-capability-review

RAEng/Kit Oates

The status of engineering in sub-Saharan Africa

Engineering capacity continues to be crucial to sustainable development.

Engineers, as creative problem-solvers and innovators, contribute to diverse fields like civil, software, biomedical, and industrial engineering. Their expertise is vital across all aspects of the economy including advancing research, improving data systems, and developing infrastructure.[28] [29] Global and regional challenges such as climate change affect sub-Saharan Africa disproportionately,[30] and are further accelerating the demand for skilled engineers in the region. Addressing this need swiftly and attracting more of the region's youth to engineering is vital to achieving development goals and fostering a sustainable future.

RAEng/James Oatway

Some of the most pivotal and interconnected trends with implications for engineering capacity include:

- **Industrialisation.** Despite comprising 17% of the world's population, Africa accounts for less than 2% of global manufacturing output.[31] Recent disruptions to global supply chains have amplified the importance of reducing dependency on imports with more localised production.[32] Accordingly, many African countries, with support from non-African funders, are prioritising expansion of their manufacturing and industrial sectors, evident in plans such as the African Development Bank's 'Industrialise Africa' strategy,[33] Ghana's One District One Factory initiative,[34] Ethiopia's 10-year development plan[35] and Rwanda's National Strategy for Transformation.[36] In line with these ambitions, there is a growing demand for the expertise of manufacturing, industrial and chemical engineers.

- **Climate change.** The African continent is set to be one of the regions hardest hit by climate change. Rising temperatures and more extreme weather events have significant implications for local communities and economies because of a heavy reliance on vulnerable sectors (e.g., agriculture), high poverty burden, gaps in climate data and warning systems, and funding constraints on adaptation efforts.[37] To address these challenges, there is a need for a wide range of engineering expertise to decarbonise industries including transport and logistics, enhance infrastructural resilience and develop localised solutions for systemic impact across sub-Saharan Africa. At the same time, aligning industrialisation efforts with climate targets requires investing in new skills.[38]

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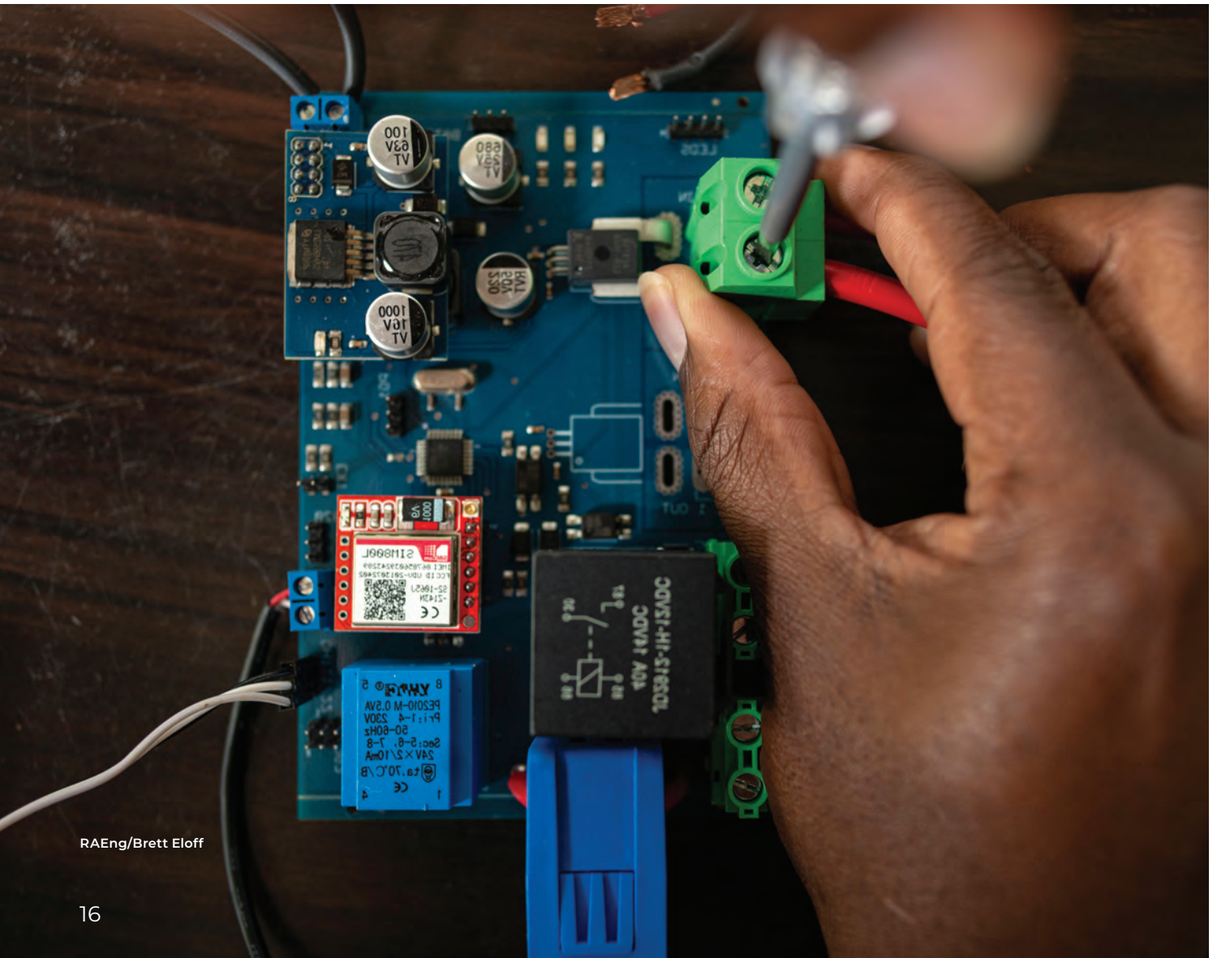
- **Urbanisation.** Sub-Saharan Africa is the world's fastest urbanising region with an annual urbanisation rate of 4% over the last decade,[39] driven by strong population growth, rural-to-urban migration, and rural densification,[40] with the number of people living in cities doubling to more than one billion by 2042.[41] There have already been some significant efforts to strengthen critical infrastructure in rapidly growing African cities. For example, the African Development Bank's Urban and Municipal Development Fund (UMDF) has supported 35+ cities in 20+ countries to improve urban planning, prepare concrete infrastructure projects and secure investment since 2019.[42] However, more public and private investment is needed to improve access to healthcare, transport and other necessities. As reported by the World Economic Forum, 60% of residents in African cities reside in poor conditions,[43] a number that risks being compounded by growing urbanisation, the climate crisis and new health threats. Addressing these challenges through large-scale projects will require the diverse expertise of civil, electrical, transportation and other engineers.[44]

28. Global review of engineering response to COVID-19, The Royal Academy of Engineering & Dalberg, 2022
29. Department of Engineering – Strategy, University of Cambridge, Accessed June 2024
30. Africa faces disproportionate burden from climate change and adaptation costs, WMO, 2024
31. State of Africa's Infrastructure Report 2024, Africa Finance Corporation, 2024
32. Manufacturing Africa's Future, McKinsey, 2023
33. Industrialize Africa, African Development Bank Group, Accessed June 2024
34. About Us, One District One Factory, Accessed June 2024
35. Ethiopia 2030: The Pathway to Prosperity Ten Years Perspective Development Plan, Food and Agriculture Organization, 2021
36. 7 Years Government Programme: National Strategy for Transformation, Food and Agriculture Organization, 2017
37. Africa Energy Outlook 2022, International Energy Agency, 2022
38. Paris Agreement Status of Ratification, UN Treaty Collection, Accessed August 2024
39. Urbanization in sub-Saharan Africa, Center for Strategic and International Studies, 2018
40. Africa's Urbanisation Dynamics, African Development Bank Group, 2022
41. Rapid Urbanization in Africa, World Bank Group, 2017
42. African Development Bank, UMDF Annual Report 2023, 2024
43. African cities will double in population by 2050. Here are 4 ways to make sure they thrive, World Economic Forum, 2018
44. Engineering for Sustainable Development, UNESCO, 2021

- **Digitalisation and artificial intelligence (AI).** Increasing connectivity across sub-Saharan Africa unlocks opportunities for a range of digital solutions – such as mobile money, e-learning platforms, telemedicine and digital agriculture – that expand access to essential services or make processes more efficient. With around 240 million people using mobile internet regularly and the mobile subscriber base projected to surpass 600 million by 2025, the digital landscape is expanding rapidly.[45] This surge in connectivity and the advent of emerging technologies, particularly AI,[46] will drive further growth and intensify the demand for skilled data, software, and engineering professionals to innovate and tailor solutions for local challenges. The African Union has adopted a Continental Artificial Intelligence Strategy that provides guidance to its member states on how to harness AI to meet their SDGs, focusing on capacity building, investment, risk mitigation and regulation, and inclusive governance.[47]

  As generative AI models to date have been trained mostly with data from the US, Europe and China, there is a need for expertise in cloud infrastructure, data collection and computing to ensure AI solutions are suitable for use in sub-Saharan Africa.[48] National policies must also be strengthened to ensure there are adequate regulations around data privacy and AI use.[49]

Engineering capacity will need to keep increasing to overcome present and future challenges across sub-Saharan Africa. Industry reports and interviews indicate employers in sectors such as construction, ICT, and logistics have experienced a shortage of suitably experienced candidates for available positions.[50] At the same time, many qualified engineers are finding it difficult to access suitably skilled employment, indicating a potential mismatch in the skills of engineers and those required by employers.[51] As well as a mismatch in skills, there are too few engineers in some countries and sectors to meet the rising demand.



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RAEng/GGImages/Luke Dray

Closing the engineering capacity gap therefore will require:

- **Better aligning the skills of engineers with the needs of employers.** There is often a mismatch between the skills of local engineers and industry needs in sub-Saharan Africa.[52] During interviews for this report, employers in West, East and Southern Africa noted that African engineering graduates often lack practical experience and non-technical/soft skills, necessitating significant investment in onboarding. This is a common challenge globally that has significant consequences in resource constrained environments. They also observed that many project developers and funders prefer to import foreign engineers for more senior or specialised positions as they struggle to find the technical expertise needed in the local market.[53]

- **Increasing the number of engineers to meet rising demand.** Although numbers vary considerably across countries and sub-fields,[54] UNESCO has identified Africa as the region with the lowest number of engineers per capita in the world[55] and the quantities in sub-regions lag behind global averages.[56] Recent publications have also pointed to the shortage of engineers as a critical barrier to socioeconomic progress and identified building skilled capacity as essential to growth in emerging sectors such as renewable energy and electric mobility.[57] However, efforts to increase the quantity of engineers must be accompanied by sufficient investment in quality training and engineering projects they can work on if this is to help further skills building and accelerate sustainable development.

