African Union

THE AFRICAN CAPACITY BUILDING FOUNDATION | FONDATION POUR LE RENFORCEMENT DES CAPACITES EN AFRIQUE

AFRICAN UNION AGENDA 2063

African Critical Technical Skills

Key Capacity Dimensions Needed for the First 10 Years of Agenda 2063

2, Fairbairn Drive, Mt Pleasant, Harare, Zimbabwe

Produced by the Knowledge, Monitoring & Evaluation Department
The African Capacity Building Foundation
First printing February 2016

For additional information on other knowledge products as well as project and program operations of the African Capacity Building Foundation, please visit our website at the following address: http://www.acbf-pact.org

ISBN: 978-1-77937-063-1
EAN:9781779370631

CONTENTS

Boxes

Figures

Tables

ACKNOWLEDGEMENTS

The African Capacity Building Foundation (ACBF) Executive Secretary and the African Union Commission (AUC) Chairperson, who have provided close guidance for this work, are thankful to the institutions and individuals collaborating to support this important capacity exercise. These include the leadership of the African Union (AU) organs, leadership of the Regional Economic Communities, AUC Commissioners, leadership of the AU Specialized Institutions, other development institutions working closely with the AU, and representatives from various stakeholder groups.

Appreciation is also recorded for the continuing joint collaboration and effective support from AUC officials and departments, including the Deputy Chairperson, focal persons of the Office of the Chairperson, the Strategic Planning Department, and the Agenda 2063 Technical Team.

The ACBF and the AUC also extend their appreciation to the Senior Team put together from the Capacity and Development Services entity that has been working on this assignment, with focal persons of the ACBF.

The ACBF collaborates closely with the AUC on the capacity agenda, as well as with the New Partnership for Africa's Development (NEPAD), the United Nations Economic Commission for Africa, the African Development Bank, and other key institutions. As an African continental institution, the ACBF will continue to focus on building human and institutional capacity for economic development in Africa, working closely under the AU system on the capacity dimensions of Agenda 2063.

LIST OF ABBREVIATIONS AND ACRONYMS

ACBF	African Capacity Building Foundation
AfDB	African Development Bank
AHE	Africa's higher education
AIDA	Accelerated Industrial Development of Africa
AIMS	African Institute for Mathematical Sciences
AMV	African Mining Vision
AOSTI	African Observatory of Science, Technology, and Innovation
AU	African Union
AUC	African Union Commission
CAADP	Comprehensive Africa Agriculture Development Programme
CD	Capacity development
CEN-SAD	The Community of Sahel-Saharan States
CFTA	Continental free trade area
COMESA	Common Market for East and Southern Africa
CSO	Civil society organization
CTS	Critical technical skills
DRC	Democratic Republic of the Congo
DRM	Domestic resource mobilization
EAC	East African Community
ECCAS	Economic Community of Central African States
ECOWAS	Economic Community of West African States
EST	Engineering, Science, and Technology
GDP	Gross domestic product
GERD	Gross domestic expenditure on research and development
ICT	Information and communications technology
IGAD	Intergovernmental Authority on Development
ILO	International Labour Organization
IT	Information technology
LIC	Least-income country
LMIC	Lower-middle-income country
M&E	Monitoring and evaluation
NEA	New education agenda
NEPAD	New Partnership for Africa's Development
NGO	Nongovernmental organization
OAU	Organization of African Unity
OECD	Organisation for Economic Co-operation and Development
PAP	Pan-African Parliament
PIDA	Programme for Infrastructure Development in Africa

PPP	Purchasing power parity
R&D	Research and development
REC	Regional economic community
SADC	Southern African Development Community
STEM	Science, technology, engineering, and mathematics
STI	Science, technology, and innovation
STISA	Science, Technology, and Innovation Strategy for Africa
TAWW	The Africa We Want
TIC	Tertiary institution clusters
UMA	Union du Maghreb Arabe
UMIC	Upper-middle-income country
UNDP	United Nations Development Programme
UNECA	United Nations Economic Commission for Africa
UNESCO	United Nations Educational, Scientific, and Cultural Organization
WEF	World Economic Forum

OVERVIEW

The single biggest challenge to ownership of Africa's development agenda and management of its key development programs is grounded in the issue of critical technical skill (CTS) in Africa. To achieve the vision of Agenda 2063, as well as Africa's ideology and existential imperative to fulfill its destiny as a great continent of the future, it must own, use, and have faith in its own CTS professionals, trained and working to a world-class standard.

While the accuracy of CTS gaps and projections can always be improved, it is important to underscore at this early stage of Agenda 2063 the size of CTS shortages that Africa will face. This magnitude indicates that urgent programs of "massified" education and investments in training must be promoted at all levels—national, regional, and continental.

A new tripartite planning dialogue for reinventing education is vital, among government, the private sector, and academia. Youth and women should always be involved, too, as they constitute critical capacity pillars for achieving the vision of Agenda 2063.

Considering the huge importance of capacity dimensions for Agenda 2063, it might be helpful to incorporate within the African Union (AU) system the continued partnership support of the African Capacity Building Foundation (ACBF) on issues of capacity imperatives and robust African skills development for Agenda 2063. Institutionalizing ACBF's operational capacity support, working in collaboration with the New Partnership for Africa's Development (NEPAD) Planning and Coordinating Agency, the United Nations Economic Commission for Africa (UNECA), and the African Development Bank (AfDB), would help raise attention to capacity dimensions of "The Africa We Want" strategic vision.

Key messages

1. A severe critical technical skills emergency is gripping Africa

Africa is seriously short of the CTS and professionals to help accelerate achieving the key initiatives of the First 10-Year Implementation Plan of Agenda 2063.

2. Africa's critical technical skills development agenda has not been pushed forward for more than two decades

There is very little evidence of purposeful inclusion and prioritization (with robust financial allocations) in national development plans of critical technical skills development.

3. Reliance on expatriate critical technical skill professionals in executing Africa's industrial and technological projects is worrisome

Programs for importing and using non-African expatriate CTS professionals are still widespread in major construction, engineering, and other sophisticated initiatives. They are generally unquestioningly accepted under the guise of foreign direct investment or external aid. A fast switch from this approach requires deliberate emphasis and investments to expand the stock of African expertise in CTS.

4. Capacity retention and utilization policy packages, at national and regional levels, are hard to find

Even when skills development initiatives are in place, it is important to craft capacity retention and utilization policies. Strategically, they should go beyond standard human resource management work.

5. Technical and vocational education and training holds promise for addressing a large part of the youth unemployment challenge

A huge increase in technical and vocational education and training (TVET) initiatives is crucial for maximizing gains from the youth bulge and the youth dividend. Youth and women constitute central capacity pillars for achieving the key initiatives of the Plan and Agenda 2063. New approaches should be developed to overcome the usual challenges of TVET (supply and demand, rates of return, harmonized private and public sector roles, and so on).

6. The skills and capacity dimensions of the African diaspora have so far been unintentionally treated as "black box" information

A skills assessment of the diaspora should be undertaken, as this will better inform how to manage and use its members, including the remittances that Africa receives from its diaspora. (Some estimates suggest $40 billion comes from the US diaspora alone.)

7. African universities must share the blame for Africa's critical technical skill shortages

African universities must shoulder some of the blame for not meeting the workforce needs of the continent, with their focus on non-CTS courses. They also need to refocus on indigenous knowledge systems, Africanizing their approach.

8. Business and economic operators at all levels on the continent should lead a new skills development agenda

The fundamental issue in skills development is how best to balance the supply of skills with labor market demand. If the demand is unsatisfied, skill bottlenecks impede growth and development; if the supply is not absorbed, unemployment and waste of resources ensue. The issue of who should provide and pay for skills development continues to occupy policy makers. Thus basic questions for Agenda 2063 are:

- Should it be a government's responsibility to finance skills development from public revenue and provide it in government-sponsored institutes?
- Should those who capture the benefits —employers and trainees—pay for the training and should provision be left to the market and non-government providers?
- Should all training be turned over to employers or private sector providers, given the private benefits obtained?

The Capacity Team proposes that business and economic operators at all levels on the continent take the lead role. In some sectors, they should collaborate and provide skills training by setting up academic and training centers. Additionally, national governments and the private sector should form public–private partnerships to produce CTS, exemplified by the Sector Education and Training Authority in South Africa. Replicated in other African countries, such an approach could help to ensure CTS as well as vocational skills needed by Agenda 2063's flagship projects and other major continental programs.

9. We should launch tertiary institution clusters to reinvent African education

The following figure illustrates our proposal to initiate tertiary institution clusters for "The Africa We Want" education dialogue.

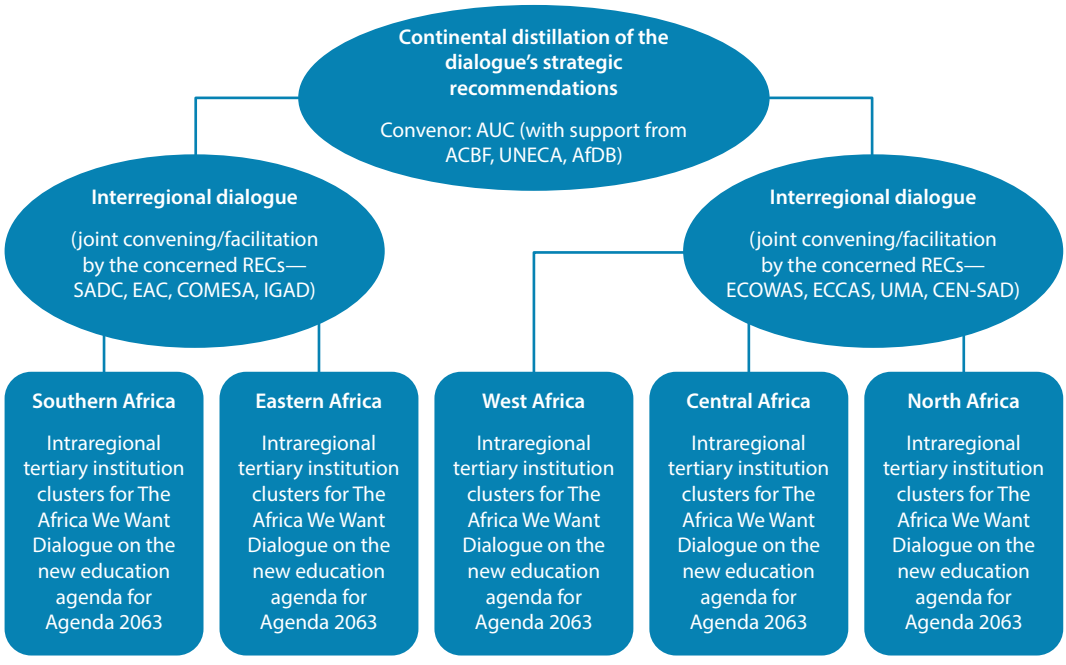
Recommendations

1. Identify the critical technical skills essential for the growth of economies

The literature acknowledges the skills shortage and the importance of prioritizing skills development in Africa but offers few hard data on countries' situations. Surrogate data from the numbers of expatriates and highly skilled nationals from African countries working in key sectors of other African countries can, however, provide a useful pointer to CTS.

Therefore, a coordinated collective effort (from skills surveys and diagnostic analysis) should be mounted across countries to identify the critical skills essential for countries' economic growth—and the current CTS gaps—depending on their resource endowments and national development plans. This exercise should involve government, the indigenous private sector, and academia. Such information is of immense strategic importance for tracking how many potential high-skilled

Figure 1 Tertiary institution clusters for "The Africa We Want (TAWW)" education dialogue



Note: CEN-SAD = Community of Sahel-Saharan States; COMESA = Common Market for Eastern and Southern Africa; EAC = East African Community; ECCAS = Economic Community of Central African States; ECOWAS = Economic Community of West African States; IGAD = Intergovernmental Authority on Development; SADC = Southern African Development Community; UMA = Arab Maghreb Union.

Source: ACBF Capacity Team.

jobs could be filled by nationals, and for labor planning. The information could also provide a basis for career counselling in schools and colleges.

2. Pool critical technical skills

The critical skills for executing the flagship projects must come from member states. It is recommended that a Regional Database of Critical Skills for Agenda 2063 be established from national skill inventories to create a comprehensive and adaptive skills pool as a basis for intra-African cooperation in using African skills. Such a database will serve as an essential mechanism for mobilizing and exploiting skills that may be "locked up" in individual countries. The database will also provide a basis for intercountry partnerships and exchanges.

It is also recommended that skill-based networks be created to allow African professionals abroad to mentor, train, and add to the skills base available to the continent. This could be one practical mechanism to tap into the diaspora as a potential asset to transfer short-term sector-specific skills through work placement on projects, and to share best practices from the developed world. In the long term, strategies should be developed and implemented with clear incentives to attract back some members of the diaspora.

3. Transfer essential skills critical for strategic sectors

Capacity substitution through technical assistance and use of external contractors, service providers, and other forms of capacity acquisition (for example, importation) allows CTS to be mobilized quickly for project start-ups. But it is vital that African countries take steps to transfer essential Africa-focused skills that are critical for strategic sectors. It is strongly recommended that policies and legislation be promulgated so that negotiated capacity-substitution mechanisms have a legal requirement for clear exit strategies and residual capacity outcomes in terms of skills and knowledge transfer, operational systems and processes, and so on. Strategies and practical measures should also be developed to safeguard and retain essential indigenous skills.

4. Undertake medium- to long-term skills development

The prosperity of a country depends on a productive labor force, which in turn rests on the skills they have and the effectiveness with which they deploy them. There is therefore a clear need for policies that prioritize human resource development at a technical level supported by budget allocations.

The data from skill surveys and diagnostic analysis of skill needs will provide a useful basis for skills reorientation and retraining where there may an oversupply (or undersupply) of skills. It is also recommended to integrate the rich talent, creativity, and entrepreneurship (demonstrated daily by the huge informal artisan class in most African countries) into the formal economy, and to provide mentorship, training, and technical assistance to enable those in the informal sector to contribute to the formal skills pool. This is one way of finding African solutions to African problems.

In the long term, the diagnostic analysis of skill needs should guide the development of curricula and targeted training programs intended to redress the skills shortage in the trade, craft, and engineering fields. Emphasis should be on TVET, including in-work apprenticeships and on-the-job experience. Lifelong learning for employable skills should be the guiding policy principle.

5. Tighten the links between universities, industry, and labor markets

Skills development does not happen in a vacuum. The supply of skills must closely match the needs of enterprises and labor markets. The alignment of skills development with market needs as well as Agenda 2063 priorities will bring industry practitioners into the development of capacity, enabling training institutions to draw on both policy and practice to enrich training curricula. This will nurture a virtuous circle in which more and better education and training fuels innovation, investment, economic diversification, and competitiveness, as well as social and occupational mobility and greater work opportunities. Ongoing conversation among the public and private sectors, and academia, should form the basis of this circle.

6. Improve capacity at training institutions

Equally important for redressing the existing skills shortage in African countries is to improve the quality of training providers and to target technical training. Capacity developers support a chain, leading to development of sustained capacity in delivering sector and thematic programs—hence the need to strengthen skills development institutions responsive to immediate needs and adaptive to emerging demands.

7. Overhaul training and education

The urgent need for fundamentally reforming the educational system and redesigning the content of a new African educational agenda cannot be overemphasized. A critical element of this transformation is to ground education and training in African values, aspirations, realities, and priorities. High-quality education must be complemented by TVET anchored in Agenda 2063 in such a manner as to create opportunities to equip jobseekers with the core values and skills that enable them to continue learning, secure decent jobs, and contribute to the transformation. Critical consideration must be given to the legacy of colonialism, which is one reason that the overhaul is so important. Recommendations include:

- Reorienting academic and skills development programs to correct the disjuncture between university and technical curricula to align with current and emerging priorities, focusing on the CTS needed for Africa's development.

- Designing and urgently initiating massive medium- to long-term training for critical technical/sector skill sets.

- Urgently prioritizing and expanding the focus of science, technology, engineering, and mathematics (STEM) education at all levels to address the imperatives of Agenda 2063.

- Leveraging public sector funding to incentivize academic, research, and training institutions to prioritize technical skills development and innovation.

Follow-up

The Capacity Team suggests that, the African Union Commission (AUC) and ACBF, after reviewing this document, undertake urgent follow-up to initiate progressive implementation of the key recommendations permeating this document, sequenced in a way that enhances capacities for implementation of the First 10-Year Implementation Plan of Agenda 2063. As a capacity entity working for Africa, the ACBF should exercise first level continental responsibility for promoting capacity development and a new African technical skills agenda for Agenda

2063, including mobilizing partnerships for implementing recommendations.

It is also suggested that a small "Capacity Task Force" be put together immediately, to work with the AUC and ACBF to implement pertinent key findings and recommendations. Its participants could include persons from NEPAD, AfDB, UNECA, Regional Economic Communities (RECs), other institutions, and one or two capacity experts from the Capacity Team.

1

FRAMING A NEW AFRICAN AGENDA TO PROMOTE CRITICAL TECHNICAL SKILLS FOR THE AFRICA WE WANT

The June 2015 AU Ministerial Retreat of the Executive Council and the Summit in Johannesburg, South Africa emphasized the importance of the capacity dimensions for delivering on Agenda 2063. The retreat acknowledged the work accomplished by the AUC and the ACBF in assessing the capacities required for successfully implementing that Agenda. The Executive Council proposed that the finalized capacity assessment work should highlight the critical skills needed and the role of universities in providing training.

Before the Summit, the work on Capacity Dimensions for Agenda 2063 was initiated by the AUC, with close support of the ACBF, which has been leading the work, through a senior Capacity Team, which has produced three documents:

- *African Critical Technical Skills: Key Capacity Dimensions Needed for the First 10 Years of Agenda 2063,* the present document.
- *Capacity Requirements for the New African Vision: Agenda 2063—"The Africa We Want,"* the Agenda 2063 capacity needs assessment review.
- *Capacity Development Plan Framework: Buttressing Implementation of the First 10-Year Plan—"The Africa We Want,"* the capacity development plan document.

This document focuses on the CTS needed to implement the flagship projects and AU priority programs in support of Agenda 2063. Its purpose is to complement the work done in the Capacity Needs Assessment review, by taking a close look at CTS issues slowing progress in the First 10-year Implementation Plan as well as Agenda 2063 overall. This document therefore provides an initial framing of CTS, provides an illustrative listing of such skills, and captures information on multiple dimensions tightly linked to CTS. These aspects include skills development and training; the situation of STEM education in Africa; TVET; and the role of higher education and the diaspora dimension for CTS. The document also undertakes a situation analysis and provides information on Africa's CTS gaps.

The Proposed Framework builds on the other two documents and proposes initial and foundational capacity development activities to strengthen capacities and arrangements for successfully conducting activities in the first 10 years of Agenda 2063.

This report first stresses the importance and urgency of identifying and prioritizing CTS for the continent and provides an indicative listing of CTS areas for the First 10-year Implementation Plan. It analyzes the situation of CTS in Africa; that of CTS education as well as that of STEM; and that of youth in CTS and in TVET.

It next elaborates the indicative capacities required for the flagship programs for the First 10-Year Implementation Plan and other continental programs, also developing suggestions for organizing and mobilizing CTS and other professional skill areas and capacities.

It then discusses three areas critical to boosting deployment of CTS in Africa: the African diaspora; technology, innovation, and research; and universities.

Importance and urgency of enhancing African critical technical skills and capacity

In the context of the knowledge economy, skills development in the form of education and training provides a sound investment for an economy—nationally and regionally. Skills development is important in Africa today as the continent aims to become an influential global player. Implementing Africa's transformation agenda requires investment in human capital to channel the continent toward "the Africa we want" as envisioned in Agenda 2063. Enhancing human capacity and skills for implementing the Agenda will provide the continent with the foundation to successfully carry out its flagship projects and programs in the First 10-year Implementation Plan.

A dearth of CTS constitutes, however, a fundamental threat to achieving the Africa we want. Africa's stocks of human capital in CTS are dangerously low. This challenge is compounded by low CTS enrollment at the tertiary level and by low educational attainment, as well as insufficient attention and focus on STEM and TVET disciplines. This point cannot be said too much in what we term the *"skills-for-capacity equation."* This equation refers to the acquisition of knowledge and skills ("hard" and "soft"),[1] which is the foundation for capacity development.

For the categories of skills below, we stress that key competencies and achievement of results are greatly enhanced where *composite capacities, soft capacities* and transformative *leadership capacities* are present.

While the skills discussion highlights the human capital dimension of capacity, other dimensions such as the *institutional set-up and arrangements, systems and work processes,* and the financial and physical *enabling environments* constitute key elements of the *capacity imperatives equation* (as analyzed in other documents prepared on the capacity dimensions of Agenda 2063).

Emphasizing critical technical skills for Agenda 2063

Many skills are required to meet the commitments embodied in such a wide-ranging and all-encompassing continental initiative as Agenda 2063. The framing of CTS and sector-specific skills has thus been informed by *anchoring the critical part of skills that are urgently needed to implement the flagship projects and other programs* referred to. They've also been informed by *programs* that are either directly part of the Indicative Strategies of the First 10-year Implementation Plan or lay a foundation for achieving Agenda 2063's goals.

The word *critical* in "critical technical skills" is firmly underscored by the oft-cited *urgent short supply* of qualified and experienced people whose occupations are essential for executing these priority initiatives under "clusters" (table 1.2). The word *technical* emphasizes the technological, scientific, and practical grounding that people in CTS professions should possess.

In view of the linkages and complexity of the initiatives' fit-for-purpose for Agenda 2063, CTS is more than academic or technical

qualifications and experience. Many academically qualified engineers and technicians would not by themselves guarantee successful execution of projects—the *skill sets* need to be considered, that is the combination of *technical expertise* and *composite competencies.* These include management, coordination, negotiation, entrepreneurship, and logistics that enable the assembly and effective use of resources.

In this framing, what constitutes *competence* is the extent to which the hard skill functional elements and other *intangible factors* (including mind-set, and attitudinal and other attributes) drive technical know-how to identify issues, scanning and analyzing the operational environment to identify opportunities. This includes the will to formulate and execute operational strategies and plans of action in whatever area of endeavor—be it an engineering project, an agricultural program, or the Free Movement of People.

Attention also needs to be paid to develop training programs in Africa on issues that have been on the African agenda for years, but *sufficient attention has not been paid to developing institutions dedicated to finding "African solutions to African problems,"* and to developing the requisite skills and professional cadres to deal with them as *occupations*. The paucity of qualified and experienced people in these occupational categories makes it equally critical to meet current needs and projected requirements for the near future.

Another dimension of the CTS shortage concerns the extent to which Africans possessing CTS are recognized and imbued with responsibility. Several key sectors of African economies, particularly those highly dependent on the extractive industry, are mainly run by skilled, expatriate personnel. The argument could be made (given the timeframe for the First 10-year Implementation Plan and the lack of prior investment and thus the scarcity of urgently needed skills) that *the continent could train Africans and tap into pools of skills available elsewhere*, if it could find the financial resources to do so.

Countries in the Gulf offer instructive lessons. While the private sector could use its own mechanisms to address skill gaps in the short term, *ownership* of the African agenda dictates the urgency of looking at CTS from an *African ownership* perspective of *training, imbuing with responsibility, and skill transfers,* including industry/private sector and the educational system—to focus on African needs and priorities.

An indicative list of critical technical skills

In categorizing the critical skills required for Agenda 2063, the Capacity Team looked closely at developing CTS requirements that go beyond the Agenda's first 10 years. It developed an initial list (table 1.1) of professional skill areas, taking into consideration key documents such as the A*genda 2063 10-Year Implementation Plan of Action* and the *Agenda 2063 Framework Document*. It also reviewed a wide array of reports and strategy documents from African and international sources.

African sources included:[2]

- AU Science, Technology, and Innovation Strategy for Africa (STISA-2024).
- The AfDB Human Capital Strategy for Africa 2014–2018.
- The South African Department of Higher Education and Training: National Scarce Skills List: Top 100 Occupations in Demand (South African Government Gazette No. 37678, May 23, 2014);

Table 1.1 Indicative list of professional skill areas needed to achieve Agenda 2063

No.	CTS category
1	Agriculture engineers
2	Agricultural economists
3	Agricultural scientists
4	Forestry specialists
5	Agro-processing specialists
6	Food scientists
7	Food security specialists
8	Nutrition specialists
9	Architects
10	Urban and regional planners
11	Land tenure specialists
12	Construction financiers
13	Surveyors
	Quantity surveyors/technicians
	Road surveyors
	General surveyors
14	Industrial specialists
	Industrial designers
	Industrial engineers/technologists
	Industrial machinery specialists
	Industrial and production specialists/managers/engineers
15	Engineers
	Mining engineers
	Civil engineers/technologists
16	Aeronautical engineers
17	Energy engineer technologists
	Solar energy engineers
	Solar physicists
18	Telecommunications specialists
19	Metallurgical engineers/technologists
20	Electrical engineering technologists (electrical installation inspectors)
21	Mining specialists and engineers/technologists
22	Materials engineering technicians—road materials
23	Mechanical electrical plumbing engineers
24	Electronic engineers/technologists
25	Chemical scientists/engineers/technologists
26	Railway and transportation engineers
27	Materials engineer/technologists
28	Financial investment specialists/advisors

No.	CTS category
29	Geologists
30	Manufacturing specialists/advanced manufacturing
31	Mechanical engineers/mechanical engineering technologists
32	Researchers (research and development managers)
33	Actuary specialists
34	Mechatronics technicians
35	Specialized legal experts in various technical areas and sectors
36	Physical and engineering science technicians
37	Medical specialists and practitioners (health professions and related clinical sciences)
	Public health physicians
	General and specialist medical practitioners
	Nursing professionals
38	Industrial pharmacists
39	Environmental specialists/engineers
40	Climate change specialists
41	Ecological scientists
42	Ecosystem-based water management specialists
43	Geographic information systems specialists
44	Biodiversity specialists
45	Dry land specialists
46	Toxicology scientists
47	Engineering geologists
48	Geochemists
49	Geohazard specialists
50	Construction safety, health, environment, and quality
	Safety, health, environment, and quality practitioners
51	Aquatic scientists
52	Bioeconomists
53	Biological scientists
54	Computational biologists
55	Bioinformaticists
56	Biochemists/physicists
57	Statisticians
58	Chemical scientists
59	Natural and applied sciences
60	Water specialists/hydrologists
61	Irrigation and dam specialists
62	Irrigation design engineers/animal scientists/veterinarians

(continued)

Table 1.1 Indicative list of professional skill areas needed to achieve Agenda 2063 *(continued)*

No.	CTS category
63	Dam construction and management specialists
64	Sewerage network construction professionals
65	Computerized irrigation systems design specialists
66	Urban water and sanitation specialists
67	Technology and innovation specialists
68	Space technology specialists
69	Radar specialists
70	Ship's engineers
71	Earthmoving and related plant operators
72	Satellite positioning and information management specialists
73	Robotics engineers
74	Space weather specialists
75	Magnetic technology specialists
76	Radar engineers
77	Radio frequency engineers
78	Landscape architects
79	Landscape horticulturalists
80	Mining technicians
81	Land and engineering surveyors
82	Oceanographists
83	Marine bioscientists/marine scientists
84	Biomedical engineers
85	Network controllers
86	Medical information analyst
87	Tropical disease specialists
88	Radio astronomy specialists
89	Cosmology and dark energy specialists
90	Cosmic magnetism specialists
91	Calibration and imaging of radio interferometer data specialists
92	Nanophotonics specialists
93	Nanotechnology researchers and scientists
94	Palaeoscience experts
95	Space science and technology specialists
96	Energy security specialists
97	Solutions architects in telecommunications and information and communications technology (ICT)
98	Integrated developers (Java, Perl, PHP)
99	Information technology (IT) security specialists
100	Systems integration specialists
101	Enterprise architects
102	Data center operators/analysts/scientists
103	Network specialists (security)
104	Database specialists
105	Microsoft system engineers
106	Technicians and operators in various technical sector areas, including:
	Machine operators
	Railway construction technicians
	Road constructor infrastructure and construction technicians
	Metal fabricators

Source: ACBF Capacity Team.

- Human Resource Development Strategy for South Africa 2012–2030 (as approved, March 18, 2009).
- National living standard and labor force surveys (Botswana, Cameroon, Ghana, Kenya, South Africa, Uganda, and Zambia).

International sources included:[3]

- Two reports from the International Labour Organization (ILO): *A Skilled Workforce for Strong, Sustainable, and Balanced Growth – A G20 Strategy;* and Director General's Report: *Empowering Africa's Peoples with decent Work: 12th African Regional Meeting Johannesburg, October 11–14, 2011.*
- *Skills Development in Sub-Saharan Africa*
- Better Skills, Better Jobs, Better Lives: A Strategic Approach to Skills Policies (Organisation for Economic Co-operation and Development

Table 1.2 Clusters of key thematic areas with programs and projects

Cluster	Key programs and projects of the First 10-year Implementation Plan
Agriculture and food security	• Comprehensive Africa Agriculture Development Program (CAADP). • STISA Pillar 1: Eradicate hunger and ensure food and nutrition security. • Accelerated Industrial Development of Africa (AIDA), value chains, and agro-production. • Flagship: Africa Outer Space Strategy: Strengthen Africa's use of outer space to bolster its development in Agriculture and climate
Natural resources and extractives	• Program for Infrastructure Development in Africa (PIDA)—Energy (regional and continental clean power generation and transmission projects; high-capacity oil refineries and oil and gas pipeline projects; and renewable energy resources). • African Mining Charter. • STISA Pillar 6: Create wealth (exploitation and management of mineral resources, forests, aquatics, marines, and so on). • Flagship: Africa Outer Space Strategy: Strengthen Africa's use of outer space to bolster its development in the natural resources
Infrastructure and industrialization	• PIDA Priority Action Plans on energy, water resources, and transport sectors. • AIDA—Infrastructure and energy development for industrial processes and value chains. • PIDA—Energy. • Flagship: *Grand Inga Dam Project* (PIDA) to support regional power pools. • Flagship: Build an *Integrated High-Speed Train Network* to facilitate movement of goods, services, and people.
Regional integration and trade	• Flagship: Establish a *Continental Free Trade Area* by 2017 to double intra-African trade by 2022 and strengthen Africa's common voice and policy space in global trade negotiations. • Flagship: *African Passport and Free Movement of People* (by 2018). • PIDA—Transport : To work toward an integrated continent where the transport infrastructure and services enable the free movement of goods and passengers.
Wealth creation and management	• Flagship: *Continental Free Trade Area* facilitated by regional financial institutions: African Investment Bank and Pan-African Stock Exchange (2016). African Monetary Fund (2018); and African Central Bank (2028/34). • Flagship: *Commodity Strategy* to promote value addition, leveraging commodities and maximizing rents; integration into the global value chains, and promotion of vertical and horizontal diversification anchored in value addition and local content development. • STISA Pillar 6: Create wealth (education and human resource development; exploitation and management of mineral resources, forests, aquatics, marines, and so on; management of water resources).
Pan-Africanism and governance	• Flagship: Establish an *Annual African Forum* to bring African political leadership, the private sector, academia, and civil society together periodically. • Flagship: *Silencing the Guns by 2020*—Ending all wars, civil conflicts, gender-based violence and violent conflicts, and preventing genocide. • STISA Pillar 5: Live together—Build the society (citizenship, history and shared values, Pan-Africanism and regional integration, governance and democracy, city management, and mobility).
E-Society	• Flagship: *African Virtual and E-University* to increase access to tertiary and continuing education in Africa by reaching numerous students and professionals in multiple sites simultaneously and developing relevant and high-quality open, distance, and e-learning resources. • Flagship: *Pan-African E-Network* involving e-applications and services in Africa, especially the intra-African broadband terrestrial infrastructure, and cyber security, making the information revolution the basis for service delivery in the bio and nanotechnology industries and ultimately transform Africa into an e-society. • PIDA—ICT (vision): To enable Africa to build an information society and an integrated digital economy in which every government, business, and citizen has access to reliable and affordable ICT networks. • STISA Pillar 3: Communication (equipment, infrastructure, energy, and intellectual communications in terms of ICT).
Wellness and health	• STISA Pillar 2: Prevent and control diseases, and ensure well-being. • AIDA (industrial value chains—pharmaceutical, technology, and innovation cluster).