45. The Mobile Economy sub-Saharan Africa, GSMA, 2023
46. The State of AI in Africa Report, GSMA, 2023
47. Continental Artificial Intelligence Strategy, African Union, 2024
48. Artificial intelligence and Africa, United Nations, 2024
49. Reforming data regulation to advance AI governance in Africa, Brookings, 2024
50. Skilled Workers Demand is High, But There's a Shortage in Africa, Workpay, 2024
51. Dalberg interviews with recent engineering graduates in Southern and East Africa, July 2024
52. In a 2022 survey, >80% of employers in South Africa's engineering-heavy construction, ICT and manufacturing sectors reported difficulties filling engineering and technical roles; Source: South Africa's 2022 Talent Shortage, Manpower Group, 2022
53. Dalberg interviews with private sector employers across sub-Saharan Africa, June & July 2024
54. There is significant variation across the Southern African Development Community (SADC) with 1 engineer for every ~5,500 people in Malawi versus 1 for ~380 people in Botswana. In East Africa, there was 1 registered engineer for every ~8,000 people in Tanzania, ~30,000 in Uganda, and ~825,000 in Burundi in 2021. Sources: Improving competences of engineering graduates through student industrial secondments, STIPRO Tanzania, 2022; SADC, 2018 SADC Research – SADC Research site for SAICE-PDP
55. Engineering for Sustainable Development, UNESCO, 2021
56. In contrast to a global average of >50 engineers per 10,000 people, quantitative assessments of engineering capacity in sub-Saharan Africa have estimated that there are <2 in the East African Community and <7 in the Southern African Development Community; Sources: Engineering Numbers & Needs in the SADC Region, SADC, 2018; Tracer Study on Destination of Graduate Engineers from Public and Private Universities in Kenya, Kenya Ministry of Education, 2023
57. Engineering for Sustainable Development, UNESCO, 2021; Help Us Engineer a Better Sustainable World, World Federation of Engineering Organizations, Accessed August 2024

Challenges to building engineering capacity

Sub-Saharan Africa's engineering capacity is constrained by interconnected challenges across the engineering career journey[58] (Figure 1).

African universities and TVET institutions often battle with inadequate funding, outdated curricula, and limited practical training opportunities.[59] Many graduates struggle to find quality jobs because of a mismatch between learned and necessary skills for engineering roles. This contributes to a cycle in which the lack of local skills leads to employers seeking skills from other countries or regions, further depriving local engineers of opportunities to acquire practical experience. Private sector employers interviewed for this report noted that they must take on the burden of upskilling engineers across their careers, but they lack the capacity to do this on the scale needed without additional support and investment.[60] Significant progress has been made to address these challenges since the publication of the 2012 report, but they continue to be a constraint to delivering sufficient engineering capacity – **section 4** of this report covers this progress.

"Poor quality education leading to insufficient output from training institutions is the biggest challenge for engineering capacity. Most of what is being taught to students is very theoretical and they are not exposed to practical knowledge from the outset."

- Senior representative from professional engineering body in West Africa

"Academically there are a lot of loopholes. The technical base [of engineering graduates] does not exist because academic training is not up to date with the latest tools and practices and does not focus enough on the application of technical principles to different settings."

- Private engineering firm in East Africa

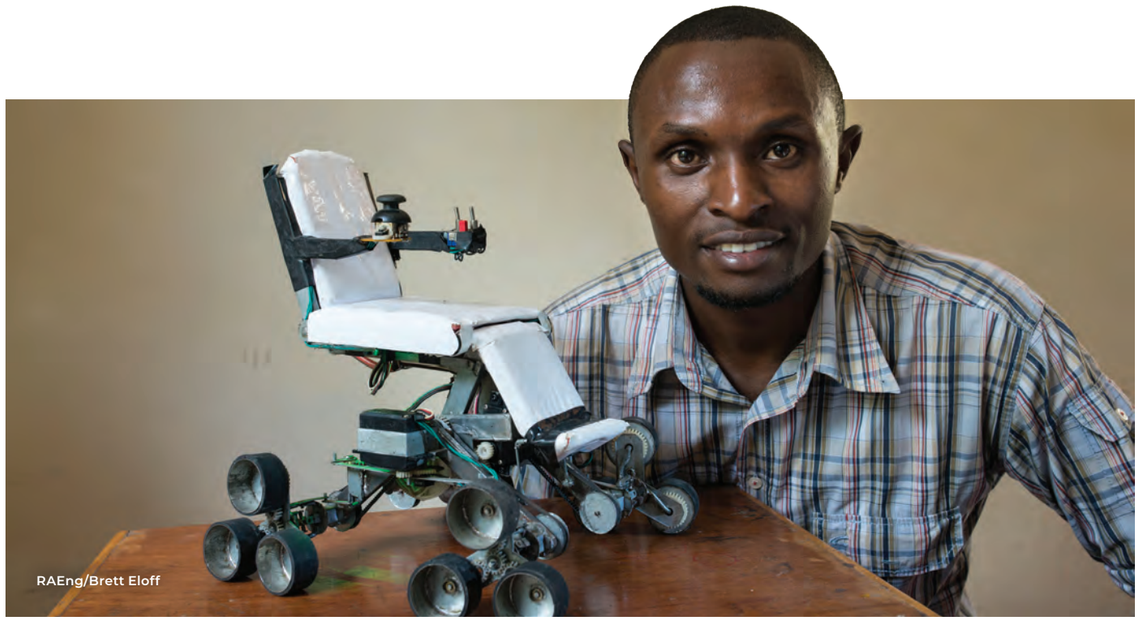
Technical education and qualifications

Many aspiring engineers graduate from African institutions without the practical and soft skills required for entry-level engineering jobs. University and TVET courses often focus on theoretical knowledge and are not up to date with the latest changes in industry. This is a challenge worldwide,[61] but interviewees flagged that budget constraints and a lack of links to employers increase the scale of the challenge in many academic institutions across sub-Saharan Africa.[62] According to recent engineering graduates and a PEB representative interviewed for this report, courses provide limited practical training on the latest tools and techniques and often do not cover non-technical topics, such as ethics, teamwork and business management.[63] A 2023 review of engineering education in Africa identified a lack of funding, inadequate staff training, and outdated curricula as some of the biggest challenges for engineering departments at African higher education institutions.[64] Budget constraints hinder their ability to upgrade equipment and pay competitive compensation to retain academic staff with more experience.[65] As a result, the staff teaching engineering courses often do not have the higher-level academic qualifications or experience (as educators or practising engineers) needed to deliver content to students in an effective manner.[66] Staff shortages also increase the size of classes, reducing the individual attention and assistance

Figure 1: Journey for building engineering capacity and challenges at each step

Journey →	General education (primary & secondary)	Technical education & qualifications	Education to employment	Progression within employment
Challenges	Not covered in this report	There is a mismatch between the skills of many qualified engineers and employer requirements • Engineering graduates often lack non-technical skills and practical knowledge • Limited industry involvement to refine training curricula hinders alignment with its present needs	Recent graduates do not have sufficient opportunities to gain valuable practical experience • Graduates have insufficient opportunities to develop skills in professional environments (e.g., graduate placement programmes) • Limited standardisation of education and professional registration constrains the mobility of entry-level engineers • The quality of on-the-job training differs significantly across firms • Limited support is available to help entrepreneurial ventures launch and scale	Limited compensation and access to upskilling restrict advancement in the local job market • Limited access to CPD makes it difficult for engineers to stay up to date with developments in industry • Few initiatives exist to equip engineers with additional skills for new jobs in evolving industries • Outsourcing for senior roles limits local engineers' exposure to complex tasks and their promotion prospects • Many engineers emigrate to other geographies in search of more opportunities or higher pay
	Disproportionate impact on women and other marginalised communities			
	The impact of technology on the work of engineers			

58. See also the Global Engineering Capability Review (GECR) 2024, which emphasises the importance of taking a systems approach to building engineering capacity: https://engineeringx.raeng.org.uk/programmes/skills-for-safety/global-engineering-capability-review
59. Engineering Education in Africa: Challenges and Mitigation Measures, Falade, 2023
60. Dalberg interviews with private sector employers in East and Southern Africa, June & July 2024
61. In 2019, The Academy's Global Engineering Capability Review identified concerns about graduates' soft skills and outdated coursework as universal challenges for engineering education; Source: Global Engineering Capability Review, The Royal Academy of Engineering, 2019
62. Dalberg interviews with a private sector employer, engineering graduate and lecturer in sub-Saharan Africa, July 2024
63. Dalberg interviews with recent engineering graduates in East and Southern Africa and PEB representative in West Africa, July 2024
64. Engineering Education in Africa: Challenges and Mitigation Measures, Falade, 2023
65. Dalberg interviews with recent engineering graduate and engineering lecturer at a public university in Southern Africa, July 2024
66. Transforming Engineering Education in Sub-Saharan Africa: A case for Nigeria, Fomunyam, 2020


RAEng/Brett Eloff

each student can receive from the instructor.[67] These challenges are amplified in lower-income countries on the continent.[68]

At the same time, limited private sector involvement in education has restricted (i) the integration of industry perspectives in course materials and (ii) opportunities for students to acquire relevant work experience during the academic year.[69] [70] In countries with government schemes that mandate industrial work experience as a graduation requirement for engineering students, a lack of funding and organisational capacity (of employers and universities) has hindered effective enforcement, meaning many students still do not have the opportunity to complete a placement in which they gain useful practical experience.[71] Underfunded or inadequately run internship programmes also contribute to this issue, leaving aspiring engineers with limited opportunities to practise skills that are relevant to the workplace.

Education to employment

The mismatch between industry requirements and skills of recent graduates means many newly qualified engineers struggle to find or excel in quality jobs. Graduate placement programmes remain uncommon across sub-Saharan Africa, which has also made it difficult to attract buy-in from employers to introduce more.[72] Challenges securing a first job dampen future career

"They do not teach the principles of engineering [in African universities]. They teach the code."

- Private sector employer in East Africa

prospects by limiting opportunities to gain essential experience, develop professional skills, and build a network. Limited standardisation of education and professional registration requirements across countries also constrains the job prospects and mobility of entry-level engineers with African qualifications as employers lack a consistent mechanism to verify skills.[73]

When employers do hire local graduates, they must invest heavily to provide the on-the-job training to bridge the knowledge and skills gaps of new employees. During interviews for this report, employers in East, West and Southern Africa noted that the onboarding processes and training needed to bridge the skill gaps of entry-level recruits require substantial financial and human resources.[74]

"Engineering is taught outside the university. Universities only teach you how to learn."

- Senior representative from international engineering NGO based in West Africa

"There is an emerging mesh of entrepreneurial activity and good universities in hubs like Nairobi, Lagos and Cape Town but networks are still patchy."

- President of engineering body and venture investor working across sub-Saharan Africa

Many firms lack the capacity to help graduates bridge this skills gap and therefore reduce the number they hire. Limited on-the-job training at the start of their careers has long-term implications for the employment prospects of African engineering graduates; even after years of working, they encounter challenges when transferring roles as their accumulated expertise does not match the expectations of their new employers for the number of years worked.

Similarly, it is challenging for engineering graduates to transition from education to starting their own businesses. Not only does this group have limited real-world engineering experience, financial expertise and business management skills, but they also can lack access to key resources in Africa's nascent entrepreneurial ecosystem. In 2023, Africa accounted for <1% of the global venture capital volume.[75] While key hubs have emerged in larger cities such as Accra, Cape Town,

"Funding is very unevenly distributed. Investors must realise there are more than three countries in Africa."

- Startup founder in Southern Africa

Lagos, Kampala, Kigali, and Nairobi, support for students and recent graduates who wish to pursue entrepreneurship – such as tech transfer offices at universities, research-to-commercialisation programmes and other accelerator opportunities – remains limited and unevenly distributed. Challenges for new ventures exist in obtaining funds, finding suitable business partners, overcoming physical infrastructure gaps, and surviving competition from larger, more established organisations. Limited and inconsistent availability of venture capital and market intelligence further constrain any efforts to grow entrepreneurial businesses.