Source: ACBF Capacity Team.

The indicative list of CTS professional skill areas serves to illustrate the special skills critical for African transformation and ownership. Believing in and counting on Africans to plan and handle the most technologically advanced dimensions for key national, regional, and continental projects is a fundamental tenet of Agenda 2063's strategic vision.

Compilation of a more complete list should include guidance from stakeholders in these skill areas (and programs).

Other core areas of skill specialties required for Agenda 2063

Africa-focused professional skill areas: Working toward Africa's solutions to Africa's problems

Africa—especially its universities and other tertiary institutions—*urgently needs to develop new educational degrees and certificates* in areas where specialized African training and knowledge is vital (figure 8.2 toward the end of the document).

A broad spectrum of skills and qualifications in soft disciplines

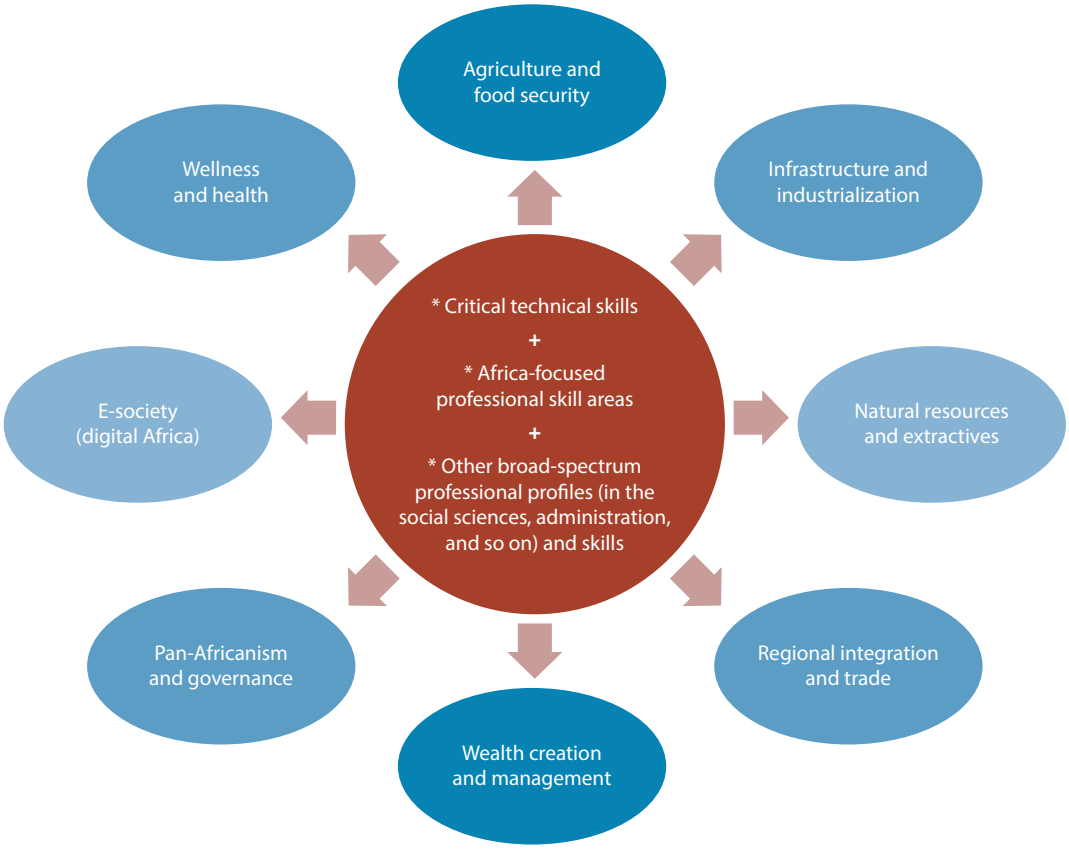
Africa's workers must—beyond the above professional skill areas—have knowledge and skills in a wide range of disciplines, including the "soft" disciplines of the social sciences, humanities, and administration, among many others. Not enough Africans are being educated and trained in these areas, but progress over the past few decades is praiseworthy: The jump in numbers of Africans being educated in these soft disciplines is more than 10 times that in CTS disciplines.

The skills combination for Africa: Critical technical skills plus Africa-focused professional skill areas plus other broad-spectrum professional profiles and skills

In identifying CTS, special focus has been placed on strategic critical path elements of the flagship projects of the First 10-year Implementation Plan, bearing in mind the constraints of time, as well as the human and financial resources required to fulfill the Plan. In addition, in view of the critical skills shortage, we followed a value chain and systems approach to identify those skill sets that have the greatest cross-multiplier effects and synergistic delivery impacts across eight priority clusters (figure 1.1 and table 1.2).

The emphasis is on essential skill combinations that would generate immediate returns, while mechanisms are put in place to develop essential stocks of African skills in the near term to ensure ownership and sustainability.

Figure 1.1 Skill combination scenario to enhance flagship initiatives and programs



Source: ACBF Capacity Team.

2

ANALYSIS OF CRITICAL TECHNICAL SKILLS IN AFRICAN COUNTRIES AND AFRICAWIDE

Alarms should be sounding over the dearth of critical technical skills in Africa

Finding data and information on CTS in Africa is a major challenge. Most African countries do not seem to possess organized and accessible datasets or systems that can provide data on professionals trained in critical and sector-specific skill areas. Considering the importance of CTS in driving social and economic development, this lacuna is a major constraint. Where CTS information was available, our analysis showed major shortages.

Documents we consulted also show that the African continent—and individual African countries—are worryingly behind on numbers and availability of CTS specialists (typified in box 2.1).

Based on rough calculations and estimates, the challenge in Africa's low CTS comes through the following examples.

Analytical examples of critical technical skills in Africa and elsewhere

The continent faces an enormous challenge in implementing Agenda 2063, which the data

Box 2.1 Africa's CTS shortages

Africa now lacks an estimated 8,167,172 medical doctors and specialists, and should aim to have, given the projected population increase, 9,503,000 by 2023 (the end of the First 10-Year Implementation Plan).

Africa is short of an estimated 1,168,571 researchers, and should aim to have 1,405,300 by 2023.

The continent currently lacks an estimated 4,309,065 engineers (and should aim to have 4,865,270 in 2023).

It is short of 382,127 quantity surveyors and should be aiming to have 456,534 by 2023.

Africa is now short of an estimated 9,090 mining specialists/engineers, and should aim to have 26,927 of them by 2023.

In terms of geologists, Africa lacks an estimated 152,929, and should have 193,583 by 2023.

Source: ACBF Capacity Team.

Table 2.1 Selected CTS in Africa and international norms

CTS	International norm	Current situation in Africa	Current estimated gap in Africa	Projected desired number in 2023	Comparison with developing countries outside Africa	Comparison with developed/OECD countries
Medical doctors and specialists	The internationally accepted number of medical doctors and specialists for a country is 2.5 per 1,000 population[a]	Estimated average ratio of physicians or medical doctors for Africa is about 0.307 per 1,000 population For an African population of 1,166,239,000, this translates into about 358,035 medical doctors and specialists Ideally, the target number of medical doctors and specialists Africa could have is approximately 2,915,598	An approximate ratio of 2.193 per 1,000 population 2,557,563	In 2023, Africa's population is estimated to reach 1.3 billion About 3,250,000	Brazil's estimated ratio of medical doctors and specialists: 1.89 per 1,000 population; 378,756 for a population of 200.4 million Compared with Brazil, an ideal number of medical doctors for Africa is 2,204,192 Thus Africa has a gap of 1,846,156 medical doctors Using Brazil as a benchmark, Africa should aim to have 9,503,000 more medical doctors by 2023	Canada's estimated ratio of medical doctors and specialists: 2.07 per 1,000 population; estimated total: 71,247 US estimated ratio of medical doctors and specialists: 2.45 per 1,000 population; estimated total: 787,001 UK estimated ratio of medical doctors and specialists: 2.79 per 1,000 population; estimated total: 168,979 Estimated total ratio for the three countries is 7.31 physicians per 1,000 population; an estimated total of 3,042,495 medical doctors for a combined population of 416,210, 000. Compared with Africa with a population of 1,166,239,000, this translates into an ideal number of 8,525,207 medical doctors. With its current medical doctors of about 358,035, Africa has a gap of 8,167,172 and should be aiming for about 9,503,000 by 2023
Researchers in STEM-related areas (see text)	World average of researchers estimated at 1,081 researchers per million population	The ratio of scientists and researchers in Africa stands at just 79 per million population.[b] For an estimated African population of 1,166,239,000, this translates into 92,133 researchers Based on the world average, an ideal number of researchers for the continent is 1,260,704	1,168,571	1,405,300[c]		
Veterinarians[d]	The international norm of veterinarians is estimated between 200 and 400 (or an average of 300) per million population	Estimated average ratio of veterinarians for Africa: 2.31 per million population This implies Africa, with a population of about 1,166,239,000 has only 2,700 veterinarians Based on the international norm, ideally, Africa should have 349,872 veterinarians	347,172	About 390,000		

(continued)

Table 2.1 Selected CTS in Africa and international norms *(continued)*

a. The World Health Organization estimates that at least 2.5 physicians, nurses, and midwives per 1,000 people are needed to provide adequate coverage with primary care interventions associated with achieving the Millennium Development Goals. Source: World Bank (2011), World Health Organization (2014).

b. Kigotho (2015).

c. According to the United Nations Educational, Scientific, and Cultural Organization (UNESCO) Institute for Statistics, 2.7 percent of gross domestic product (GDP) is devoted to research and development activities in North America, while only 0.4 percent is devoted to it in Africa; of the world's researchers, only 27 percent are women. Source: UNESCO (2010).

d. Among its peers in Africa, South Africa as a country is expected to be doing well in CTS professions such as veterinary medicine, considering its level of development. The international norm ratio of veterinarians per million population is between 200 and 400 (or an average of 300). With a population of 53,491,333, South Africa has between 60 and 70 (or an average of 50) veterinarians per million population, an average total of 2,675 veterinarians for the whole country. Source: Swan (2011). By way of extrapolation, assuming the average of 50 veterinarians for each of the 54 African countries, this would mean a total number of 2,700 veterinarians for the whole of Africa. That is a ratio of 2.31 veterinarians per million population.

the Capacity Team collected can only hint at (owing to data scarcity).

The African continent comprises 54 countries with different CTS numbers and availability. One cannot therefore generalize. But we found it useful to draw some comparisons on the CTS picture with other countries and regions of the world. (Smaller, developing countries in other continents were selected for comparison.) Thus the examples are based on three entry points (the following three subsections).

For Sub-Saharan African countries, research in the physical sciences and STEM makes up only 29 percent of all research output. By contrast, STEM makes up the largest share of Malaysia and Vietnam's total research output, with an average of 68 percent. Moreover, Sub-Saharan Africa relies on overseas collaboration and visiting academics for its research output.[4] The continent remains far from the target set by the Lagos Plan of Action and African Union 2007 initiative calling on African countries to allocate 1 percent of their GDP to science. With Africa's GDP of close to $2.6 trillion, the amount potentially allocable to science is $200 billion. African countries can no longer depend only on external financiers to fund basic and strategic research. African governments and the private sector should make a firm commitment to invest in science, technology, and innovation, particularly if the continent wants to participate actively in the global knowledge economy and cultivate local capacity, including the full participation of youth and women.

According to the Africa Agriculture Status Report 2013,[5] of the 48 countries in Sub-Saharan Africa with data, half had fewer than 100 scientists (full-time equivalents) and 40 percent of the agricultural scientists were working in just five countries. In 2007 in Africa, only one-fourth of researchers held a PhD, compared with nearly two-thirds in India.

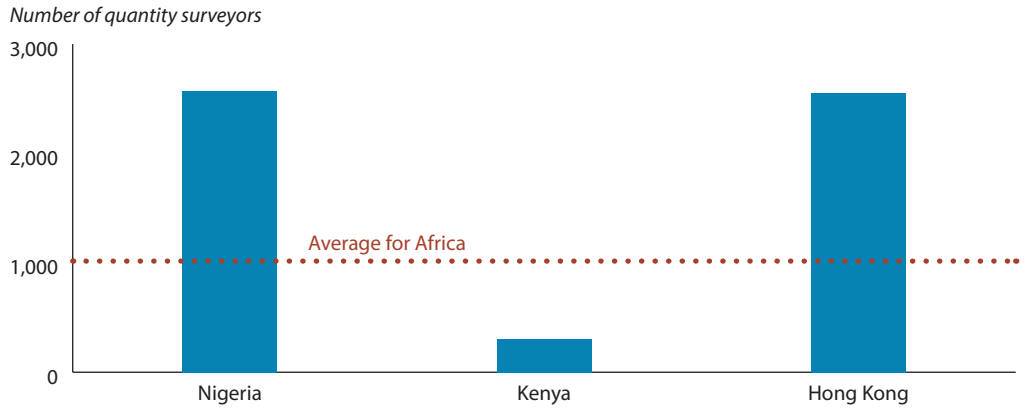
Table 2.2 CTS in Africa versus selected emerging economies in other continents

CTS	Comparison with developing countries outside Africa	Current situation in Africa	Current estimated gap in Africa	Projected desired number in 2023
Engineers	Brazil has an estimated 750,000 engineers A ratio of 3.75 engineers per 1,000 population	The estimated number of engineers in Kenya is 7,221; Tanzania, 2,614; Malawi, 300;[a] and Rwanda, 175[b] The average number of engineers in these countries is 2,577 Since many countries in Africa are least-developed countries, their average is probably below that average It would be more realistic to consider the average for Tanzania, Malawi, and Rwanda—around 1,029 engineers This suggests a possible 55,601 engineers in Africa The estimated ideal number is 4,364,667	4,309,065	4,865,270
Quantity surveyors (figure 2.1)	Hong Kong population (2015 estimate): 7,266,360 Estimated number of quantity surveyors: 2,551	The average number of quantity surveyors in Nigeria and Kenya is estimated at 1,016 These two countries appear to be doing well considering their GDP compared with most African countries Assuming half of that average (508) is more or less realistic for most African countries, the current number of quantity surveyors on the continent is estimated at 27,432 With Hong Kong as a benchmark, the ideal number for Africa is 409,559	382,127	456,534
Agricultural scientists and researchers (see text and figure 2.2)	Indian population: 1,210,193,422 Indian ratio research capacity: 130 researchers per million population Estimated number of researchers: 157,325	Africa's research capacity ratio: 70 per million population This gives an estimated total of 81,637 An ideal number for Africa is an estimated 151,611	69,974	169,000

a. Nyasa Times (2011).

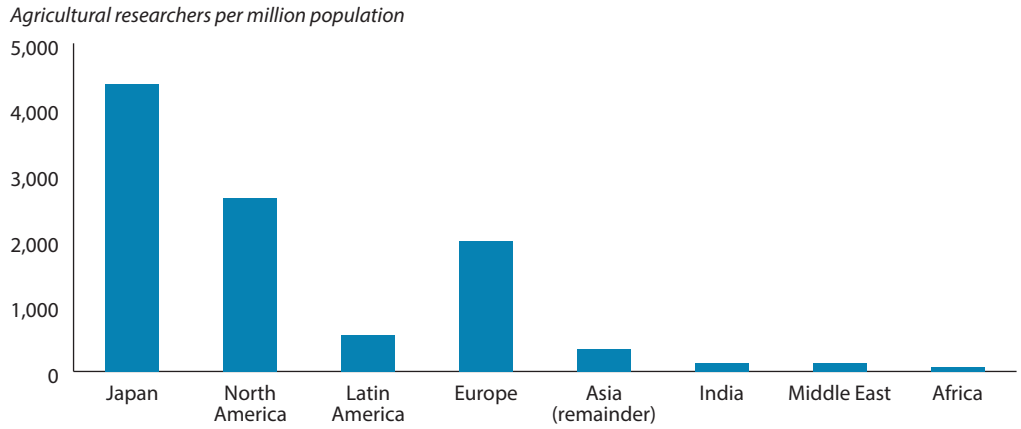
b. Institution of Engineers Rwanda (2015).

Figure 2.1 Numbers of quantity surveyors, various jurisdictions



Source: ACBF Capacity Team.

Figure 2.2 Agricultural researchers per million population, by region



Source: Alliance for a Green Revolution in Africa (2013).

Table 2.3 CTS in Africa versus selected developed/OECD countries

CTS	Comparison with selected developed/OECD countries	Current situation in Africa	Current estimated gap in Africa	Projected desired number in 2023
Urban and regional planners[a] (table 2.4)	UK (2015 population estimate 64,952,549) Number of accredited planners: 23,000 Ratio of planners per 100,000 population: 37.63	African population: 1,166,239,000 Estimated ratio: 1.95 per 100,000 population Estimated total: 22,761[b] Based on the UK, ideally Africa should have 438,856 urban and regional planners	416,095	489,190
Mining specialists/ engineers (figure 2.3)	US with 6,630 mining specialists for a population of 320,090,857 Ratio of 20.7 per million habitants	Estimated ratio: 12.92 per million population[c] Estimated total: 15,066 Ideally, the continent should have 24,156 mining specialists	9,090	26,927
Geologists (figure 2.4)	Canada estimated population: 35,589,809 Number of geologists: 5,300 Ratio of planners per million population: 148.91	Estimated ratio: 17.78 per million population[d] Estimated total: 20,736 Based on Canada, the ideal total would be 173,665	152,929	193,583

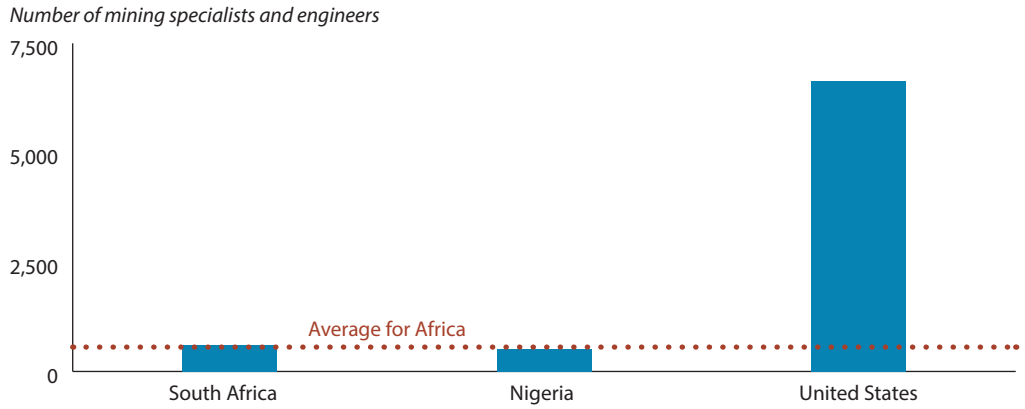
a. United Nations Human Settlements Programme (2014).

b. According to table 2.4, urban and regional planners in the selected African countries total 5,058 or a ratio of 12.04 planners per 100,000 people—an average of 422 planners or a ratio of 1.003 planners per 100,000 population. Even though the above average of 422 could be very high for certain African countries (as for Burkina Faso), we can assume that to be the average for most African countries.

c. This ratio was obtained by considering the average of mining specialists/engineers for South Africa and Nigeria and extrapolating to the rest of the continent.

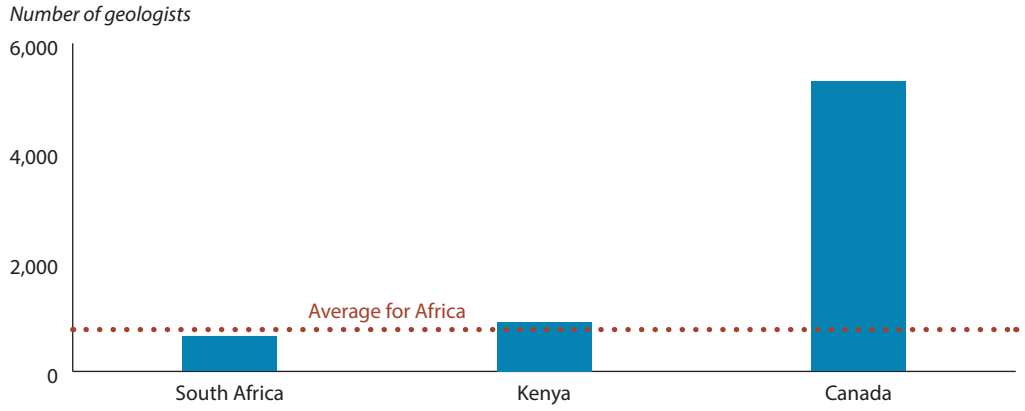
d. This estimated ratio for Africa is obtained by considering the average number of geologists for Kenya and South Africa (figure 2.4) and extrapolating to the rest of the continent.

Figure 2.3 Numbers of mining specialists and engineers



Source: ACBF Capacity Team.

Figure 2.4 Comparative situation on numbers of geologists



Source: ACBF Capacity Team.

Table 2.4 Ratio of urban and regional planners in selected countries

Countries	Population 2015	No. of accredited planners	No. of planners per 100,000	Countries	Population 2015	No. of accredited planners	No. of planners per 100,000
Burkina Faso	18,422,734	14	0.08	Tanzania	51,448,768	158	0.34
Ghana	27,134,945	150	0.60	Uganda	41,388,792	90	0.26
Kenya	47,264,812	194	0.47	Zambia	15,741,062	60	0.45
Malawi	17,600,778	30	0.20	Zimbabwe	16,033,327	262	2.45
Mali	16,346,293	50	0.32	**(Africa)**	**1,166,239,000**	**22,761 (est.)**	**1.95**
Mauritius	1,327,169	27	2.10	Australia	23,714,794	4,452	23.47
Nigeria	181,365,350	2,333	1.44	UK	64,952,549	23,000	37.63
South Africa	53,491,333	1,690	3.33	US	325,691,267	38,830	12.77

Source: UNESCO (2010).

Table 2.5 Summary of current and projected CTS gaps

CTS	Current situation in Africa versus international norms, emerging economies in other continents, and developed/OECD countries	Ideal number of CTS specialists based on comparison in the previous column	Estimated current number of CTS specialists	Current gap	Projection in 2023
Medical doctors and specialists	Africa: 0.307 per 1,000 population; international norm: 2.5 per 1,000 population.	2,915,598	358,035	2,557,563	3,250,000
	Africa: 0.307 per 1,000 population; Canada, UK, and US: 7.31 per 1,000 population.	8,525,207	358,035	8,167,172	9,503,000
Researchers in STEM-related areas	Africa: 79 per million population; international norm: 1,081 per million population.	1,260,704	92,133	1,168,571	1,405,300
Veterinarians	Africa: 2.31 per million population; international norm: between 200 and 400 (average 300) per million population.	349,872	2,700	347,172	390,000
Engineers	Africa: average 1,029; Brazil: 3.75 per 1,000 population.	4,364,667	55,601	4,309,065	4,865,270
Quantity surveyors	Africa: average 508 per current African population; Hong Kong: 2,551 per current Hong Kong population.	409,559	27,432	382,127	456,534
Agricultural scientists and researchers	Africa: 70 per million population; India: 130 per million population.	151,611	81,637	69,974	169,000
Urban and regional planners	Africa: 1.95 per 100,000 population; UK: 37.63 per 100,000 population.	438,856	22,761	416,095	489,190
Mining specialists/ engineers	Africa: 12.92 per million population; US: 20.7 per million population.	24,156	15,066	9,090	26,927
Geologists	Africa: 17.78 per million population; Canada: 148.91 per million population.	173,665	20,736	152,929	193,583

Summary of current and projected critical technical skill gaps

Table 2.5 summarizes the above CTS findings. It also presents the gap between where Africa ought to be right now and projections of where Africa should be by 2023. It shows that Africa faces an enormous CTS challenge. For the continent to deliver its flagship projects in Agenda 2063, it needs to make real efforts to bridge that CTS gap.

Hypothetical estimates of three critical technical skill professional groups in Africa

The Capacity Team attempted to estimate the number of CTS professionals in African countries in three CTS areas: medical doctors and specialists, water and sanitation engineers, and researchers in STEM-related areas (table 2.6). The aim was two-fold: to expand awareness of the need for greater attention to the scarcity of CTS and the need to develop inventory on stocks of CTS professionals among individual African countries; and to encourage the flow of data as well as data systems development and accessibility on CTS. As with the continent as a whole, the table shows a very large gap between current estimates of CTS professionals and the minimum number countries should strive to have.

To arrive at estimated desirable numbers for each country, it used international norms in relation to the estimated population of each country. Because of data unavailability, the hypothetical averages have been derived from an estimated continent-wide ratio per number of population.

Comparisons of highly skilled expatriates versus highly skilled national staff in selected African countries

Most African countries are challenged to create jobs in engineering, science, and technology (EST), and so they resort to importing human capital (table 2.7).

Although in many African countries there are more highly skilled nationals than expatriates, in two countries expatriates are more than 50 percent of the workforce (Mauritius and Angola). This number of highly skilled expatriates in Africa applies to major infrastructure programs and projects in industries such as oil and gas, mining, petrochemicals, food processing, energy (electricity), and roads. Broadly, employment and engagement for technologically sophisticated work is dominated by foreign multinational companies prevalent in these sectors in Africa.

Current critical technical skills among African youth

Africa's current population is estimated at around 1.1 billion, with 41 percent under the age of 15, and 65 percent under 35.[6] The AfDB reports that the African population is likely to grow to 2.3 billion people by 2050, with most of this population accounted for by youth. This youth bulge presents Africa's with its greatest asset—human capital. But youth employment in Africa does not now show the continent harnessing its human capital stock.

Africa's youth bulge

The demographic dividend (figure 2.5) presents phenomenal potential with advanced uptake of technology and improved education among African youth. Comparing the age dynamics in 1950, 2010, 2050, and 2100, the graphic illustration of Africa's youth boom is evident.

Table 2.6 Hypothetical CTS gaps, by country

No.	Country and population		Medical doctors and specialists: International norm 2.5 per 1,000 population			Water and sanitation engineers: International norm 5.5 per 1,000 population			Researchers in STEM related areas: World average 1,081 per million population		
	Country	Population (2015 estimate)[a]	Estimated desirable number	Estimated current situation	Hypothetical gap? (TBD)	Estimated desirable number	Estimated current situation	Hypothetical gap? (TBD)	Estimated desirable number	Estimated current situation	Hypothetical gap? (TBD)
	African continent	**1,166,239,000**	**2,915,598**	**358,035**	**2,557,563**	**6,414,315**	**3,586,611**	**2,827,704**	**1,260,704**	**92,133**	**1,168,571**
1	Algeria	40,633,464	101,584	12,474	89,110	223,484	124,745	98,739	44,250	3,210	41,040
2	Angola	22,819,926	57,050	7,005	50,045	125,510	70,057	55,453	24,668	1,803	22,865
3	Benin	10,879,828	27,200	3,340	23,860	59,839	33,401	26,438	11,761	860	10,901
4	Botswana	2,056,370	5,141	631	4,510	11,310	6,313	4,997	2,223	163	2,060
5	Burkina Faso	17,914,625	44,787	5,499	39,288	98,530	54,998	43,532	19,366	1,415	17,951
6	Burundi	10,812,619	27,036	3,319	23,717	59,469	33,195	26,274	11,688	854	10,834
7	Cameroon	23,393,129	58,483	7,182	51,301	128,662	71,817	56,845	25,288	1,848	23,440
8	Cape Verde	508,315	1,271	156	1,115	2,796	1,561	1,235	550	40	510
9	Central African Republic	4,803,082	12,008	1,474	10,534	26,417	14,745	11,672	5,192	379	4,813
10	Chad	13,605,625	34,014	4,177	29,837	74,831	41,769	33,062	14,708	1,075	13,633
11	Comoros	770,058	1,925	236	1,689	4,235	2,364	1,871	833	61	772
12	Congo, Rep. of	4,671,142	11,678	1,434	10,244	25,691	14,340	11,351	5,050	360	4,690
13	Côte d'Ivoire	21,295,284	53,238	6,538	46,700	117,124	65,376	51,748	23,020	1,682	21,338
14	Democratic Republic of the Congo (DRC)	71,246,355	178,116	21,873	156,243	391,855	218,726	173,129	77,017	5,628	71,389
15	Djibouti	899,658	2,249	276	1,973	4,948	2,762	2,186	973	71	902
16	Egypt	84,705,681	211,764	26,005	185,759	465,881	260,046	205,835	91,567	6,692	84,875
17	Equatorial Guinea	799,372	1,998	245	1,753	4,397	2,454	1,943	864	63	801
18	Eritrea	6,737,634	16,844	2,068	14,776	37,057	20,685	16,372	7,283	532	6,751
19	Ethiopia	98,942,102	247,355	30,375	215,980	544,182	303,752	240,430	106,956	7,816	99,140
20	Gabon	1,751,199	4,378	538	3,840	9,632	5,376	4,256	1,893	138	1,755