67. Dalberg interviews with recent engineering graduates in Southern and East Africa, July 2024
68. Dalberg interview with private engineering consulting firm in Southern Africa, June 2024
69. Building pathways to sustainable growth, African Development Bank Group, 2023
70. Dalberg interview with engineering lecturer at a public university in Southern Africa, July 2024
71. Achieving the effectiveness of the Students Industrial Work Experience Scheme for sustainability of the Nigerian economy, Alao, 2022
72. Toolbox: Improving engineering graduates' employability, The Royal Academy of Engineering, Accessed June 2024
73. Dalberg interview with senior representative from regional NGO, July 2024
74. Dalberg interviews with private employers in East, West and Southern Africa, June & July 2024
75. Venture Capital in Africa Report, AVCA, 2024
76. Dalberg analysis; Sources: African Small and Medium Enterprises (SMEs) Contributions, Challenges and Solutions, Muriithi, 2017; Challenges of Doing Business in Kenya - Kasi Insight; The Challenges and Opportunities of SME Financing in Africa, SME Finance Forum, 2018; Catalyst for Growth Initiative in South Africa: Final Report, JPMorgan Foundation & Dalberg, 2014; Landscape Study of Accelerators and Incubators in East Africa, GALI, 2020


RAEng/Brett Eloff

RAEng/Kit Oates

Figure 2: Common challenges at key stages of an entrepreneurial journey in Africa[76]

Venture Stage / Challenge Type	Seed/Startup	Growth/Scale
Funding	• Limited availability of R&D, innovation & project finance • Investor aversion to higher-risk unproven models • Unwillingness to lend to early-stage ventures or unfavourable loan conditions (larger collateral, higher interest rates and extra bank charges)	• Misalignment between entrepreneur expectations and accelerator service offering (leads to high drop-out rates) • Lack of low-cost growth capital • Lack of post-investment support
Operational	• Difficulties finding suitable co-founders/partners • Lack of qualified personnel to build team	• Limited awareness of appropriate business development services (and few mechanisms to assess their quality) • Challenges formulating growth and marketing strategies • Challenges identifying and connecting with growth partners • Difficulties managing growing workforce
Human Capital & Knowledge	• Little prior management and business experience • Lack of reliable data from government/service providers • Limited financial knowledge • Limited market intelligence	• Low capacity and need for upskilling to facilitate growth • Lack of knowledge on consumer demand/preferences in new markets
Market & Environment	• Infrastructure challenges (electricity & water shortages) • Regulatory hurdles (with limited policies specific to entrepreneurial ventures) • Competition from larger, more established organizations • Cash flow uncertainty • Costly efforts to keep up with technological advancement • Limited defensibility of product(s)	• Underdeveloped sales channels • Lack of access to high-value markets • Logistical and regulatory obstacles to expansion.

RAEng/Kit Oates

Upskilling and progression within engineering

Engineers often experience barriers to progression or mobility throughout their careers. African engineers have less access to CPD than in other regions, making it difficult for them to stay up to date with the latest developments in industry best practices and standards and adapt to perform optimally in their current roles.[77] Those interviewed report that CPD offerings have increased over the last decade but there is a need for further improvement. In a 2022 survey of engineers across sub-Saharan Africa, only 46% agreed that engineers in their country have access to sufficient CPD courses after graduating.[78] In many countries, nascent or resource constrained PEBs, the primary providers of CPD, do not have the capacity, funding nor reach to engage and support all the engineers in their locale.[79]

"You need to have the right (more challenging) projects to build practical skills."

- Private engineering consultancy in Southern Africa

There are also limited opportunities for African engineers to build skills for (i) more advanced roles or (ii) jobs in new sectors. Employers do not invest consistently in upskilling local engineers and often recruit foreign engineers for more senior and specialised positions, reducing African engineers' exposure to the more challenging tasks that facilitate the development of stronger technical and leadership skills. According to private sector employers interviewed for this report, there are few effective mechanisms to encourage or mandate local labour inclusion and skills transfer on privately, nationally or internationally funded projects.[80] With growing demand for engineering skills in newer sectors (for example, renewable energy and electric mobility), initiatives that allow engineers to build expertise on these topics specifically have become even more critical. Multiple countries are addressing this need through policy interventions and investing in CPD offerings,[81] but more must be done as opportunities for engineers remain limited across sub-Saharan Africa.[82]

"Funders often bring engineers from elsewhere for complex technical tasks and use local engineers as contractors for simpler roles."

- Private engineering consultancy in Southern Africa

Emigration of African engineers further complicates this issue. National PEBs across sub-Saharan Africa have reported a substantial loss of experienced professionals to other locations, such as the UK, US, Canada, and France,[83] as systemic issues in the local job market push them to search for more opportunities and better compensation elsewhere. From 2015 to 2018, there was an 11% decline in the professional member body of Consulting Engineers South Africa because of emigration.[84] Beyond its direct impact on the quantity of engineers on the continent, the exodus of experienced professionals further reduces the pool available to supervise, train and mentor engineers at earlier stages in their careers.[85]

Across the journey, these challenges disproportionately impact women

There has been considerable progress in increasing women's participation in higher education across sub-Saharan Africa, evident in a four-fold increase in overall women's tertiary enrolment between 1990 and 2020.[86] However, gender norms and sociocultural barriers still limit many aspiring female students from pursuing engineering professions in the region. A 2022 survey of 38 higher education institutions in nine countries found that women students comprised only 27% of their engineering enrolment versus 56% of their total enrolment for all disciplines.[87] Consistently, in 2023, women comprised only 14% of the Engineering Council of South Africa's total registrations[88] and only ~8% of registered engineers in Kenya were women.[89] Biases and harassment remain key barriers; while culture, family and the media also tend to promote stereotypes and discriminatory practices that discourage girls from pursuing STEM careers.[90] [91]

RAEng/James Oatway

77. Toolbox: Continuous professional development, The Royal Academy of Engineering, Accessed June 2024
78. U&A on the State of the Engineering in Africa, Sagaci Research, 2022
79. Dalberg interviews with private sector employer in East Africa & senior representative from a regional NGO, July 2024
80. Dalberg interviews with private sector employers across sub-Saharan Africa, June & July 2024
81. For example, Kenya's Green Economy Strategy and Implementation Plan, Nigeria's Renewable Energy and Efficiency Policy and Rwanda's Green Growth and Climate Resilience Strategy target green skills development, particularly in engineering and other STEM fields; Sources: Green Economy Strategy and Implementation Plan 2016-2030, Government of Kenya, 2016, National Renewable Energy and Energy Efficiency Policy (NREEEP), FAO, 2015, Revised Green Growth and Climate Resilience, Republic of Rwanda, 2022
82. Dalberg interview with private sector employer in Southern Africa, July 2024
83. Africa's migration and brain drain revisited, Firsing, 2024
84. South Africans are emigrating with some of the scarcest most valuable skills, Business Tech, 2019
85. Dalberg interview with a private engineering firm in Southern Africa, June 2024
86. School enrolment, tertiary, female (% gross) – sub-Saharan Africa, World Bank Group, Accessed August 2024
87. Women's participation in higher education in Southern Africa, UNESCO, 2024
88. ECSA Annual Report 2022/2023, Engineering Council of South Africa, 2023
89. International Day of Women and Girls in Science, Alliance for Science, 2023
90. STEM education and inequality in Africa, United Nations, 2022
91. Dalberg interview with young women engineer in Southern Africa, July 2024


RAEng/GGImages/Patrick Meinhardt

"Women are often discouraged from pursuing engineering and biases in employers often slows development when they do. We need to remind the community that it is okay for girls to be engineers. Women can still bare children and do other things."

- Woman engineer in Southern Africa

For women already in engineering, gaps to progression and promotion are amplified in contrast to their male counterparts. Many women who are engineers encounter unconscious bias, limited workplace flexibility, and restricted promotion paths.[92] [93] This has contributed to a cyclical problem: women engineers who are not given major projects miss out on essential project management experience, prompting questions around their ability to handle bigger challenges. At the same time, the limited number of women engineers in senior positions across sub-Saharan Africa discourages younger women from entering or progressing in the male-dominated profession.[94]

The impact of technology on engineering work has the potential to exacerbate challenges across the career journey

Technological advancement continues to reshape the work environment of engineers worldwide, making some expertise obsolete and creating demand for new skills and channels through which to develop them. For example, new AI solutions have emerged that engineers can use to automate laborious processes and dedicate more time to higher-order tasks like design and quality control.[95] Digital and non-digital technologies are also influencing the delivery of infrastructure and services and thereby the expertise engineers need to work on related projects. In the transport sector, for example, the growing sophistication of infrastructure requires expertise in associated fields like AI, but its complexity also requires inputs from system engineers and architects. The most sought-after engineers in these situations are those who have experience across several disciplines and understand how various systems interact and support each other.[96] This has led to an increased emphasis on multidisciplinary engineering degrees and the use of multidisciplinary teams to deliver projects.[97] The implications of these changes on the type of skills engineers will require in the future is profound.

Technological advancement and infrastructure investment have exacerbated challenges faced 12 years ago

The 2012 summary of the Engineers for Africa report highlighted a set of similar challenges to engineering capacity, including a lack of skilled and experienced engineers, low levels of public investment and national engineering accreditation standards, and a loss of engineering talent to other countries.[98] Recent trends in infrastructure investment and technology further bolster the need to boost engineering capacity across sub-Saharan Africa through focused skills training, better education-to-employment transitions, and more upskilling and career development initiatives aligned with current employer needs.

92. Industry needs to address challenges to retain female engineers, Engineering News, 2023
93. Dalberg interviews with representatives from a multilateral organisation and PEB based in West Africa, June & July 2024
94. Industry needs to address challenges to retain female engineers, Engineering News, 2023
95. Explore the most significant technological advancements in engineering, Atkins Réalis, 2023
96. Six Ways Technology Is Changing Engineering, IndustryWeek, 2018
97. The Rise of the Multidisciplinary Engineering Team, ASME, Accessed September 2024
98. Engineers for Africa Report, Royal Academy of Engineering, 2012

RAEng/GGImages/Patrick Meinhardt

Progress towards building capacity

The success of individual initiatives to improve engineering capacity, albeit at a modest scale, demonstrates that persistent challenges are not insurmountable.

The Academy and other diverse stakeholders (including African policymakers, private employers, academic and professional institutions, development and civil society organisations) have demonstrated solutions that address the underlying causes of low engineering capacity identified in **section 3**. Their experiences have also clarified how to deliver these in a cost-effective and practical manner, an important consideration in low-income countries where public budgets are constrained. This section highlights specific interventions across the engineering career journey that can guide the replication and scaling of solutions across sub-Saharan Africa.

Initiatives to improve the quality of technical training have focused on improving the links between academic institutions and employers to (i) better align coursework with industry requirements and (ii) increase student exposure to the workplace. For example, the Academy's Higher Education Partnerships in sub-Saharan Africa (HEP SSA)[99] and Transforming Systems Through Partnerships (TSP)[100] programmes have supported the formation of multistakeholder networks through which industry partners advise on curriculum development, contribute to joint research, and facilitate student and lecturer secondments. The World Bank has also established Africa Centres of Excellence (ACE) at higher education institutions that specialise in engineering and other technical fields to involve industry partners in training and applied research.[101] These activities have increased the integration of industry perspectives in the classroom, broadened students' practical skills and established platforms for ongoing collaboration.