(continued)

Table 2.6 Hypothetical CTS gaps, by country *(continued)*

No.	Country and population		Medical doctors and specialists: International norm 2.5 per 1,000 population			Water and sanitation engineers: International norm 5.5 per 1,000 population			Researchers in STEM related areas: World average 1,081 per million population		
	Country	Population (2015 estimate)[a]	Estimated desirable number	Estimated current situation	Hypothetical gap? (TBD)	Estimated desirable number	Estimated current situation	Hypothetical gap? (TBD)	Estimated desirable number	Estimated current situation	Hypothetical gap? (TBD)
21	Gambia	1,970,081	4,925	605	4,320	10,835	6,048	4,787	2,130	156	1,974
22	Ghana	26,984,328	67,461	8,284	59,177	148,414	82,842	65,572	29,170	2,132	27,038
23	Guinea	12,347,766	30,869	3,791	27,078	67,913	37,908	30,005	13,348	975	12,373
24	Guinea-Bissau	1,787,793	4,469	549	3,920	9,833	5,489	4,344	1,933	141	1,792
25	Kenya	46,748,617	116,872	14,352	102,520	257,117	143,518	113,599	50,535	3,693	46,842
26	Lesotho	2,120,116	5,300	651	4,649	11,661	6,509	5,152	2,292	167	2,125
27	Liberia	4,503,439	11,259	1,383	9,876	24,769	13,826	10,943	4,868	356	4,512
28	Libya	6,317,080	15,793	1,939	13,854	34,744	19,393	15,351	6,829	499	6,330
29	Madagascar	24,235,390	60,588	7,440	53,148	133,295	74,405	58,890	26,198	1,915	24,283
30	Malawi	17,308,685	43,272	5,314	37,958	95,198	53,138	42,060	18,711	1,367	17,344
31	Mali	16,258,587	40,646	4,991	35,655	89,422	49,914	39,508	17,576	1,284	16,292
32	Mauritania	4,080,224	10,200	1,253	8,947	22,441	12,526	9,915	4,411	322	4,089
33	Mauritius	1,253,581	3,134	387	2,747	6,895	718	6,177	1,355	99	1,256
34	Morocco	33,955,157	84,638	10,424	74,214	186,753	104,242	82,511	36,706	2,682	34,024
35	Mozambique	27,121,827	67,805	8,326	59,479	149,170	83,264	65,906	29,319	2,143	27,176
36	Namibia	2,392,370	5,981	734	5,247	13,158	7,345	5,813	2,586	189	2,397
37	Niger	19,268,380	48,171	5,918	42,253	105,976	59,154	46,822	20,829	1,522	19,307
38	Nigeria	183,523,432	458,809	56,342	402,467	1,009,379	563,417	445,962	198,389	14,498	183,891
39	Rwanda	12,428,005	31,070	3,815	27,255	68,354	38,154	30,200	13,435	982	12,453
40	São Tomé and Príncipe	202,781	508	62	446	1,115	623	492	219	16	213
41	Senegal	14,967,446	37,419	4,595	32,824	82,321	45,950	36,371	16,180	1,182	14,998
42	Seychelles	93,754	234	29	206	516	288	228	101	7	94

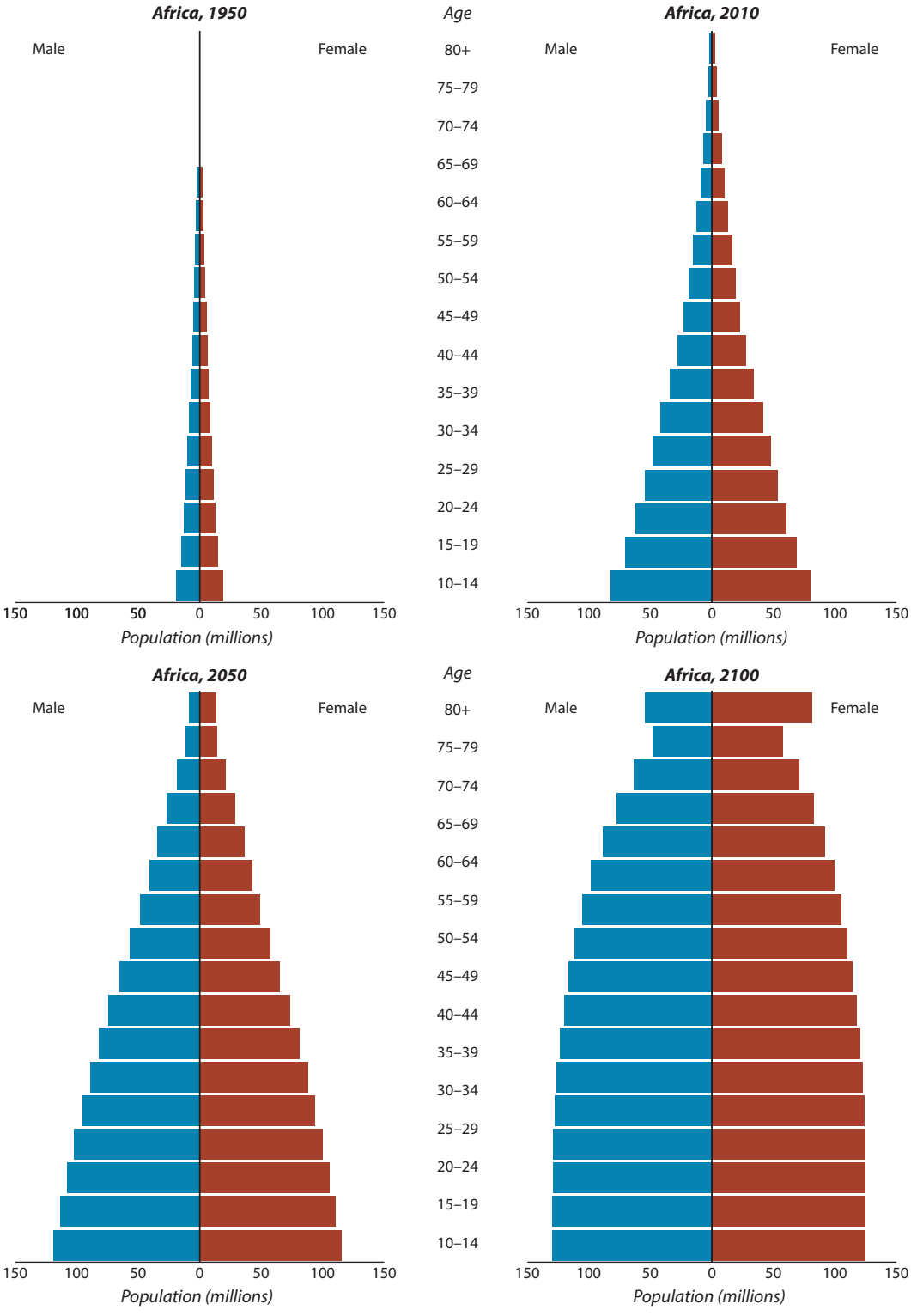
(continued)

Table 2.6 Hypothetical CTS gaps, by country *(continued)*

No.	Country and population		Medical doctors and specialists: International norm 2.5 per 1,000 population			Water and sanitation engineers: International norm 5.5 per 1,000 population			Researchers in STEM related areas: World average 1,081 per million population		
	Country	Population (2015 estimate)[a]	Estimated desirable number	Estimated current situation	Hypothetical gap? (TBD)	Estimated desirable number	Estimated current situation	Hypothetical gap? (TBD)	Estimated desirable number	Estimated current situation	Hypothetical gap? (TBD)
43	Sierra Leone	6,318,575	15,796	1,940	13,856	34,752	19,398	15,354	6,830	499	6,331
44	Somalia	11,122,711	27,807	3,414	24,393	61,175	34,147	27,001	12,024	879	11,145
45	South Africa	53,491,333	133,729	1,642	132,087	294,202	164,218	129,984	57,824	4,226	53,598
46	South Sudan	12,152,321	30,381	3,731	26,650	66,838	37,308	29,530	13,137	960	12,177
47	Sudan	39,613,217	99,033	12,161	86,872	217,873	121,613	196,260	42,822	3,129	39,693
48	Swaziland	1,285,519	3,214	395	2,819	7,070	3,947	3,123	1,390	102	1,288
49	Togo	7,170,797	17,927	2,201	15,726	39,439	22,014	17,425	7,752	566	7,186
50	Tunisia	11,235,248	28,088	3,449	24,639	61,794	34,492	27,302	12,145	888	11,257
51	Uganda	40,141,262	100,353	12,323	88,030	220,777	123,234	97,543	43,393	3,171	40,222
52	Tanzania	52,290,796	130,727	16,053	114,674	287,599	160,533	127,066	56,526	4,131	52,395
53	Zambia	15,519,604	38,800	4,765	34,035	85,358	47,645	37,713	16,777	1,226	15,551
54	Zimbabwe	15,046,102	37,615	4,619	32,996	82,754	46,192	40,562	16,264	1,189	15,075

a. United Nations Department of Economic and Social Affairs (2015).

Figure 2.5 Africa's youth bulge



Source: AfDB (2014).

Table 2.7 Highly skilled expatriates and highly skilled national staff working in selected African countries

Country	Number of highly skilled expatriates and % of total EST workforce	Number of highly skilled national staff and % of total EST workforce	Total number of highly skilled workforce in EST
Angola	38,000 (56%)	30,000 (44%)	68,000
Benin	5,000 (8.6%)	53,000 (91.4%)	58,000
Burkina Faso	3,000 (19%)	13,000 (81%)	16,000
Burundi	4,000 (36%)	7,000 (64%)	11,000
Cameroon	25,000 (20%)	100,000 (80%)	125,000
Central African Republic	3,000 (27%)	8,000 (73%)	11,000
Côte d'Ivoire	16,670 (10%)	150,000 (90%)	166,670
Ethiopia	33,340 (20%)	133,340 (80%)	166,680
Gabon	4,000 (27%)	11,000 (73%)	15,000
Ghana	50,000 (43%)	66,700 (57%)	116,700
Kenya	83,340 (38%)	133,340 (62%)	216,680
Madagascar	25,005 (13%)	166,670 (87%)	191,675
Malawi	5,000 (19%)	22,000 (81%)	27,000
Mali	5,000 (19%)	21,000 (81%)	26,000
Mauritius	23,000 (53%)	20,000 (47%)	43,000
Mozambique	21,000 (48%)	23,000 (52%)	44,000
Niger	1,500 (13%)	10,000 (87%)	11,500
Senegal	23,000 (29%)	56,000 (71%)	79,000
Seychelles	2,000 (6%)	34,000 (96%)	36,000
Sierra Leone	12,000 (32%)	25,000 (68%)	37,000
Sudan	16,670 (6.3%)	250,000 (93.7%)	266,670
Tanzania	28,000 (44%)	36,000 (56%)	64,000
Tunisia	66,670 (21%)	250,000 (79%)	316,670
Uganda	30,000 (37%)	52,000 (63%)	82,000
Zambia	16,000 (26%)	46,000 (74%)	62,000

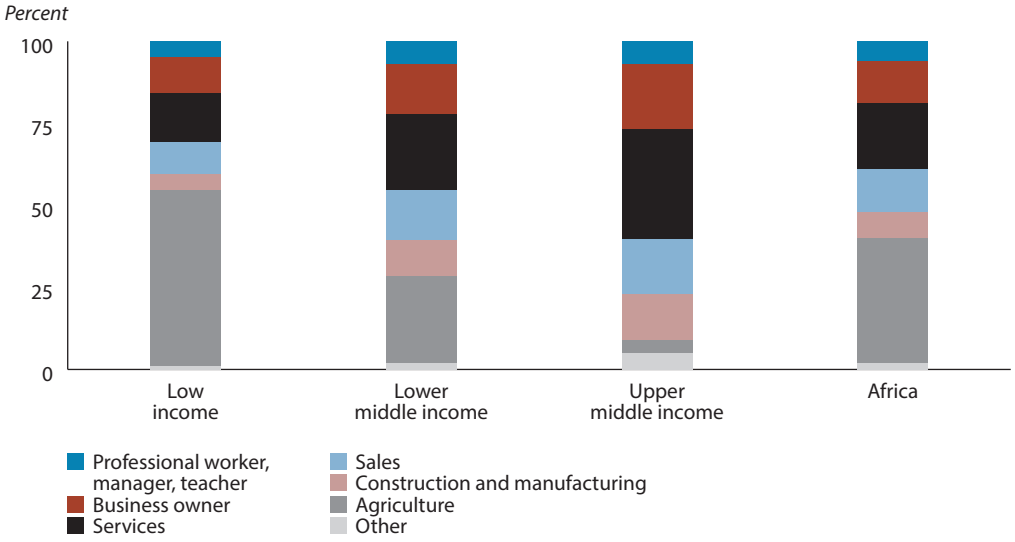
Source: Dumont and Lemaitre (2005).

Extrapolating further from the figure, from the year 2020, African youth (men and women) will constitute a vital force to be drawn on for leading and owning Africa's transformation vision. In 2100, it is estimated that Africa will still be leading the world on youth energy for development and transformation. These factors constitute a strong case for equipping African youth with the necessary CTS, including those of the highest levels of technological sophistication.

Mismatches between skills demand and supply

Present challenges must be resolved, however. For a start, there is a dichotomy between youth numbers and employment. Research for the *African Economic Outlook* on youth unemployment showed that, among the factors for high youth unemployment was a mismatch between qualifications and jobs. Of youth jobseekers, 54 percent have advanced qualifications but not in the sectors or skills

Figure 2.6 Employment by sector in Africa



Source: AfDB, OECD, UNDP, and UNECA (2012).

required by the labor market, while 41 percent of youth jobseekers in the labor market had few or no skills (according to employers).[7]

Further, according to the report, youth with tertiary education find it hard to get a job in sectors that require specific technical qualifications, such as the extractive industries, logistics, the chemical and pharmaceutical industries, manufacturing, and agribusiness. Figure 2.6 shows sectoral employment in Africa.

While employment (informal and formal) in agriculture in the least-income countries (LICs) stands at 54 percent, too few youth are being trained in the sector, and so may be unable to benefit from the jobs it offers. For employment as business owners, the shares are low (11 percent in LICs, 15 percent in lower-middle-income countries (LMICs), 20 percent in upper-middle-income countries (UMICs), and 13 percent on the continent as a whole). But this ideally should be an area where youth are trained with a mind-set of starting their own business, to become employers rather than jobseekers.

What do African students study?

Current higher education in Africa is heavily focused on non-CTS areas (table 2.8). If this pattern continues (figure 2.7), the continent is likely to have more non-CTS graduates between 2020 and 2030 than CTS graduates. Thus delivering on Agenda 2063 flagship programs and other continental initiatives could be severely hampered, given the aim to train and make Africans responsible for implementing the Agenda.

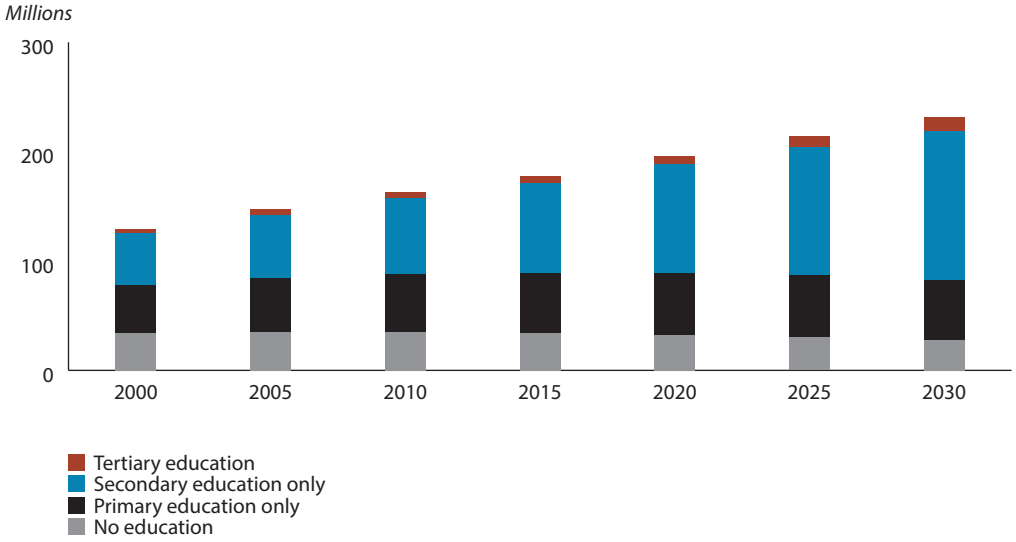
According to the figure below (2.7), it was projected that in 2015, 34 million African youth (aged 20–24) would be without education; and between 2020 and 2030, close to 30 million are still projected to be without education. If the projections are correct, by 2023 only about 10 million African youth will

Table 2.8 University graduation rates in Africa and other regions, 2008–2010 (%)

	Education, humanities, and arts	Social science, business, and law	Science	Engineering, management, and construction	Agriculture	Health and welfare	Services	Other
Sub-Saharan Africa	26	44	12 (3 ICT)	4	2	5	0	7
North Africa	22	51	8 (1 ICT)	10	1	6	1	1
Asia	23	30	6	20	4	9	4	4
Latin America	23	38	7	9	2	13	3	5
OECD	25	37	10 (3 ICT)	11	2	11	4	1

Source: AfDB, OECD, UNDP, and UNECA (2012).

Figure 2.7 Education of 20–24-year-old Africans by level, 2000–2030



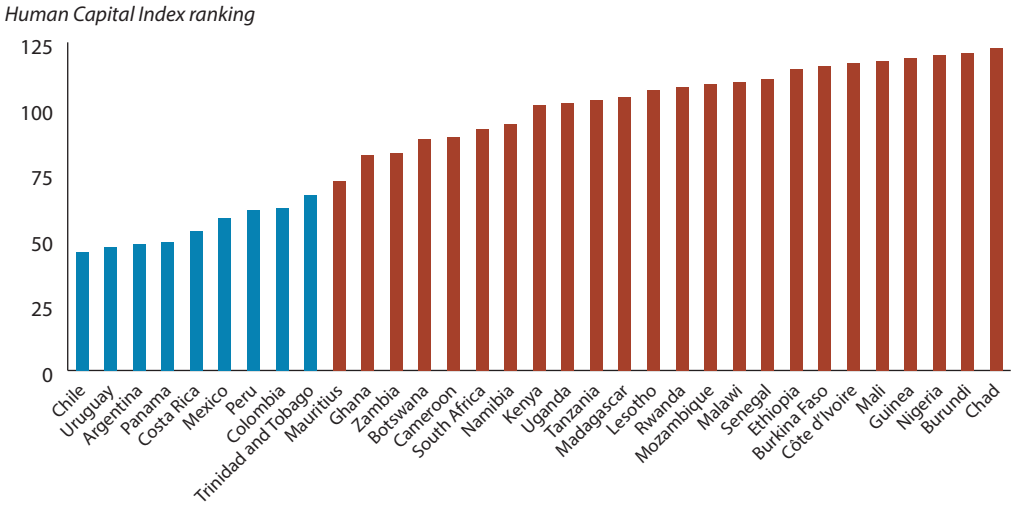
Source: AfDB, OECD, UNDP, and UNECA (2012).

have had a tertiary education and by 2030 only 12 million. Rapid increases in African education, including education in CTS, are thus urgently required.

If higher education trends are left unaddressed, implementation and ownership of Agenda 2063 by African youth will be severely jeopardized.

Some African countries have introduced policies to alter the balance between CTS and non-CTS areas of study. For example, the Ethiopian government in 2008 shifted

Figure 2.8 Human Capital Index ranking of selected African and Latin American countries



Source: World Economic Forum (WEF) in collaboration with Mercer (2015).

Note: The higher the number, the lower the level of science and technology.

the ratio of subjects in all public universities from humanities to sciences and technology to 70:30. The reason behind this policy was to train more graduates in medicine, engineering, and technology than in the social sciences.

Human Capital Index ranking: Africa and Latin America

Figure 2.8 presents the ranking of African countries (blue) and other developing countries in Latin America (green) in science and technology. African countries were ranked among the lowest in the world, with more than 17 countries scoring above 100, compared with developing economies in Latin America, such as Chile (45), Uruguay (47), and Argentina (48). Most African countries are also among the world's poor performers on skill shortages on this index.

Implications—Africa must step up a gear

The implications are compelling: *African countries and the continent as a whole need to develop their CTS through an accelerated agenda.* Skills development will always form the bedrock of capacity development. This upshot demands new (or refocused) attention on CTS policies and funding at national, regional, and continental levels.

3

EDUCATION FOR CRITICAL TECHNICAL SKILL PROFESSIONS, INCLUDING SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS

Current education patterns for critical technical skill professions

This chapter looks at estimates of Africans enrolling and graduating in CTS professions.

African universities: Few critical technical skill courses

Africa has an estimated 2,600 higher education institutions.7 Despite the emphasis on transforming higher education for achieving the goals of Agenda 2063, which requires information on numbers of African universities providing CTS education and the type of CTS degree, the lack of comprehensive data forced the Capacity Team to undertake a sample analysis of selected university websites in different regions to gauge the emphasis on CTS and non-CTS degrees offered at the master's level (table 3.1)

The number of CTS degrees offered in some universities is low relative to the non-CTS degrees, and most of the universities offer more non-CTS degrees, some twice as many. Although the information in the matrix represents a selected sample, from our discussions with education experts and review of university websites, this pattern seems to reflect many African universities' focus on non-CTS education. Universities in Africa thus contribute to low production of CTS professionals.

Annual critical technical skill graduates from higher educational institutions: Far too few

Drawing on various sources and publications such as the 2015 World Economic Forum and UNESCO Institute of Statistics report, the Capacity Team now presents estimated annual graduation numbers of Africans in four CTS areas: engineering, construction, and management (including architecture and building); health sciences; agriculture; and sciences (including earth sciences, physical sciences, mathematics and statistics, and computing).

There appears to be a significant shortfall of African graduates in CTS areas in the 18 countries considered (table 3.2). For example, the annual number of graduates from engineering, construction, and management is 75,199—yet the Republic of Korea alone produces nearly twice that number (147,858). Within Africa, two-thirds come from North Africa (49,820).

In health sciences, Burkina Faso, Burundi, Cameroon, Lesotho, Liberia, Mozambique, Swaziland, and Zimbabwe, for example, have few graduates: 4,150 together, compared with 88,872 in the Republic of Korea.

Of the four CTS areas, agriculture produces the fewest graduates every year: 24,233,

Table 3.1 Selected African universities and CTS education

University	Number of CTS degrees offered at master's level (approximate)	Number of non-CTS degrees offered at master's level (approximate)
Southern Africa		
University of Johannesburg	21	83
University of Namibia	12	19
University of Zimbabwe	33	27
East Africa		
University of Nairobi	36	68
Makerere University	33	41
West Africa		
University of Lagos	16	22
Cheikh Anta Diop de Dakar	24	43
North Africa		
University of Tunis	7	31
Central Africa		
University of Douala Cameroon	41	67

Source: University websites.

Table 3.2 African graduates from selected African countries in CTS areas, annual

Country	Engineering, construction, and management	Health sciences	Agriculture	Sciences
Algeria	27,627	7,228	3,403	24,406
Benin	1,275	—	—	—
Burkina Faso	843	120	71	1,578
Burundi	22	259	134	245
Cameroon	1,612	935	168	6,865
Ethiopia	5,007	5,500	7,878	10,628
Ghana	4,137	1,725	2,408	6,080
Lesotho	764	688	329	47
Liberia	97	120	341	—
Madagascar	1,973	716	284	2,575
Morocco	10,212	4,643	1,180	18,532
Mozambique	549	294	446	347
Rwanda	1,798	1,526	1,268	1,805
Seychelles	16	—	8	—
Sudan	9,207	11,154	4,604	—
Swaziland	124	308	149	—
Tunisia	11,981	6,691	1,125	18,875
Zimbabwe	2,962	710	437	—
Total: Africa (18 countries)	**75,199**	**42,617**	**24,233**	**91,893**

Source: WEF in collaboration with Mercer (2015).

implying an average for all African countries of only 1,346. Given that most African countries have large numbers working in agriculture, and the importance of the sector, these numbers are extremely low.

The number of graduates from the sciences is the highest, again with North Africa producing reasonable numbers. The average for the 18 countries is 5,105, a long way short of, for example, Brazil's 58,403 graduates in sciences.

More Africans are enrolled in non-critical technical skill than critical technical skill courses

More than 3 million African students were enrolled (in 2015) in non-CTS areas, but only 1.7 million in CTS areas (table 3.3). Enrollment in the social sciences, business, and law is the highest. In a few countries—Botswana, Burkina Faso, Mali, Mozambique, Rwanda, and Tanzania—an estimated 313,300 students were enrolled in non-CTS courses, and only 110,357 in CTS areas.

Only 164,245 were enrolled in agriculture, corroborating Wachira Kigotho's point that "only 2 percent of Africa's students specialize in agriculture, even though agriculture contributes 32 percent of Africa's gross domestic product, as compared to 1.4 percent in Europe."[8] The low rate of African students' enrollment in CTS programs is extremely unlikely to provide the knowledge and skills required for Africa's development.

Poor quality of math and science education

The quality of math and science education in Africa can be assumed to be an underlying factor in low enrollment and graduation in CTS

Table 3.3 Tertiary enrollment in CTS and non-CTS areas

	CTS areas				Non-CTS areas	
Country	Engineering, management, and construction	Health sciences	Agriculture	Sciences	Social sciences, business, and law	Humanities and arts
Algeria	99,897	56,638	19,904	86,084	441,486	—
Botswana	2,519	2,107	831	8,406	14,952	3,693
Burkina Faso	2,480	3,701	134	10,333	35,913	11,663
Cameroon	8,809	5,111	921	37,509	130,455	—
Côte d'Ivoire	16,380	4,300	2,177	27,128	108,901	4,103
Egypt	220,735	298,649	65,234	98,385	870,719	460,512
Ethiopia	47,036	43,603	39,618	—	214,672	—
Ghana	20,047	26,065	9,304	26,065	144,444	—
Madagascar	5,770	7,452	2,337	10,552	50,944	9,987
Mali	1,723	5,980	685	1,565	57,183	12,836
Mauritius	2,902	1,723	340	4,385	23,409	2,349
Morocco	36,706	22,737	3,520	98,842	187,914	—
Mozambique	8,523	4,760	5,213	5,633	50,192	8,048
Rwanda	3,900	4,886	5,102	9,652	40,047	3,768
Tanzania	5,846	7,424	1,636	8,318	68,391	6,614
Tunisia	55,647	20,283	7,289	89,970	91,873	—
Total	**538,920**	**515,419**	**164,245**	**522,827**	**2,516,543**	**523,573**

Source: WEF in collaboration with Mercer (2015).

fields (another is discussed under "Professions and the workplace"). Table 3.4 presents data on quality in this area in 29 African countries, showing an average score of 3.76—far worse, for example, than Singapore's 6.32, which has a modern developing economy—and paints a challenging picture for African countries. Countries well above the average include Côte d'Ivoire, Mauritius, Tunisia, and Ghana.

Ideal number of critical technical skill graduates

The 18-country average number of annual graduates produced in CTS areas (engineering, construction and management, health sciences, agriculture, and sciences) is 12,999. This is a huge shortfall against countries such as Malaysia (116,285) and the Republic of Korea (288,385).

The average number of annual CTS graduates in the Republic of Korea and Malaysia stands at 202,335 for both countries, with a combined population of about 79.4 million. This number is far higher than the 18-country African average of 12,999. For its estimated population of 1.166 billion, using these two countries as a benchmark (or "ideal"), Africa should be producing 2,971,926 CTS graduates every year.

Subtracting the estimated current annual average of CTS graduates in Africa (701,946) from the ideal (about 2.9 million), leaves Africa short of about 2.3 million CTS graduates annually. In 2023—the end of the First 10-year Implementation Plan of Agenda 2063—the African population is projected to climb to 1.3 billion, leaving a shortage of 2,530,334 CTS graduates.

Table 3.4 Quality of math and science education in selected African countries

Country	Score	Country	Score
Algeria	3.16	Mauritania	2.89
Botswana	3.57	Mauritius	4.55
Burkina Faso	3.84	Morocco	4.19
Burundi	3.46	Mozambique	2.59
Cameroon	4.26	Namibia	2.86
Chad	2.82	Nigeria	2.62
Côte d'Ivoire	5.06	Rwanda	4.13
Egypt	2.39	Senegal	4.01
Ethiopia	3.62	South Africa	1.89
Ghana	4.38	Tanzania	2.38
Guinea	3.09	Tunisia	4.71
Kenya	4.03	Uganda	3.06
Lesotho	3.81	Zambia	4.29
Madagascar	3.75	**African average**	**3.76**
Malawi	2.96	**Singapore**	**6.32**
Mali	3.14		

Source: WEF in collaboration with Mercer (2015).

Note: 1 = poor, 7 = excellent.

Science, technology, engineering, and mathematics

Back to basics

The acronym STEM is long-standing shorthand to cover the four fields of science, technology, engineering, and mathematics.

Science refers to basic and applied sciences. Technology refers to the application of science, engineering, and other fields, such as medicine. Innovation includes all of the processes, including business activities that bring a technology to market. Science and technology are linked to economic growth; scientific and technical capabilities determine the ability to provide clean water, good health care, adequate infrastructure, and safe food. The first priority for African countries is to build indigenous scientific and technological capacity, including research infrastructure, as part of their national development planning strategies.

Technology is a knowledge system, not simply physical technology and equipment. It relies heavily on modes of learning; adaptation to new technologies; educational systems; industrial policies and policies on science, technology, and innovation; the nature and composition of the private sector; and the capabilities inherent in the public sphere. Technology also relies heavily on demand: Strong demand for technological solutions directed to local capabilities can be one of the strongest incentives to learning accumulation. Technology also depends on the flows of knowledge, resources, and people between public and private domains of knowledge and the mechanisms by which information on specific innovations is shared, developed, commercialized, and diffused. In Africa, the incentive structure that causes different parties to become involved and stay committed to technological enterprises needs robust attention from policy makers.