Africa Centres of Excellence (ACE)

WORLD BANK GROUP

Capacity building, industry linkages & applied research

Objectives

The Africa Centres of Excellence (ACEs) aim to strengthen the capacity of universities to deliver high quality training in STEM and other technical fields and conduct applied research to address development challenges on the continent.

Activities

The World Bank has collaborated with national governments to establish 54 ACEs at higher education institutions in 17 countries across West, East and Central Africa. ACEs facilitate technical assistance to help the host institutions implement improved governance and management processes as well as partnerships through which industry players (i) contribute to academic research and course delivery, (ii) provide internship opportunities for students and (iii) support the commercialisation of research outcomes.

Lessons Learnt

- Practical sector-based internships have improved the employability of students.
- Mandatory industry advisory boards have increased the industry relevance of curricula and teaching methods.
- Results-based financing has motivated ACEs to achieve objectives (e.g., female enrolment) quickly and enabled comprehensive data collection to monitor impact.
- Technical assistance has helped several host institutions obtain international accreditation for their postgraduate programmes.
- Rigid and complex regulations have constrained the procurement of large equipment and civil works to upgrade facilities.
- Limited staff at host institutions has created difficulties in the assignment of individuals to oversee projects with full dedication.

As technological advancement transforms engineering work, initiatives have also emerged to help engineers develop additional soft skills such as project management, systems thinking, multidisciplinary collaboration, ethics and sustainability. These are now being included in engineering curricula and teaching methods, as well as becoming part of engineering practice.[102]

Engineering X[103], a growing collaboration between the Academy and Lloyd's Register Foundation[104], through its skills programmes[105] has promoted innovative education tools and multidisciplinary approaches to tackle safety and sustainability challenges. This includes encouraging the incorporation of systems thinking and safety in curricula, as well as the development of new methods for teaching engineering competencies[106]. In sub-Saharan Africa, the programme has supported academic institutions to develop systems thinking[107] skills to apply to energy sector challenges in Kenya and fire risk emergence in Cape Town.

Safer Complex Systems Programme

EngineeringX

Systems thinking in education and governance to strengthen safety

The Safer complex systems programme promotes the use of systems approaches to enhance the safety and implementation of complex engineering challenges . It supports the incorporation of systems thinking in engineering courses and encourages the application of systems approaches to urgent issues such as the energy transition.

Project Spotlight

University of Strathmore, Nairobi, Kenya Applying systems approaches to energy supply

The University of Strathmore received support to develop skills in systems approaches. They then explored and mapped issues of governance in Kenya's energy system through participatory workshops with key stakeholders, focusing on solar-based component systems and mini grids. The discussions provided a better understanding of the main challenges, motivating the Strathmore team to update their curricula to teach students how to think and work beyond silos effectively.

99. Evaluation of the Higher Education Partnerships in sub-Saharan Africa Programme, Technopolis, 2021
100. Evaluation of the Transforming Systems through Partnerships Programme, Technopolis, 2023
101. World Bank ACE Case Study Sources: Summary - Nimble Impact Evaluation of the Africa Higher Education Centers of Excellence (ACE) Program, World Bank Group, 2023; About The Africa Higher Education Centers of Excellence (ACE) Project, ACE, Accessed August 2024
102. On a global level, The Academy's 'Engineers 2030' initiative is exploring how to adapt engineering knowledge, skills and behaviours for the 21st century. It examines what and how we currently teach engineers and technicians to determine if current systems and policies deliver what we need in the future; Source: Engineers 2030, The Royal Academy of Engineering, Accessed October 2024
103. https://engineeringx.raeng.org.uk/
104. https://www.lrfoundation.org.uk/
105. https://engineeringx.raeng.org.uk/programmes
106. See Transforming Systems through Partnership pg 24.
107. Safer Complex Systems, Engineering X, Accessed October 2024

Higher Education Partnerships in Sub-Saharan Africa (HEP SSA)

Royal Academy of Engineering

Stronger academia-industry linkages & curriculum improvement

Objectives

The Academy's HEP SSA programme aims to address the engineering skills shortage in sub-Saharan Africa through collaborations involving many academic and industry partners that facilitate the incorporation of the latest industry practices in higher education courses to ensure they produce engineers with the expertise to meet industry needs.

Activities

With funding from the Global Challenges Research Fund (GCRF) and Anglo American Group Foundation, the Academy has funded 50+ HEP SSA projects involving 100+ higher education institutions across 17 countries since 2013. Eligible projects range from 6 months to 2 years and include activities such as curriculum development and review, joint research, academia-industry secondments, or training and workshops. The programme's hub and spoke delivery model requires the applicant university to partner with other local universities, industry partners and UK-based academic partners to qualify for funding.

Lessons Learnt

- Lecturer secondments to industry have increased the integration of current industry perspectives into curricula and teaching methods.
- Hub-and-spoke delivery model has established networks for ongoing collaboration among grantees and their academic/industry partners.
- Ample flexibility from the Academy and GCRF has accommodated the varying priorities of and regional/cultural differences across projects.
- Limited pipeline of female staff/students has required the rollout of clear inclusion guidelines to improve the gender balance grantee projects.

Project Spotlights

Makerere University (Uganda) | 2016 – 2018

Improving teaching methods & training content through industry engagement & international collaboration

Makerere University engaged the University of Leeds and seven higher education institutions in East Africa for a series of workshops and industry-academia exchanges to inform modifications to engineering courses. The project led to (i) the adoption of a problem-based learning approach, (ii) a new curriculum with direct industry involvement in the form of two-way secondments and research projects and (iii) an ongoing collaborative initiative to strengthen technical capabilities in biomedical engineering in the region.

University of Zambia | 2017 - 2019

Engaging industry partners to produce quality and employable engineering graduates

The University of Zambia and four partner institutions collaborated to improve their linkages with local industry. The project specifically aimed to increase the number of students getting industrial placements, establish a two-way staff exchange programme and align classroom tools and technology with those of current practitioners. As a result, the number of industrial placements increased from 40 to 90% of students and 10 bilateral secondments took place between academic faculty and industry representatives.

Transforming Systems through Partnership (TSP)

EngineeringX

Collaborative course design, challenge-led research & bilateral exchanges

Objectives

The Academy's TSP programme aims to foster challenge-led research and innovation to address sustainable development challenges, equip young engineers and researchers with relevant skills and experience, and promote collaboration for building better systems globally.

Activities

With support originally from the Newton Fund and now the International Science Partnership Fund (ISPF), the Academy has funded 41 TSP projects in South Africa since 2015. To be eligible for TSP funding, a partnership must consist of at least one university or research institution, one industry organization (ranging from startups to national-level companies) in the partner country, and one university in the UK. Core project activities include joint research projects, bilateral visits and exchanges, and capacity building. In addition, partners develop professional training modules for early-career engineers, advise the reform of higher education curricula and participate in networking and community engagement.

Lessons Learnt

- Collaborative design and delivery have contributed positively to the relevance and quality of higher education curricula.
- Working on real-world problems has broadened students' practical skills, research literacy and career horizons.
- Denser cross-sector networks have improved knowledge sharing processes and strengthened the wider research and innovation systems in participating countries.
- UK university participation has yielded mutual benefits in the form of wider research portfolios, the ability to engage more students in research, better talent mobility and acquisition and more knowledge of global industrial challenges. However, some applicants have required additional support to overcome difficulties finding UK partners.
- Country-level grant management has led to some challenges in access to funds, financial constraints and practical issues

Project Spotlights

University of Pretoria | Since 2022

Designing and implementing innovative integrated engineering curricula across South African universities

With support from UCL, the University of Pretoria brought together teams from seven engineering schools in South Africa to develop a framework for an integrated curriculum. This blends technical skills with skills for employability and interdisciplinary approaches, focusing on developing clear methodologies to test student competencies. This approach has led to a broader pan-Africa project funded by the EU that is developing a community of practice across South Africa, Uganda, Kenya and Nigeria.

University of Cape Town | 2021 - 2023

Developing sustainable housing for South Africa using innovative technologies

The University of Cape Town partnered with the Central University of Technology, National Home Builders Association and Leeds Beckett University in the UK to research key factors and suitable technologies for the delivery of sustainable, affordable housing. In addition to increasing the quality and relevance of knowledge on the topic, the project improved education by exposing engineering students to real-world problem solving and the latest construction technology. The team supervised 40+ student dissertations, four of which won awards.

RAEng/GGImages/Patrick Meinhardt

Initiatives to help graduates transition to employment have focused on supplementing gaps in formal education with additional practical training and on-the-job mentorship.[108] For example, a few private companies such as TotalEnergies have introduced programmes in sub-Saharan Africa to recruit recent graduates and provide job-specific training under the supervision of professional engineers and technicians before participants work on actual projects.[109] PEBs in Rwanda and Tanzania have also introduced placement programmes that match engineering graduates with employers to complete a 'traineeship', after which they may receive a job offer.[110] These initiatives have improved participants' employment prospects by providing them with practical, hands-on experience, as well as the chance to build professional networks and showcase their skills to secure full-time roles.[111]

Initiatives to support the transition to entrepreneurship have focused on expanding access to the resources and funding students and recent graduates need to start their own businesses. Many higher education institutions across sub-Saharan Africa now have onsite commercialisation offices and innovation hubs that provide business development support, training on entrepreneurial skills, networking opportunities, and access to office space and equipment.[112]

Total Energies Young Graduate Programme

33 countries (incl. Egypt, Ghana & Malawi), since 2014

Placement programme in private company for recent engineering graduates

Global integrated energy company, TotalEnergies, recruits ~60 recent African engineering and business graduates to participate in an 18-month placement programme each year. Participants gain hands-on professional experience and develop their soft and intercultural skills through 6 months of training in their home country and 1 year working in the Paris headquarters or a different African country. Upon completion, ~80% of alumni secure jobs at TotalEnergies or another company, signaling a successful transition from higher education to full-time employment.

Bridging the Gap Traineeship Programme

Coordinated industry placements for recent graduates

Objectives

The initiative of the Institution of Engineers Rwanda (IER) aims to increase the practical experience of Rwandan graduate engineers to better align their skills with the needs of local employers and improve their future employment prospects.

Activities

Since 2017, IER has partnered with large construction, energy and other companies to provide "traineeship" positions of up to 6 months for its graduate members. Each cohort completes a pre-placement training workshop and has opportunities to work on a wide range of tasks on different types of infrastructure projects. A mentorship scheme also links participants with industry professionals who provide guidance and feedback on their work.

Lessons Learnt

- Participants have gained more practical, general business, and soft skills, boosting their confidence about their employability
- Opportunities to build professional networks and showcase skills in a workplace context have helped many participants secure full-time jobs
- Strong mentorship relationships have enhanced the performance of participants
- The duration and limited number of projects/units at host companies has restricted the development of sufficiently varied practical knowledge

RAEng/Kit Oates

108. Bridging the Gap Case Study Sources: Toolbox: Improving engineering graduates' employability, The Royal Academy of Engineering, Accessed June 2024; Bridging The Gap – building capacity, local content and resilience in Rwanda's engineering sector, Engineers Against Poverty, 2019; Spotlight on Africa Catalyst: Cecile Uwimana, Institution of Engineers Rwanda, Engineers Against Poverty, 2020
109. Graduate Program, TotalEnergies, Accessed June 2024
110. Toolbox: Improving engineering graduates' employability, The Royal Academy of Engineering, Accessed June 2024
111. Bridging The Gap – building capacity, local content and resilience in Rwanda's engineering sector, Engineers Against Poverty, 2019
112. Report from scoping of innovation hubs across Africa, Cherunya & Ahlborg, 2020

Africa Prize for Engineering Innovation

Shortlisted innovators from 23 countries across SSA since 2014

Benefits package to help shortlisted entrepreneurs accelerate their businesses

The Royal Academy of Engineering offers commercialisation support to 16 African innovators each year to help develop scalable solutions to local challenges. Participants benefit from access to the Academy's wide network of business and technical experts, 8 months of tailored training and mentorship, media coverage and prize money of up to £25,000. 71% of the Prize's 149 alumni businesses are now generating revenue, a promising sign their founders will be able to sustain livelihoods as entrepreneurs.