Engineering is the field or discipline, practice, profession, and art that relates to the development, acquisition, and application of technical, scientific, and mathematical knowledge about the understanding, design, development, invention, innovation, and use of materials, machines, structures, systems, and processes for specific purposes. Engineering encompasses a range of more specialized sub-disciplines, each with a more specific emphasis on certain fields of applications and particular areas of technology.

The engineering profession plays a major role not only in the growth and development of a country's economy but also in improving its citizens' quality of life. The engineering profession is also playing an ever-increasing role in enabling a country to participate in the global economy and to protect the environment. The linkage between a country's indigenous engineering capacity and its economic development is clear, as is Africa's need to develop more engineering professionals to address sustainable development issues.

Development in Africa

The development trajectory of STEM education, skills, professions, and capacity on the continent has been undermined by long-standing systemic challenges, such as:

- Weak links between scientific enterprises and political institutions/policy makers.
- Outdated STEM policies frozen in post-colonial frameworks.
- Low and falling STEM public and private funding as a share of GDP.
- Declining quality of STEM education at all levels of education—primary, secondary, tertiary, and vocational.

- Brain drain—Africa is losing its best scientific and technical experts to other regions.
- Lack of institutions dedicated to scientific and technological innovation and commercialization.
- Weak links between public research and development (R&D) institutions and industry.
- Other aspects related to STEM that impede further scientific and technological development, such as the impact of globalization on trade and technology transfer.

Tertiary education and skills

African universities have been the foremost sites for delivering STEM education, skills, and capacity on the continent. To understand the quantity and quality challenges facing them, one needs to delve into their historical context and trajectory in the post-colonial era.

From independence, the developmental significance of African universities ensured their initial establishment and proliferation and generated an impressive increase in access to higher education in most of the continent (Ajayi and others, 1996). Since the development crisis of the 1980s, however, Africa's capacity to supply higher education has been severely diminished, and resources for this expanding sector have been curtailed. The World Bank and the International Monetary Fund were key players among the architects of the structural adjustment programs that contributed to the qualitative deterioration of African universities during the 1980s, against widespread campus resistance and expressions of concern from the African intelligentsia. African governments found themselves caught between the directives of international financial institutions and popular demand but, increasingly indebted to the former, demanded reductions in public expenditure (Sawyerr, 2002).

As observers have pointed out over the years, the resulting externalization and depletion of African intellectual capacity has had major implications for the capacity of universities to generate the much-needed cadres of skilled professionals, with long-term implications for regional development, integrity, and autonomy. The lack of intellectual capacity across Africa has now become a key feature of the development crisis and its perpetuation. Nevertheless, the 21st century has seen a change of heart even within the powerful international financial institutions, which only a decade or so ago considered higher education a luxury that Africa could ill afford (Sawyerr, 2002).

But this shift has arrived at a juncture where a rising population and ensuing youth bulge are placing huge demands on universities. The combination of increasing students and the huge infrastructure and capacity backlogs after nearly two decades of underinvestment (which have still not been mitigated by current funding streams) mean that the quality of education in African universities is below par. It is also a fundamental fact that Africa continues to suffer from gross underprovision of higher education compared with other developing regions, not to mention developed nations and regions such as Japan, North America, and Western Europe.

Vocational and polytechnic institutes in African countries are also key sites for STEM capacity development. Technologists, technicians, artisans, and craftspeople are the bedrock on which small and medium-sized enterprises and businesses are founded, especially in operation and maintenance. Many African countries have made the mistake of neglecting the training of technicians, technologists, and artisans, while TVET systems have been left in a parlous state.

African economies are therefore systematically undermined by the impact of this "double

whammy" of the lack of educated and skilled high-level STEM professionals and of technician-grade artisans and craftspeople.

Needs and numbers

There is, in particular, a need for improved statistics and indicators on STEM education and on numbers of professionals in Africa. The dearth of such data—gender disaggregated in particular—points to a challenging context in which to discuss capacity or under-capacity of STEM professionals. There is also a need to disaggregate data into the four STEM fields. This is critical as there is a tendency for data collected to lump "scientists and engineers" together.

The data from UNESCO (table 3.5) highlight the gross disparities between enrollment and graduation rates from engineering courses in 13 African countries. These dismal data are a manifestation of the dire state of engineering education, teaching, and learning conditions in African universities, including the shortage of qualified and experienced academics and lecturers.

Gender equality

Access to STEM for women on an equal basis with men is necessary to transfer patterns of productivity, contribute to job creation and new ways of working, and to promote the establishment of a knowledge-based society resulting in wealth creation. Such access also has the potential to improve the quality of life of women and men in African societies and communities. The challenge that Africa faces is to turn these noble aspirations into actions. Table 3.6 highlights the stark nature of Africa's gender divide in engineering education.

Professions and the workplace

It has long been suggested that STEM professions suffer from a profound lack of social and professional status in Africa, in that they are not perceived by the youth and the public as professions to be aspired to in terms

Table 3.5 Number of students graduating in tertiary-level engineering, 13 African countries

Country	1999	2000	2001	2002	2003	2004	2005	2006
Algeria	—	—	—	—	—	10,842	—	12,156
Botswana	54	—	38	—	—	—	—	—
Eritrea	—	—	159	65	185	82	—	—
Ethiopia	661	704	—	1,259	2,197	2,511	2,396	2,235
Madagascar	—	—	306	102	—	—	632	441
Mauritius	—	—	387	329	294	734	743	729
Morocco	—	721	—	—	1,243	1,099	2,829	3,550
Mozambique	—	—	—	—	—	105	162	—
Namibia	—	—	10	—	38	—	—	—
South Africa	—	5,360	—	7,079	7,364	8,358	9,003	10,387
Swaziland	—	3	—	8	—	5	36	6
Tanzania	957	—	—	—	—	727	—	—
Uganda	519	1,077	—	—	—	1,354	—	—

Source: UNESCO Institute for Statistics (2015).

Table 3.6 Number of students enrolled in tertiary-level engineering, five African countries

Country	1999 (M)	1999 (F)	2000 (M)	2000 (F)	2001 (M)	2001 (F)	2002 (M)	2002 (F)
Ethiopia	5,402	516	5,438	454	10,430	991	8,618	765
Mauritius	1,476	433	1,495	338	1,580	398	1,457	390
Morocco	4,083	1,267	5,542	1,628	10,831	5,686		
South Africa			36,164	7,190				
Swaziland	336	25	308	19	227	41		

Country	2003 (M)	2003 (F)	2004 (M)	2004 (F)	2005 (M)	2005 (F)	2006 (M)	2006 (F)
Ethiopia	12,548	1,077	15,415	1,932	14,539	2,433	10,833	2,134
Mauritius	1,682	487	1,820	662	2,130	841	1,877	708
Morocco	10,546	3,024	10,130	3,091	12,772	4,018	15,588	5,804
South Africa	40,913	13,125	46,257	15,756	52,181	16,847	52,108	18,231
Swaziland			257	48	201	24	159	15

Source: UNESCO Institute for Statistics (2015).

of high-profile careers, pay, wealth creation, social cachet, and so on. This is in contrast to professions such as medicine (doctors) and the legal profession (lawyers, judges, and so on). This perception points to an essential dichotomy in the role of African STEM professionals in their countries, in that, while the continent is crying out for infrastructure development of roads, bridges, airports, seaports, schools, hospitals, and other key public facilities and installations, its STEM professionals have little support for work in these areas.

These dynamics of exclusion and underemployment have stalled the development of robust indigenous STEM professional capacity in Africa, and have further exacerbated the poor pace of development on the continent. They also create the imperative for African countries to accelerate their development of indigenous industrialization, manufacturing, and natural resource-processing infrastructure and capacities. This rationale is obvious because, as long as foreign-owned multinational companies dominate the industrial and manufacturing sector in Africa, the continent will struggle to achieve sustainable growth of its cadre of highly educated, skilled, and employed STEM professionals who enjoy the status and recognition that their profession deserves.

Communication and popularization

STEM communication and the notion of "public understanding of science" has been a growing and emerging agenda since the 1980s, particularly in the developed world, where it is mainstreamed as a key plank of the science, technology, and innovation (STI) policy and outreach strategy for advancing society and entering the "economy of discovery."

A key driver has been the growing recognition of STI's critical role in the development trajectory and thus the need to enhance citizens' scientific knowledge base and capacity. Africa, however, continues to lag behind in popularization.

STEM communication and the public understanding of science should help overcome

Africa's myriad and intractable development challenges by highlighting and promoting the pivotal role of STEM in developing innovations and solutions. This is evident in the area of health where dismal levels of scientific literacy in African countries is a huge challenge in addressing public health pandemics and pathologies, such as Ebola, HIV/AIDS, tuberculosis, malaria, high maternal and infant mortality rates, and the remaining gaps in childhood vaccination.

There is a strategic rationale for popularizing science capacity, expertise, and innovative good practices in Africa, based on African-centered approaches. Despite major advances in the global north and in parts of the developing world (such as Latin America, the Caribbean, India, and some other Asian countries), such popularization has failed to take off and remains marginalized in Africa's scientific landscape. Such marginalization stems from factors such as the lack of policy development and institutionalization of the agenda by African governments and by Africa's STEM institutions. There is thus a growing understanding of the rationale for strengthening the agenda within STI policies among African nations, RECs, and continental development frameworks, such as Agenda 2063 itself and the AU/NEPAD STISA 2024 (see chapter 1).

African STEM professionals should be skilled and their capacity enhanced so that they can undertake and deliver scientific literacy, community engagement, and STEM outreach on the continent. The aim is to reduce knowledge gaps at individual, policy, institutional, government, and socioeconomic levels and reduce the knowledge gaps in legislation and implementation (Rasekoala, 2015)..

Policy development should be addressed toward capacity building and the training of a new generation of multidisciplinary STEM communicators and journalists to work for—and with—their fellow citizens to communicate STEM's pivotal role in sustainable development and the betterment of societies, in an inclusive and empowering dynamic, in Africa.

STEM communication could be an evolving, empowering, and progressive journey for African citizens to own and include scientific notions in their everyday experiences, so that they are better able to make informed choices and decisions that will improve the quality of their lives. This firm foundation (without which all other progressive indicators in STEM cannot be delivered) is imperative for viable growth of educated and skilled professionals on the continent.

4

TECHNICAL AND VOCATIONAL SKILLS: THE PITFALLS AND THE PROMISE

Declining attention to training technicians in Africa

The past decade has seen a sharp drop in attention to training technicians through TVET in Africa. TVET challenges today revolve around issues of assuring enough TVET training, balancing supply and demand, delineating the roles of the public and private sectors, recognizing TVET professionals, and ensuring cost-effectiveness of training. Schools and universities—and the well-trodden path between them—dominate thinking about education policy and development. But outside these two institutions is a less well understood world of colleges, diplomas, certificates, and professional examinations—the world of TVET.

TVET systems in Africa differ by country, and are delivered at different levels in many types of institutions, including technical and vocational schools (public and private), polytechnics, enterprises, and apprenticeship training centers. In West Africa in particular, traditional apprenticeship offers the largest opportunity for acquiring employable skills in the informal sector: In Ghana for example, that sector accounts for more than 90 percent of all skills training.

Technical and vocational education and training in Africa

Historically, TVET in Africa has been delivered by government and private providers, which include for-profit institutions and nonprofit, nongovernmental, and faith-based institutions. In almost all countries, non-government provision of TVET is on the increase in numbers of institutions and students. To a large extent, private providers train for the informal sector (which is an expanding job market all over Africa) while public institutions train mostly for the (virtually stagnant) industrial sector. Private providers also target "soft" business and service-sector skills like secretarial practice, cookery, and dressmaking, which do not require much capital. A limited amount of in-company or enterprise-based training also takes place in some countries, though this type of training is often dedicated to sharpening employees' specific skills.

The current status of TVET in Africa is not all about weaknesses. TVET systems in a growing number of countries are undergoing or have undergone promising reforms that are designed to build on the inherent strengths of the system. The major reforms concern setting up national training bodies and enacting laws to strengthen national vocational training programs. The need to link training to employment (either paid or self-employment) is at the root of all best practices worldwide.

Share of enrollment in technical and vocational education and training, 2005

The UNESCO Institute for Statistics survey on TVET education indicated the enrollment share in TVET education in the majority of African countries a decade ago (table 4.1).

Status of technical and vocational education and training in the Economic Community of West African States region, 2012

The general trend in the Economic Community of West African States (ECOWAS) region is a growing supply of TVET teachers. During the six years under review, TVET teachers at the secondary level in Ghana increased by 281 percent, while Guinea also recorded strong gains. The teaching profession, however, remains male dominated.

TVET enrollment in the region remains very low: Only 20 percent of secondary programs were TVET in Mali in 2012, and the remaining countries had less than 10 percent as TVET. Women accounted for a minority of enrollment, possibly because of lower participation rates of girls at lower educational levels, higher illiteracy rates and higher dropout rates. Women's participation in TVET was weakest in Ghana at 37 percent in 2012.

The issue of skill development programs is particularly important in African countries, given the rapidly increasing populations that include a high proportion of young people. A third of the 30 million illiterate youths (15–24 years) in Africa are in the ECOWAS region. Young women still constitute 60 percent of all illiterates in this age group. TVET is a positive response to the challenge of illiteracy, and the provision of skills for employability should take into consideration the diverse realities of learners.

Status of technical and vocational education and training in the Southern African Development Community region, 2003–2010

The UNESCO Institute for Statistics undertook a comprehensive analysis of TVET in the Southern African Development Community (SADC) region (tables 4.2 and 4.3).

Addressing youth unemployment through strong technical and vocational education and training

African youth face very high unemployment rates, yet could constitute a vast reservoir of

Table 4.1 Share of enrollment in TVET education in Africa, 2005

Africa		Three Asian countries		Three OECD countries	
Country	Enrollment (%)	Country	Enrollment (%)	Country	Enrollment (%)
Rwanda	36	Korea, Rep. of	19	Australia	70
Algeria, Cameroon, Benin, DRC, Egypt, Libya, Mali, and Mauritius,	10	Thailand	18	Austria	62
Burkina Faso, Burundi, Djibouti, Mozambique, and Tunisia	8	Indonesia	16	Belgium	68
Botswana, Cape Verde, Morocco, South Africa, and Togo	5				
Mauritania	4				
Uganda	4				
Chad, Eritrea, Ethiopia, Gambia, Ghana, Guinea-Bissau, Kenya, Lesotho, Niger, São Tomé and Príncipe, Senegal, Sudan, and Zambia	1				

Source: Adapted from the AfDB, OECD, UNDP, and UNECA (2008).