Leaders in Innovation Fellowship (LIF)

15 countries worldwide incl. Egypt, Kenya & South Africa, since 2015

Support for innovators to commercialise and scale engineering innovations

This Royal Academy of Engineering initiative provides engineering and technology innovators with mentorship, international peer networks and tailored sector-specific skills training to commercialise and maximise the social impact of their inventions. Worldwide, LIF has supported 1,400+ innovators (incl. 170+ from Africa) and helped create 6,700+ jobs. LIF's efforts to build sustainable and successful businesses not only enhances the innovators' livelihoods but may generate livelihood opportunities for the broader ecosystem of engineers and technicians.

Additionally, competitions and fellowships have been established to encourage young engineers to develop and commercialise innovative engineering solutions to local challenges.[113] For example, the Academy's Africa Prize for Engineering Innovation[114] and Leaders in Innovation Fellowships (LIF)[115] have provided 300+ African innovators with access to capital, commercialisation support and mentorship to help turn their innovations into revenue-generating models. These initiatives enhance domestic engineering capacity by (i) providing opportunities beyond the traditional job market in which young engineers can gain practical experience; and (ii) supporting the creation of sustainable businesses that not only enhance the innovators' livelihoods but generate livelihood opportunities for the broader ecosystem of engineers and technicians.

Actions to support engineers in progressing in engineering careers have prioritised improving access to CPD and upskilling opportunities that enable African engineers and technicians to update their skills in line with the rapidly evolving job market.

This includes efforts to strengthen the capacity of PEBs across sub-Saharan Africa. The Academy's Africa Catalyst programme, for example, has awarded grants to 30+ PEBs in 11 countries to develop systems and policies, train staff, and introduce outreach and upskilling initiatives. These activities boost the progression of local engineers by enabling PEBs to grow their membership base and offer more frequent and comprehensive CPD and upskilling opportunities.[116] Many PEBs themselves have also been active in enhancing CPD through stricter registration renewal requirements, and new training events and seminars. For example, the Engineers Board of Kenya has mandated its members obtain 50 credits each year to renew their professional registration by publishing articles, attending webinars, and taking industry tours.[117]

Upskilling opportunities have focused on equipping engineers or technicians with additional expertise to use new digital technologies in the workplace or pursue new jobs in rapidly growing sectors. For example, the South African Renewable Energy Technology Centre offers working professionals with training for solar and wind energy jobs[118] and AfricaNEV has launched a course on electric vehicle maintenance and repair for technicians in Ghana, Kenya and Nigeria.[119] A mix of theoretical and practical modules have ensured that participants of these programmes are prepared to action their learnings quickly.[120] In addition, private sector involvement has facilitated the inclusion of local and international experts as instructors and tours to operating facilities, further increasing participant exposure to relevant industry examples.

Electric Vehicle Technician Training Program

Ghana, Nigeria & Kenya, since 2023

Upskilling initiative with a focus on skills for the e-mobility sector

AfricaNEV works with private companies and other stakeholders to run this e-mobility course for automotive and electrical technicians and professionals. Training by local and international experts covers EV history, architecture and batteries, safety procedures, maintenance and repair. The programme also includes the breakdown and reassembly of an electric vehicle and a tour of local e-mobility businesses. A combination of theoretical and practical content ensures participants are sufficiently equipped to work in the growing EV sector as the needs of the African job market continue to evolve rapidly.

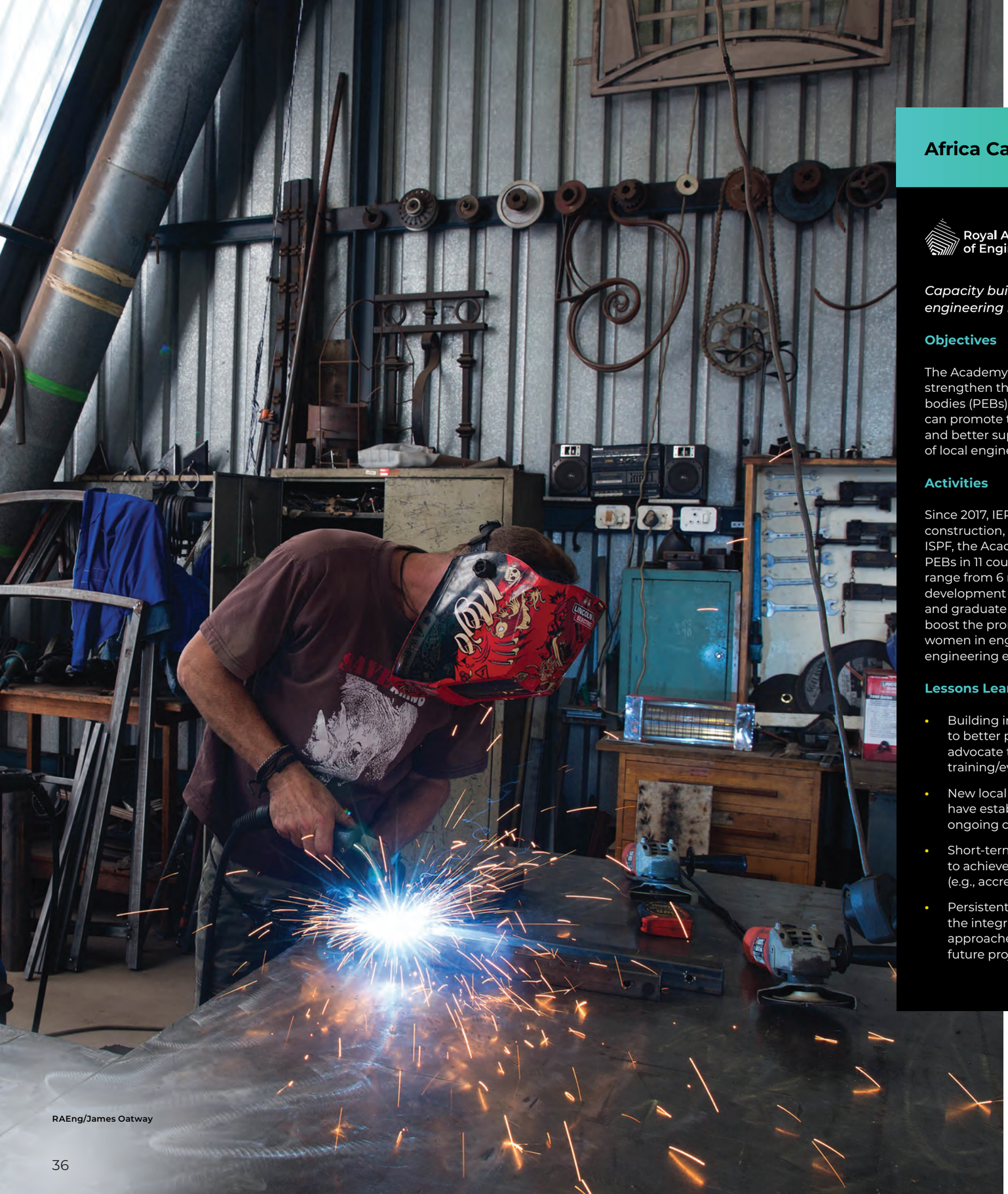
South African Renewable Energy Tech Centre

South Africa, since 2016

Technician upskilling for the wind and solar energy industries

SARETEC offers accredited courses and workshops for the renewable energy sector in partnership with academia, government, associations and private companies. This includes a 7-month course in which electrical and mechanical artisans and engineers train to qualify as wind turbine service technicians. After five months learning the relevant theory at the SARETEC campus in Cape Town, the participants complete two months of in-service training on an active wind farm to practice applying their new skills. SARETEC also actively looks for programme sponsorship to make the course more accessible to lower-income individuals.

113. Toolbox: Improving engineering graduates' employability, The Royal Academy of Engineering, Accessed June 2024
114. The Africa Prize for Engineering Innovation, The Royal Academy of Engineering, Accessed June 2024
115. Leaders in Innovation Fellowship, The Royal Academy of Engineering, Accessed June 2024
116. Africa Catalyst, The Royal Academy of Engineering, Accessed June 2024
117. Toolbox: Continuous professional development, The Royal Academy of Engineering, Accessed June 2024
118. SARETEC Spotlight Sources: Wind Turbine Service Technician Qualification, SARETEC, Accessed August 2024; South African Renewable Technology Centre (SARETEC), Cape Peninsula University of Technology, Accessed August 2024
119. AfricaNEV Spotlight Sources: E-mobility Technician Training Across Africa 2023, AfricaNEV, 2023; AfricaNEV's First EV Technical Training Course Was Held In Nairobi Last Month - CleanTechnica; AfricaNEV & Advanced Mobility Conclude Successful E-Mobility Training Program in Kenya, Clean Technica, 2024
120. Southern Africa Fellowship Impact Report, WomEng, 2021
120. E-mobility Technician Training Across Africa 2023, AfricaNEV, 2023



RAEng/James Oatway

Africa Catalyst

Royal Academy of Engineering

Capacity building for professional engineering bodies

Objectives

The Academy's Africa Catalyst programme aims to strengthen the capacity of professional engineering bodies (PEBs) in sub-Saharan Africa so that they can promote the profession to a wider audience and better support the professional development of local engineers.

Activities

Since 2017, IER has partnered with large construction, With funding from the GCRF and ISPF, the Academy has awarded 50+ grants to 30+ PEBs in 11 countries since 2013. Eligible projects range from 6 months to 3 years and involve the development of policies and systems, student and graduate training schemes, activities to boost the promotion, retention and upskilling of women in engineering, and the harmonisation of engineering education and professional training.

Lessons Learnt

- Building internal capacity has enabled PEBs to better promote the engineering profession, advocate to local stakeholders, and run training/events more effectively
- New local and international partnerships have established solid platforms for ongoing collaboration
- Short-term funding has not been sufficient to achieve objectives with longer timelines (e.g., accreditation)
- Persistent gender inequality has motivated the integration of gender-inclusive approaches in the requirements for future projects

Project Spotlights

Uganda Institution of Professional Engineers (UIPE)

Strengthening institutional capacity to enhance professional development of Ugandan engineers

UIPE has received multiple grants to expand its services and member base. Projects have included (i) further training for engineers and technicians to improve work performance, (ii) outreach to attract and retain more members with a focus on women, and (iii) an Initial Professional Development programme for final year students. The Academy has also funded efforts to identify, develop and scale the prototypes of student innovators into bankable models.

Sierra Leone Institution of Engineers (SLIE)

Upgrading and standardising engineering training and professional accreditation

SLIE has used Academy funding to (i) raise standards at local universities to attain international accreditation, (ii) improve CPD and supplementary training, including a new soft skills development and placement programme for young engineers, and (iii) promote the commercialisation of research innovation. In addition, SLIE has partnered with other PEBs in West Africa to pilot a standardisation process for the accreditation of professional engineers in the region.

To address the gender gap in engineering, interventions have focused on equipping girls and women with useful skills and resources to progress in the field or reducing structural barriers they face. Programmes such as the WomEng Southern Africa Fellowship provide exclusive training on leadership, problem-solving and applying for jobs,[121] and engage working women engineers to mentor students or recent graduates.[122] Participants have reported that expanding their expertise alongside peers in these settings boosted their confidence and employment prospects, indicating a higher likelihood they will continue in the profession.[123]

RAEng/GGImages/Francis Kokoroko

The Womeng Southern Africa Fellowship

WomEng
A non-profit subsidiary of WomHub

Skills development programme for women engineering students

Objectives

This programme for women students in engineering and technology aims to build the confidence, networks and skills they require to succeed in industry.

Activities

WomEng delivers the programme in a hybrid online format to full-time students in South Africa, Botswana and Namibia. It consists of three modules on leadership, skills for the future of work, and thriving in the workplace that each conclude with an assignment and feedback submission. Participants have access to online materials to learn in their own time and opportunities for live engagement via WhatsApp chats, Zoom master classes and networking events.

Lessons Learnt

- The programme's digital format has helped increase its reach and engagement, allowing for a stronger sense of community among participants
- Participants have noted gaining better leadership and employability skills (e.g., in CV writing, interviews, negotiation etc.), leading to improved confidence in employability and job prospects
- Basic infrastructure challenges such as unreliable internet connectivity have limited programme reliability, requiring multiple communication channels and comprehensive offline backups
- Limited job availability in Southern Africa's current economic climate has made it difficult for some alumni to secure employment, suggesting it could be worthwhile to focus more on entrepreneurial paths in future iterations

In the entrepreneurial space, the Africa Innovation Fellowship (AIF) offers training, resources and networks to help women founders scale early-stage innovations and thereby increase women's participation in the ecosystem.[124] Ten AIF alumni subsequently have been selected for the Africa Prize for Engineering Innovation, leading to a greater gender balance in the competition's cohorts.[125]

Many of the Academy's Africa Catalyst grantees have used the funds for community outreach, industry engagement and the development of equality, diversity and inclusion (EDI) policies that aim to increase the participation of women and combat gender-based discrimination in the workplace.[126] The Association of Professional Women Engineers in Nigeria (APWEN) used Africa Catalyst funding to develop a gender parity policy and a network of employers committed to achieving a 30% minimum gender balance by 2030. The policy development led to the election of the first woman president of the Nigerian Society of Engineers since the 1950s.[127]

Africa Innovation Fellowship (AIF)

All SSA countries, since 2019

Leadership and business development programme for women founders

AIF is an eight-month accelerator programme run by the Academy and WomHub that aims to increase the number of women founders developing early-stage STEM innovations and applying for the Africa Prize for Engineering Innovation. Participants benefit from comprehensive training in business development and strategy, access to dedicated workspace, networking with peers and experts, and opportunities to pitch to potential investors and partners. Since 2019, ten AIF alumni have been selected as finalists for the Africa Prize for Engineering Innovation, helping improve the gender balance of the competition's cohorts.

RAEng/James Oatway

121. Southern Africa Fellowship Impact Report, WomEng, 2021
122. Toolbox: Improving engineering graduates' employability, The Royal Academy of Engineering, Accessed June 2024
123. Southern Africa Fellowship Impact Report, WomEng, 2021
124. Africa Innovation Fellowship, WomHub, Accessed September 2024
125. Africa Innovation Fellowship (AIF), The Royal Academy of Engineering, Accessed September 2024
126. Awardees, The Royal Academy of Engineering, Accessed August 2024
127. Dalberg interview with senior PEB representative in West Africa, July 2024

Africa Catalyst Programme

Royal Academy of Engineering

Project Spotlights – Women in Engineering

Association of Professional Women Engineers of Nigeria (APWEN) | 2019 - 2022

Building capacity & convening employers to improve gender parity in engineering workplaces

With Academy funding, APWEN strengthened its internal capacity, developed a gender parity policy and established the SheEngineer 30% Club: a network of 30+ engineering organisations that have committed to achieving a 30% minimum gender balance by 2030 and providing mentorship and training to drive industrywide transformation. Implementation of the gender parity policy also led to the first women president of the Nigerian Society of Engineers since the 1950s.

WomEng & PEBs in eSwatini, Malawi, Tanzania & Zimbabwe | 2018 - 2020

Building capacity & coordinating outreach to bolster the pipeline of female engineering talent

WomEng worked closely with four Women in Engineering (WIE) bodies to strengthen their capacity and build a female talent pipeline to improve gender diversity in the field. This involved training 100+ staff and coordinating outreach programmes for girls at local schools and universities. 365 secondary school students increased their awareness of engineering opportunities, while 200 engineering students received leadership, networking and employability training.

The interventions described in this section have generated valuable knowledge of practical and cost-effective ways to address the drivers of low engineering capacity across sub-Saharan Africa

The Academy and other organisations have demonstrated practical solutions to improve engineering capacity – addressing challenges identified in the 2012 Engineers for Africa report and those that have emerged since. The most successful interventions focus on: (i) improving employer links with academia to improve the quality and relevance of training; (ii) providing additional on-the-job training programmes to fill practical skills gaps; and (iii) strengthening upskilling opportunities to equip engineers with new skills. This success is enabled by drawing from international best practices but tailoring them to local contexts with support from a network of actors and practitioners. Successful interventions deliver good value for money. In surveys for independent evaluations of the HEP SSA and Africa Catalyst programmes, most grantee respondents reported that they felt that their projects represented good value for money and that the benefits of their projects outweighed the costs. The next section recommends actions that will build on this progress to address the persistent challenges for engineering capacity across sub-Saharan Africa.

128. Evaluation of the Higher Education Partnerships in sub-Saharan Africa Programme, Technopolis, 2021; Evaluation of the GCRF Africa Catalyst Programme, Technopolis, 2022

RAEng/Kit Oates

Recommendations

The magnitude and complexity of the interventions needed to build engineering capacity will require effective coordination among multiple stakeholders. Actors like the Academy and its partners can help coordinate action around proven models.

To date, the role of the Academy and similar organisations has been that of funder, programme coordinator and partnership broker, piloting promising solutions (as highlighted in **section 4**). What is needed now is to scale these promising solutions nationally or regionally. This requires action from governments, intergovernmental bodies, the private sector and non-African development organisations and funders. Organisations like the Academy, with relevant knowledge and experience in the field, can play a crucial role in advocating with these actors to:

1. Continue to strengthen academia–industry links to better align engineering training with current and changing, industry requirements.
2. Standardise education and registration requirements across countries to boost the job prospects and mobility of African engineers, while broadening the pathways to achieve skill verification.
3. Incentivise the hiring and upskilling of local workers on infrastructure projects to help African engineers gain hands-on experience.
4. Convene stakeholders to develop unified agendas for emerging jobs and priorities (e.g., AI, green sectors) including skill development strategies.
5. Launch and scale initiatives to increase women's participation and progression in engineering.

1.

Continue to strengthen academia–industry links to better align engineering training with current industry requirements

To align educational programmes with job market needs and boost youth employability, it is essential to establish stronger connections between industries and academic institutions. While progress has been made in small pockets, scaling and institutionalising these efforts across regions outside economic hubs is crucial. Government support (such as funding, mandates or incentives) will be helpful to achieve this at a national level and reap wider socioeconomic benefits: strategic investment in engineering capacity has the potential to increase productivity, stimulate economic activity and boost government revenues. Importantly, it can also accelerate the adoption of green technologies that strengthen countries' climate resilience.

- **Expand private sector involvement in training and curriculum development, especially outside the economic hubs (for example, Nairobi, Lagos, Johannesburg):** to enhance the integration of the private sector in education, it is crucial to broaden its role beyond existing partnerships.

Key strategies include:

- **Involve employers in curriculum development:** engage industry experts in the design and review of engineering courses and foster academia–industry exchange programmes to ensure teaching materials reflect current industry perspectives.

- **Match employers with training programmes:** collaborate with employers to provide job-specific training from experienced working professionals.

- **Integrate practical experience:** offer internships, graduate trainee schemes, demo trainings, and other opportunities for hands-on experience to complement theoretical learning.

RAEng/Brett Eloff

Examples:

1. IBM's P-TECH model forms partnerships (1) IBM's P-TECH model forms partnerships among industry, education, and government to integrate internships and mentorship from IBM staff in high school and college education. Upon graduation, students have the academic and professional skills required to pursue four-year postsecondary qualifications or entry-level careers in IT, healthcare, advanced manufacturing and other fields.[129] The P-TECH network currently comprises 300+ schools in 28 countries, including South Africa and Kenya,[130] and 600+ industry partners that provide mentors and 1,000+ internship opportunities annually.[131]

2. Through its University Alliances programme, SAP has partnered with companies and 3,000+ universities, including ~50 located in 17 sub-Saharan African countries, to give students access to SAP software and training.[132] The programme includes curriculum development support, student internships, and hands-on practice with SAP technologies to cultivate a talent pipeline proficient in data analytics and enterprise resource planning (ERP) software.[133] In addition to the positive impact on student employability, affiliated companies have benefited from priority claim to qualified job candidates and the ability to influence training to better align with their current needs.[134]

3. The National Apprenticeship Promotion Scheme (NAPS) in India encourages private sector participation in skilling by offering financial incentives and technical assistance to companies for the setup and management of apprenticeship programmes.[135] To boost the employability of apprentices, NAPS also provides certification to affiliated programmes. As a result of NAPS, the annual number of apprenticeships in India increased twenty-fold in five years, exceeding 730,000 in 2023. There has also been a seven-fold increase in the number of women apprentices.[136]

129. Pioneering education reform initiative created by IBM, P-TECH, Accessed August 2024
130. IBM Makes Education & Hiring More Inclusive Worldwide with P-TECH Model Expanding Across 28 Countries, IBM, 2020; The Evolution and Significance of P-Tech, Good News: Edtech, 2023
131. IBM Defining Global Education Market Beyond Traditional Borders, Forbes, 2020
132. University Alliances Member Universities, SAP, 2024
133. SAP University Alliances | SAP Next Gen Community, SAP, Accessed August 2024
134. The Impact of the SAP University Alliance Program on New College Graduates and the Organizations that Hire Them, Education Technology Insights, Accessed August 2024
135. National Apprenticeship Promotion Scheme (NAPS), India Ministry of Skills Development and Entrepreneurship, Accessed August 2024
136. Apprenticeship training sees twenty-fold jump in five years, The Economic Times, 2023

- **Build evidence for employer integration initiatives:** Evidence is required in order to demonstrate long-term impact and drive expansion of industry engagement. These may include impact assessments and long-term evaluations that support advocacy and attract funding for large-scale projects.

- **Create sustainable funding models for employer integration:** employer engagement programmes have been piloted in pockets, but need reliable, long-term funding to be scaled to drive systemic change on aligning skills with the evolving job market.

Example:

The World Economic Forum's Reskilling Revolution tracks the impact of its initiatives on workforce skills and employability. They use impact assessments and long-term evaluations to gather evidence on how the skilling programmes of private companies, academic institutions and non-profit organisations improve career outcomes and skill development, which supports their advocacy and funding efforts.[137] Evidence of impact, such as the enrolment of over two million students in its Brazil Skills Accelerator, has enabled the Reskilling Revolution to mobilise a multistakeholder community of 370+ organisations, including educational practitioners, NGOs, government ministers in 17 countries and companies such as Coursera, PwC and Salesforce.[138]

Example:

The UK government's Employer Investment Fund (EIF) used a co-investment model to encourage employers to invest in skills development opportunities for employees. Employers took the lead role in identifying skills needed in their industries and developing solutions tailored to these, including apprenticeships and improved vocational qualifications.[139] The EIF invested ~£70 million in 80+ projects over four years, which was matched by ~£54 million of private investment.[140] Projects that were sustained gained employer commitment to fully fund programme facilitation in the future.[141]

137. Towards a Reskilling Revolution, World Economic Forum, 2019; Putting Skills First, World Economic Forum, 2024
138. Reskilling Revolution: Preparing 1 billion people for tomorrow's economy, World Economic Forum, 2024
139. UKCES Employer Investment Fund, UK Government, 2014
140. UKCES Employer Investment Fund, UK Government, 2014
141. Employer Investment Fund (EIF) and Growth and Innovation Fund (GIF) Programme Level Evaluation, UK Government, 2016

2.
Standardise education and registration requirements across countries to boost the job prospects and mobility of African engineers, while broadening the pathways to achieve skill verification

Greater harmonisation in education and registration requirements would make it easier for engineers to validate their qualifications and secure work in different countries across sub-Saharan Africa, providing more employment opportunities and reducing market frictions. To enhance accessibility and ensure that practical experience and opportunities outside the formal job market are given equal value, it is also critical to both recognise non-traditional learning pathways and support young engineers who want to pursue unique career paths by increasing the support available for entrepreneurial ventures.

- **Increase the standardisation of education and professional registration:** regional and non-African development organisations and funders should leverage their reach to (i) help more African academic institutions obtain the same external accreditation for their courses and (ii) better align professional registration and renewal requirements. This could involve supporting countries to gain international accreditation for their engineering degrees (through accords such as the Washington Accord) or establishing and expanding regional professional harmonisation and accreditation councils. Greater standardisation would increase the intra-regional mobility and employment prospects of African engineers. Alignment with the criteria of reputable external bodies would also strengthen the overall robustness of academic and professional standards.

Examples:

International initiatives have been established to accredit or recognise the equivalency of accredited engineering programmes in different countries. More recently, there have also been regional efforts with a focus on standardising education and professional practices in Africa. **Notable examples include:**

1. The Washington Accord[142] is an international agreement among 25 national bodies that accredit tertiary-level engineering programmes. By recognising the equivalency of their standards, the Accord eases the movement of graduates between signatory countries and improves external actors' knowledge of each country's education and certification systems.[143] At present, South Africa is the only full signatory from Africa and Nigeria became a provisional signatory in 2023. Mauritius also achieved provisional signatory status in 2024, the initial stage of which was supported by the Academy's 2017 Africa Catalyst programme.
2. The Accreditation Board for Engineering and Technology (ABET)[144] is an independent agency that has accredited 4,500+ applied science, engineering and other technology programmes at 900+ institutions in 42 countries.[145] Egypt, Ethiopia, Morocco and South Africa are the only African countries in the ABET network after Ethiopia received ABET accreditation for four bachelor's degree programmes at Bahir Dar University in 2023.[146]
3. The West African Engineering Professional Harmonisation and Accreditation Council (WAEPHAC)[147] has been developed (supported by Africa Catalyst) to standardise and accredit engineering education and professional practices across West Africa. Once established, the Federation of African Engineering Organisations (FAEO) is planning to use it as a template for replication within its member countries.

142. Washington Accord, International Engineering Alliance, Accessed August 2024
143. The Importance and Benefits of the Washington Accord, Camu Digital Campus, 2022
144. Accreditation, ABET, Accessed August 2024
145. Annual Impact Report 2023, ABET, Accessed August 2024
146. ABET Accredits 110 Additional Programs in 2023, ABET, 2023
147. Plans to establish West African Harmonisation & Accreditation Council, Ghana Institution of Engineering, 2023

- **Recognise non-traditional learning pathways:** implement systems to validate and recognise skills acquired through non-traditional means, such as informal and non-formal education. This can accelerate learning paths by avoiding redundant training, increasing access to education and career opportunities for those without formal qualifications, and boosting motivation by recognising previous achievements.

- **Foster entrepreneurship by improving links between universities and incubators and enabling access to funding:** to encourage and support engineers in starting their own ventures, focus needs to be on providing: (i) more support to develop the technical, business, and knowledge skills of potential entrepreneurs; (ii) more links and coordination between universities and incubators/accelerators to strengthen the pathway to entrepreneurship; and (iii) more financing for new and growing SMEs.[151]

Example:

The Validation des Acquis d'Expérience (VAE)[148] scheme in France allows educational institutions to award complete or partial degrees based on professional, volunteer or union experience. A dedicated committee reviews a portfolio of the applicant's achievements and work experience to determine whether they merit credit towards a formal qualification. ~130,000 VAE diplomas were awarded in the decade following its inception in 2002.[149] The African Union is attempting to introduce a similar initiative through the African Continental Qualifications Framework (ACQF).[150]

Examples:

Several flagship initiatives and programmes have been launched over the last 12 years to support entrepreneurs across the continent. **Notable examples include:**

1. The Africa Prize for Engineering Innovation,[152] run by the Academy, offers commercialisation support to 16 African innovators each year to help develop scalable engineering solutions to local challenges. It has already created 3,585 jobs – including 1,766 for women and 211 for persons with disabilities – and raised more than $14 million in grants and equity funding, directly contributing to 12 of the UN SDGs.

2. The Accelerating Women Climate Entrepreneurs (AWCE)[153] awards grants to address the financing gap and support the growth of women climate entrepreneurs (winners receive one-year grants of between $30,000 and $65,500). AWCE also produces reports on how to strengthen the gender and climate-lens across sub-Saharan Africa based on learnings across its projects.

3. African Women in Energy and Power (AWEaP)[154] is a non-profit company established to accelerate African women entrepreneurs' participation in the power and energy sector, enrolling 100 African women entrepreneurs annually in a vocational accelerator course.

148. La validation des acquis de l'expérience (VAE), Ministère du Travail, de la Santé et des Solidarités, Accessed August 2024
149. Validation of non-formal and informal learning, European Commission, 2023
150. Overview, African Continental Qualifications Framework, Accessed August 2024
151. The need for youth engagement in engineering innovation and entrepreneurship in sub-Saharan Africa, Oluwole, 2020
152. The Africa Prize for Engineering Innovation, The Royal Academy of Engineering, Accessed June 2024
153. Accelerating Women Climate Entrepreneurs, Aspen Network of Development Entrepreneurs, Accessed June 2024
154. African Women in Energy and Power, AWEaP, Accessed June 2024
155. Proclamation No. 1180/2020 - Investment Proclamation, Federal Democratic Republic of Ethiopia, 2020

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3.

Incentivise the hiring and upskilling of local workers on infrastructure projects to help African engineers gain hands-on experience

Introduce incentives or mandates for the private sector to invest in the hiring and upskilling of local labour: governments and international infrastructure funders (e.g., The World Bank) should incentivise or mandate private sector investments in upskilling local technicians and workers. This can be achieved by: (i) prioritising bids from companies with proven local capacity-building records especially for large infrastructure projects; (ii) enforcing local content policies (including at senior levels to prevent emigration) and structured skills transfer on local infrastructure projects; (iii) providing financial incentives such as subsidies, tax benefits and skill development grants for companies investing in employee training; and (iv) using the project-financed technical assistance available from development banks to meet capacity building needs.

Example:

In Ethiopia, there are several legal and policy frameworks that mandate the inclusion of local labour in infrastructure projects.[155] Regulations cover key aspects such as when foreign workers can be hired, and for how long. They also mandate that eventually local workers need to be upskilled to take up the senior or more specialised positions currently filled by foreign workers.

4.

Convene stakeholders to develop unified agendas for emerging jobs and priorities (such as AI and green sectors) including skill development strategies

Rapid global change is having a profound impact on the skills required across sectors. To prepare workers for emerging roles, all stakeholders, including employers, policymakers, universities, skilling institutions, PEBs, and non-African development organisations and funders, need to come together to create unified transition and skills development plans. By improving collaboration and coordination and sharing data, best practices and resources, we can efficiently develop a workforce in line with the demands of tomorrow and capable of adapting to any shifts.

- **Develop labour market information systems (LMIS) to reduce information asymmetry and enhance decision-making:** government departments or agencies should create LMIS platforms to: (i) collect labour market data from surveys, employment records and training institutions; (ii) analyse this data to identify current and forecast future trends related to labour supply and demand (for example, skills shortages, employment rates and sector performance); and (iii) distribute information to stakeholders through statistical summaries, dashboards and reports. **This will enable:**

1. Educational institutions to integrate the LMIS with curricula to ensure alignment with current industry needs and use it to support internship placements and practical experience

2. Employers to provide feedback on the skills and qualifications they need and collaborate with educational institutions to shape relevant training programmes

3. Policymakers/donors to use forecasting tools to predict future skill demands and develop targeted policies or skilling programmes to address evolving needs

RAEng/Kit Oates

Examples:

1. Job Bank is Canada's primary platform for job search and labour market information. It offers a searchable database of job openings, wage data and employment trends. Job seekers can use features like resume builders, career planning resources and job alerts. Employers can post job listings, search resumes and access recruitment tools. The platform also provides regional and sectoral insights, helping other users understand local job markets.[156]

2. With support from the International Labour Organisation (ILO), countries worldwide are implementing LMIS projects that facilitate (i) labour market analysis, (ii) monitoring and reporting on employment and labour policies, and (iii) information exchange and coordination among key actors.[157] African countries with initiatives in progress include Ethiopia, Uganda, Mozambique, South Africa and Namibia.[158]

- **Create skilling partnership networks involving employers, government, universities, philanthropies, and CSOs to develop reskilling/upskilling strategies that match rapidly evolving needs.** Create a skilling partnership network to develop and execute strategies for: (i) consistently identifying emerging roles and skilling needs; (ii) developing curricula and integrating new skills in existing courses to prepare tomorrows' workforce; and (iii) upskilling the existing workforce either for greater effectiveness in their current jobs or preparation for new roles – for example, through revised CPD courses or retraining by industry.

Example:

The National Skill Development Corporation (NSDC) in India is a public-private partnership that aims to align skill development with industry needs by working with employers, educational institutions and other organisations to identify skills gaps in various sectors and develop relevant training programmes. It integrates vocational training into academic curricula, partners with philanthropic and corporate social responsibility initiatives for funding and establishes Sector Skill Councils for sector-specific standards.[159] NSDC has built a network of over 500 training partners and 40 sector skills.

156. Trends and events in Ontario's labour market, Job Bank, Accessed August 2024
157. Labour market information systems (LMIS), ILO, Accessed September 2024
158. ILO Labour Market Information Systems projects around the world, 2023
159. National Skills Development Corporation, NSDC India, Accessed August 2024

5.

Launch and scale initiatives to increase women's participation and progression in engineering

To continue closing the gender gap in engineering across sub-Saharan Africa, employers and higher education institutions can (i) set specific targets for recruiting women, (ii) create or adapt programmes based on the specific needs of women, and (iii) track their effectiveness to ensure equitable participation and outcomes. Support from governments and non-African development organisations and funders will help scale initiatives with a gender focus.

Examples:

1. India's National Skill Development Corporation in partnership with philanthropies designed the Skill India Impact Bond, a pay-for-success model where investors provide upfront capital for skills development of ~50,000 youth. Payments are made based on achieving specific outcomes, such as successful job placements and retention in jobs. The bond has a clear gender focus and threshold target (with differential payment), incentivising training providers to hire and train women and place them in jobs.[160]

2. The Academy's Africa Innovation Fellowship (AIF),[161] a partnership with WomHub, aims to build a pipeline of women founders to participate in the Africa Prize for Engineering Innovation. The programme supports participants who are developing early-stage STEM innovations through access to training, resources and networking opportunities. Ten AIF alumni have been selected for the Africa Prize since 2019, helping improve the gender balance of the competition.

3. The Academy's Africa Catalyst programme awards grants to PEBs and other organisations for initiatives to increase the promotion, retention and upskilling of women in engineering.[162] Past projects include: (i) capacity building of Women in Engineering (WIE) bodies in Eswatini, Malawi, Tanzania, and Zimbabwe to expand their outreach and training programmes for girls and women;[163] and (ii) supporting the Association of Professional Women Engineers of Nigeria (APWEN) to develop a gender parity policy and establish a network of employers committed to increasing the gender balance of their workforce.[164]

160. India's First Skill Impact Bond with a Gender Lens, Invest India, 2021
161. Africa Innovation Fellowship, WomHub, Accessed September 2024
162. Africa Catalyst, The Royal Academy of Engineering, Accessed June 2024
163. Capacity Building for Women in Engineering Bodies in sub-Saharan Africa – Best Practice Report, The Royal Academy of Engineering, Accessed August 2024
164. Phase 4 projects, The Royal Academy of Engineering, Accessed August 2024

RAEng/James Oatway

Stakeholder specific calls to action

As described in this report, challenges across the engineering career journey are perpetuating the gap between the skills of engineers and industry needs across sub-Saharan Africa.

The fundamental challenge remains the same as described in the 2012 Engineers for Africa report – that there are too few engineers with sufficient skills to meet the needs of employers. This is being driven by challenges in academic institutions, graduate placement programmes, on-the-job training, CPD, and upskilling courses. The rising importance of digital tools and challenges presented by climate change are only increasing the pace of change of the skills required, exacerbating these challenges.

Overcoming these challenges will require investment and action on a much larger scale from governments, PEBs, higher education institutions, industry, infrastructure funders, and non-African organisations. As the previous sections of this report demonstrate, many solutions to close the engineering gap across sub-Saharan Africa have been tested and must now be implemented on a national or regional level to drive systemic change. Coordinated action is critical given (i) stakeholders impact engineering capacity in distinct but interconnected ways, and (ii) a common basis for engineering skills aids employers in understanding skills of potential employees.

The table to the right outlines the required action from governments, PEBs, higher education institutions, industry, funders and non-African organisations to close the engineering capacity gap across sub-Saharan Africa:

RAEng/James Oatway

Stakeholder	Recommended actions

Governments	**Use procurement to build engineering capacity through creating decent jobs, promoting enterprise development and encouraging skills transfer.**
	• Introduce or improve local content policies to ensure that a large portion of project expenditure is made in the domestic economy, without compromising quality or value for money.
	  ◦ Mandate or incentivise targeted procurement and joint venture agreements between foreign and domestic firms to support the latter to create decent jobs and grow their businesses.
	  ◦ Mandate or incentivise (e.g., through tax relief or co-funding) the hiring and upskilling of local employees on infrastructure projects – in particular government funded projects (similar to local employment requirements introduced in Ethiopia[165] and Egypt[166]).
	• Incorporate skilling initiatives to address engineering skills gaps[167] in broader economic development plans.
	• Facilitate, incentivise or mandate industry involvement in academic course development and delivery.
	• Ensure the policy environment supports skills development by creating relevant policies and frameworks to ensure high-quality and safe working conditions for engineers.

Professional engineering bodies (PEBs)	**Develop (sub)regional recognition for qualifications and professional registration, co-facilitate upskilling programmes, recognise non-traditional learning pathways and collect data on key outcomes.**
	• Develop regional standards for (i) accreditation of engineering courses, and (ii) professional registration requirements to improve the reliability for employers and ease intra-regional skills transfer.
	• Work with employers to improve CPD opportunities for engineers.
	  ◦ Increase the consistency, quantity and quality of continuing professional development.
	  ◦ Support training on new skills, either to support existing work (e.g., new digital tools) or transition to jobs in growing sectors (e.g., electric mobility and renewable energy).
	• Develop standards to recognise those who have built skills outside of formal education. Collaborate with government to drive policy changes supporting these standards.
	• Introduce better data collection on key outcomes to support continuous improvement of courses and advocacy efforts.

165. Qualified foreigners may only be employed on projects if it can be ascertained that Ethiopians possessing similar qualification or experience required by the sector are not available; Source: Proclamation No. 1180/2020 - Investment Proclamation, Federal Democratic Republic of Ethiopia, 2020

166. The foreign workforce may not exceed 10% of the total workforce in any establishment in Egypt; Source: Overview of Egyptian Labour Law, Riad & Riad, Accessed August 2024

167. Labour Market Information System will support in the identification of future skill needs.

Stakeholder	Recommended actions
African higher education institutions	Work with industry to ensure curricula and training align with its needs and collect data to track effectiveness of programmes. • Engage with employers to improve curricula and ensure students graduate with the skills required by employers, including up-to-date theoretical skills, training on latest tools and technologies, practical skills and, where feasible, soft skills. • Provide support to graduates to transition to entrepreneurship (e.g., commercialisation offices to offer entrepreneurial training and business support, access to infrastructure and physical space). • Collect and analyse data on key outcomes, including graduate employment and women's participation, to monitor programme effectiveness to build a feedback loop. • Include collaborative activities in annual plans and budgets (e.g., lecturer secondments, student industrial placements) to present them as planned and priority expenses to public and private funders.
Non-African higher education institutions	Provide support to African higher education institutions to improve the quality of engineering training – coordinating support with other higher education institutions. • Offer peer-to-peer support or mentorship services to share best practices on curricula reform and effective teaching methods. • Facilitate bilateral secondments, joint research and field trips for students and lecturers to increase exposure to international best practices, different learning environments and knowledge sharing.

Industry	Increase hiring and upskilling of local talent and collaborate with higher education institutions to shape curricula and practical training.
	• Invest in hiring and training of local graduate engineers, such as through internships, job placements, graduate trainee programmes, mentorships, and job shadowing.
	• Collaborate with higher education institutions on curriculum development and practical training.
	  • Identify the business case for these activities and communicate the benefits to staff, shareholders and customers.
	  • Advise universities to develop engineering curricula aligned with industry needs and future trends.
	  • Participate in course delivery through guest lectures, workshops and academic advisory boards.
	  • Offer secondments and joint research projects for students and faculty to gain hands-on industry experience.
	  • Provide access to the latest equipment and technology for higher education institutions.

Stakeholder	Recommended actions
International infrastructure funders	Incentivise or mandate local and diverse hiring on internationally funded infrastructure investments. • Incentivise local and diverse workforce participation (e.g., by including it in tender 'scoring rubrics') including incentivising engagement at a senior level. • Include the provision of technical assistance in project loan agreements to be used to strengthen institutions and build capacity.

Non-African development organisations	Bring together stakeholders to develop skill development plans, provide flexible funding for new pilot initiatives, and advocate for scaling proven pilots.
	• Bring together governments, employers and higher education institutions nationally or regionally to identify future engineering skills gaps and create skill development plans – and provide funding to support their development.
	• Support higher education institutions and PEBs with accreditation and pilot programmes.
	  • Assist higher education institutions to obtain regional or international accreditation for their courses (by providing funding / logistical support).
	  • Continue to provide funding and bring together higher education institutions across regions and employers to continuously improve curricula and teaching methods.
	  • Support locally led advocacy efforts for long-term funding and scaling of successful pilots.
	  • Consolidate and showcase evidence of the impact of successful pilots on key outcomes – importantly, those key to governments such as employment rates and long-term economic benefits.
	  • Advocate with governments, higher education institutions and employers to continue and scale successful initiatives, including providing long-term funding.

Intergovernmental bodies	Ensure that continental frameworks explicitly acknowledge and actively promote building engineering capacity. **These include:** • Agenda 2063: The Africa We Want[168] • Programme for Infrastructural Development in Africa (PIDA)[169] • Science Technology Innovation Strategy for Africa (STISA)[170]

168. Agenda 2063: The Africa We Want, African Union, Accessed August 2024
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Methodology

This report analyses the status of engineering capacity across sub-Saharan Africa, the challenges of growing engineering capacity and the impact of relevant interventions since 2012.

It is not a primary piece of research, rather it summarises some of the experience and learning of the Academy and others. It draws from a variety of secondary sources and studies, consultations between staff, Academy fellows, awardees and stakeholders working in and for Africa, as well as other multinational organisations. **The authors:**

- Reviewed documentation from the Academy, including summary reports from policy roundtables and closed sessions, independent evaluations of its programmes in the region and other publications it has co-authored on the topic.
- Examined literature review by Engineers Without Borders (2022) on the evolution of engineering capacity and related challenges since 2012.
- Completed a high-level literature review of additional information sources such as academic studies, industry and market analyses, institutional policy and strategy documents, organisational websites, and programme reports.
- Undertook 14 stakeholder interviews. These interviewees come from the private sector, higher education, non-governmental organisations (NGOs), CSOs and PEBs, prioritising individuals with direct experience of engineering capacity gaps across sub-Saharan Africa to ensure the report draws from local perspectives.

Table 1 provides key details on each interviewee. Representatives from the same organisation have been grouped.

RAEng/Kit Oates

Table 1 – Summary of Interviewees

Stakeholder Group	Name(s)	Title(s)	Organisation(s)
Private sector	Shantha Bloemen / Rumbie Chingosho	Founder and Managing Director / battery operations engineer	Mobility for Africa
	Greg Holden / Amantle Moeng	Director, Engineering Services / senior civil engineer	Bergstan Consulting & Development Engineers
	Duncan Kariuki	Co-founder and Chief Product Officer	Octavia Carbon
	Dr John Lazar CBE FREng	Co-founder & General Partner / President / Chair	Enza Capital / The Royal Academy of Engineering / Raspberry Pi Foundation
	Lamine Ndour	Development Manager, West Africa	Serengeti Energy
	Nicola Turrini / Jean d'Amour Rwunguko / Alex McNeill	Global Corporate Partnerships Manager / East Africa Director of Programs / Chief Operations Officer	Bridges to Prosperity
Higher education	Hilton Chingosho	Lecturer, Department of Electrical and Electronics Engineering	University of Zimbabwe
NGOs & CSOs	Ekua Nuama Bentil	Senior education specialist	The World Bank
	Tom Kaye	Senior Advisor Global Programmes	Generation Unlimited
	Papias Kazawadi	President	Federation of African Engineering Organisations (FAEO)
	Rosemond Offei-Awuku.	Chief Development Economist, Human Capital Youth and Skills Development	African Development Bank (AfDB)
	Mustafa Shehu	President	World Federation of Engineering Organisations (WFEO)
PEBs	Felicia Agubata	Vice President, Corporate Services	Nigerian Society of Engineers

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