Table 4.2 TVET provision: Agencies and share of education budget

Country	Ministries responsible for public TVET provision	Share of education budget allocated to TVET (%)
Botswana	Ministry of Education and Skills Development, Department of Technical and Vocational Education and Training Ministry of Labour and Home Affairs	Estimated at 6.9% in 2009 but not based on official data (monitoring report)
DRC	Ministry of Primary, Secondary, and Vocational Education Ministry of Public Health Ministry of Social Affairs, Humanitarian Action, and National Solidarity Ministry of Employment, Labour, and Social Welfare Ministry of Higher and University Education Ministry of Youth and Sports Inter-Ministerial Commission for Technical Education and Vocational Training	No data available
Lesotho	Ministry of Education and Training	6% (2003–-2004)
Malawi	Ministry of Education, Science, and Technology Ministry of Labour Technical, Entrepreneurial, and Vocational Education and Training Authority	3.4% (2008)
Mauritius	Ministry of Education and Human Resources	4.4% (2009)
Mozambique	Ministry of Education	4% (2009)
Namibia	Ministry of Education	2.9% (2010)
Seychelles	Ministry of Education	13.6% (2009)
South Africa	Department of Higher Education and Training	2.5% (2009)
Swaziland	Ministry of Education	No data available
Tanzania	Ministry of Education and Culture	1.4% (2009)
Zambia	Ministry of Science, Technology, and Vocational Training	0.6% (2009)
Zanzibar	Ministry of Youth, Employment, Women, and Children Development	2.8% (2009)
Zimbabwe	Ministry of Higher and Tertiary Education	4.7% (2009)

Source: Adapted from UNESCO (2013).

talents, skills, and opportunities that through smart interventions could be transformed into a productive workforce. Youth unemployment in Sub-Saharan Africa was 12 percent in 2012, and was higher among youth with less education. Whereas mathematics and science are in high demand, humanities are in high supply.

Technical and vocational education and training and youth in Africa

In all Sub-Saharan Africa, formal TVET programs are school-based. Most students enter the vocational education track at the end of primary school, corresponding to 6–8 years of education as in countries like Burkina Faso and Kenya, or at the end of lower or junior secondary school, which corresponds to 9–12 years of basic education (in for example, Ghana, Nigeria, Mali, and Swaziland). In some countries, training models follow those of the former colonial power. In either system, the vocational education track has the unenviable reputation of being a dead end as far as academic progression is concerned and fit for those pupils who are unable to continue to higher education (see "Poor public perception").

The duration of school-based TVET is between three and six years, depending on the country and the model. Some countries like Ghana, Senegal, and Swaziland attempt to expose young people to the junior secondary school curriculum. But TVET for employment is unlikely to be effective when delivered concurrently with general

Table 4.3 TVET enrollment in the SADC region

Country	No. of TVET providers (formal and non-formal)	Total enrollment (public and private TVET institutions)	Gender breakdown of total Further Education and Training enrollment		Share of TVET enrollment in population aged 15–24
Botswana	202	31,000 (2006)	Not available		30%
DRC	Unknown	755,035 (2006)	Not available		Data not available
Lesotho	69 (2010)	3,457 (2009)	1,393 (female)	2,001 (male) ([missing data)]	1%
Malawi	254 (2010)	4,164 (2010) (public TVET institutions only)	1,420 (female)	2,744 (male)	0.2%
Mauritius	576 (2010)	44,294 (levy funded learners) (2008–2009)	Not available		21.7%
Mozambique	68 (2010)	46,082 (2010)	Not available		1.2%
Namibia	15 (2008)	6,612 (2008)	2,492 (female)	3,950 (male)	Data not available
Seychelles	23 (2010)	1,699 (2010) (public TVET institutions only)	795 (female)	905 (male) (missing data on institutions)	4.5%
South Africa	914 (2010)	340,583 (2009)	Not available		3.9%
Swaziland	57 (2006)	2,858 (2006) (including pre-vocational courses in schools)	971 (female)	1,166 (male) (gender breakdown not available for pre-vocational schools)	1.2%
Tanzania	889 (2010)	177,749 (2009)	76,943 (female)	100,806 (male)	2.2%
Zambia	276 (2010)	33,399 (2009)	13,531 (female)	19,868 (male)	Data not available
Zanzibar	30 (2009)	2,894 (2010)	710 (female)	2,184 (male)	1.5%
Zimbabwe	57 (2010)	13,217 (2009) (public TVET institutions only)	5,853 (female)	7,364 (male)	0.5%

Source: Adapted from UNESCO (2013).

education in junior secondary schools. The reason is employment-oriented training requires inputs in human (qualified instructors) and material resources that are not available or too expensive to provide in all junior secondary schools or even in a cluster of secondary schools.

Vocationalizing the junior secondary school curriculum should thus be viewed with caution. A good basic education provides a solid foundation for good TVET. The only cases in which vocationalization may be helpful is probably in the use of computers, general agriculture or farming, and entrepreneurship. Computer literacy is relevant to all occupations while the teaching of basic agriculture and entrepreneurship are not capital-intensive or too costly.

On governance, oversight responsibility is usually shared between the ministries responsible for education or technical education and labor or employment, though some specialized vocational training programs (in agriculture, health, transport, and so on) fall under the supervision of sector ministries. In spite of the multiplicity of training programs, the place of TVET in the school system in many countries is marginal on enrollment and number of institutions.

Socioeconomic environment and context

Kathure, C. and Mbijjiwe, J. 2014. Weak national economies characterized by low job growth, high population growth, and a growing labor force. The per capita income of most Sub-Saharan countries (outside South

Africa) is less than $400. Although the economy in a few countries, including Botswana and Ghana, is growing at a respectable rate of about 5 percent, the annual real growth rate in many countries is less than 2 percent, limiting the prospects for employment creation. An estimated 500,000 young people add to the labor force each year in Kenya for example, and as many as 700,000 in Tanzania and 250,000 in Zimbabwe. Africa's economies face the daunting task of finding productive employment for 7 million to 10 million annual new entrants to their labor markets over the next few years, reflecting high population growth and the increasing number of countries offering universal primary education.[9]

Shrinking or stagnant wage jobs, especially in industry. Apart from Botswana, Côte d'Ivoire, Ghana, and South Africa, the industrial labor force is less than 10 percent in most African countries. The vast majority of the workforce is in the services and agriculture sectors. In many African countries, with the notable exception of South Africa and Mauritius, about 85 percent of the workforce is in the informal, non-wage employment sector. Policy makers need to bear this labor force distribution in mind when developing national TVET strategies.

Huge numbers of poorly educated, unskilled, and unemployed youth. Although some progress has been made, the illiteracy rate in many countries is still high at more than 50 percent. Of significance to TVET is that enrollment at the secondary school level, where TVET is normally provided, is also low with only few countries having a gross enrollment rate of more than 50 percent. The average school completion rates in Africa are such that many young people drop out of the school system before they have acquired any practical skills and competencies for the world of work. Average completion rates are 80–90 percent for primary school, 30–40 percent for lower or junior secondary school, and about 20 percent for senior secondary school. Only 1–2 percent of the college age group actually enter university or other tertiary institutions. In Ghana, for example, 49.1 percent of the workforce is illiterate and only 3.9 percent have had any vocational or technical training. In Tanzania, less than 5 percent of the labor force is educated beyond primary school.

Educated but unemployed college and university graduates. In almost all African countries, many graduates coming out of the formal school system are unemployed, although opportunities for skilled workers exist, bringing into sharp focus the mismatch between training and labor market skill demands. Critics argue that the lack of inputs from prospective employers into curriculum design and training delivery are partly responsible for the mismatch. Another oft-cited reason for high unemployment among graduates is the absence of entrepreneurial training in the school curriculum.

Uncoordinated, unregulated, and fragmented delivery systems. Except for few countries (notably Botswana, Malawi, Mauritius, Namibia, South Africa, and Tanzania), TVET provision in Africa is spread over different ministries and organizations, including NGOs and church-based organizations, with a multiplicity of testing and certification standards. This has implications for standardization of training, cost-effectiveness, quality assurance, recognition of prior learning, and the further education of TVET graduates. In the informal sector, traditional apprenticeship, often the only means for the rural poor and the economically disadvantaged to learn a trade, is marginalized, unregulated and lacks government support. The governance structure in many countries does not promote effective coordination or sharing of resources within the system.

Low quality. The quality of training is generally low, with undue emphasis on theory and certification rather than on skills acquisition and proficiency testing. Inadequate instructor training, obsolete training equipment, and lack of instructional materials are some reasons. High-quality skills training requires appropriate workshop equipment, adequate supply of training materials, and practice by learners.

Geographical, gender, and economic inequities. Although access and participation in TVET in Africa reflects the gender-biased division of labor (justifying therefore the current efforts of gender mainstreaming in TVET), policy makers should not lose sight of economic and geographical inequities in designing TVET strategies for poverty eradication. Economic inequity is a greater barrier to participation in TVET than gender. In many African countries, children of poor parents are unable to afford the fees charged by training institutions. Invariably, the good TVET schools are in big cities, limiting access to rural dwellers. We see therefore a paradox in which those who need TVET most—the rural and economically disadvantaged population—are crowded out.

Poor public perception. For many years, TVET in Africa has been considered a career path for the less academically endowed. This perception has been fueled by the low academic requirements for admission into TVET programs and the limited prospects for further education and professional development. Worse, the impression is sometimes created by governments that the primary objective of the vocational education track is to keep dropouts or "lockouts" (that is, students who are unable to move up the educational ladder, not because of poor grades but because of lack of places at the higher level) from the basic and secondary school system off the streets, rather than as a strategy to train skilled workers for the job market and for sustainable livelihoods.

Weak monitoring and evaluation. Current training programs in many countries are supply driven. TVET programs are often not designed to meet observed or projected labor market demands. The emphasis appears to be on helping the unemployed find jobs, without any critical attempt to match training to available jobs. This has led to many vocational school graduates not finding jobs or finding themselves in jobs for which they have had no previous training. Non-targeted skills development is one of the major weaknesses of the TVET system in many African countries. Training institutions also neglect to track the employment destination of their graduates. Consequently, valuable feedback from past trainees on the quality of their training and the opportunity for their experience-based inputs to be factored into the review of curricula and training packages are lost. In other words, tracer studies that can improve the market responsiveness of training programs are absent in many countries.

Inadequate financing, poor management, and ill-adapted organizational structures. Only a few governments in Africa are able to finance TVET at a level that can support quality training. Ethiopia spends only about 0.5 percent of its education and training budget on TVET while Ghana spends only about 1 percent. The figure is 10 percent for Mali and 12.7 percent for Gabon (table 4.2). TVET is expensive on a per student basis: In 1992, Gabon spent $1,820 by this measure. Unit costs are necessarily expected to be higher in TVET institutions than in primary and secondary schools because of smaller student-to-teacher ratios, expensive training equipment, and costly training materials that are "wasted" during practical lessons.

The diverse TVET management structures and the sharing of supervisory responsibilities by government bodies and ministries account for some of the inefficiencies in the system,

such as duplication and segmentation of training, and the absence of a common platform for developing coherent policies and joint initiatives.

Public versus private provision of technical and vocational education and training. School-based government training institutions are generally fewer than those in the private sector. In Ghana for example, government TVET institutions include 23 technical institutes under the Ministry of Education with a total enrollment of about 19,000 students. The Ministry of Manpower Development and Employment also runs 38 National Vocational Training Institutions. An estimated 500 private establishments of diverse quality enroll more than 100,000 students. The Catholic Church is the single largest private provider of TVET in that country.

The majority of students in private institutions are women (76 percent in Ghana; 60 percent in Tanzania and Zimbabwe; 55 percent in Senegal). Most for-profit private providers are concentrated in urban centers, while church-based institutions tend to be based in rural and economically disadvantaged areas.

The distribution of TVET providers in Africa is skewed in favor of private providers. In Tanzania, public institutions account for only 8 percent of the total, while enterprise-based training (22 percent), for-profit institutions (35 percent), and church/NGO providers (31 percent) make up the bulk of the private sector institutions. In Zambia, public TVET provision is at 18 percent, while church/NGO and for-profit providers are 18 percent and 36 percent, respectively.

State support for non-government providers varies from country to country. In Ghana, government support is limited to paying salaries of selected key management and teaching staff, and to small grants for administrative purposes. In some francophone countries (such as Côte d'Ivoire and Mali), non-government providers receive much more support.

Situation in conflict and post-conflict societies. War and conflict situations have destroyed the TVET delivery system in countries like the DRC, Liberia, and Sierra Leone. According to the AU, some 300,000 Liberians are internally displaced, and about 320,000 are refugees in neighboring countries. There are about 300,000 child soldiers under 18 years old in the world, half of whom are in Africa. In war-affected zones, capacity for skills development is limited and the school system suffers from low enrollment and completion rates. The TVET system in these countries is characterized by damaged infrastructure and inadequate human resources caused by the death or displacement of instructors and other workers. Vocational training can help reintegrate the victims of war and violence into mainstream society.

Stepping up to the plate

TVET plays an under-recognized role in a country's skill systems. African countries with their high under- and unemployment among youth need to make a strategic decision and follow the AU's 2007 Strategy to Revitalize Technical and Vocational Education and Training (TVET) in Africa. For the Africa we want, Africa's leaders must resolve the following strategic issues (African Union, 2007).

Institutional and funding barriers need to be overcome

Professional education and training demands an institutional base that:

- Offers short-cycle professional programs in a tier of institutions separate from universities.

- Makes use where relevant of the successful model of universities of applied science.
- Consolidates training providers into institutions of adequate size.
- Provides a consistent framework of public funding for professional education and training, avoiding distortions, and backed by quality assurance.
- Ensures an institutional framework to coordinate professional education and training, engaging employers and organized labor, so that programs and qualifications are comprehensible and accessible to key stakeholders.

Work-based learning needs to be realized systematically

The workplace provides a strong learning environment and facilitates recruitment, while trainees contribute to output. Work-based learning opportunities are also a direct expression of employer needs. All professional education and training programs should involve some work-based learning as a condition of receiving government funding. Such learning should be systematic, quality assured, and credit bearing.

Vocational teachers require teaching skills and up-to-date industry knowledge and experience

There are many challenges in recruiting and retaining vocational teachers who meet the demanding twin requirements of pedagogical skills and practical professional expertise. Keeping practical knowledge in the workplace up to date is also a major challenge. Directly recruiting practitioners from industry in mid-career can be allied with part-time working arrangements that allow teacher-practitioners to continue to work in their field. These strategies require a flexible framework of pedagogical preparation and strong leadership in professional training institutions to make the best use of a mixed teaching team, and need to ensure that the workforce in professional training institutions benefits from a strong blend of pedagogical skills, industry experience, and academic knowledge. Qualification requirements should be adapted to that end.

Clearer pathways for learners

The strongest vocational systems offer a wide range of opportunities to qualified apprentices and other vocational graduates. These help the architecture of the skills system by establishing a career structure for graduates of the initial system, supporting the training of apprentice trainers, and playing a key role in developing management skills. To meet labor market needs and the aspirations of students, policy makers should ensure that graduates from vocational programs have the opportunity to pursue higher-level vocational and academic qualifications.

Policy makers should also build articulation frameworks to support the transition from professional programs to academic tertiary education, underpinning those frameworks with measures to ensure transparency and quality in learning outcomes from professional education and training.

A parallel measure would be to underpin progression pathways with good-quality career guidance and information, before and during professional programs.

To meet the needs of adult learners, flexible modes of study should be adopted, including part-time and modular arrangements, distance learning, and competence-based approaches.

Key success factors for the new African technical and vocational education and training

Such factors include:

- Mechanisms to ensure that the mix of vocational provision corresponds to the needs of the labor market.
- Adequate core academic skills, particularly literacy and numeracy built into vocational programs.
- A range of programs that offer opportunities for all and minimize dropouts.
- Flexible modes of study suitable to adults with working and home commitments.
- Higher-level vocational qualifications, and avenues of progression from initial vocational programs to both higher-level vocational and academic programs.
- Regular financing so that individuals' choices are not distorted by lack of funds.

Supporting conditions

The policies, practices, and institutions that underpin TVET must have the backing of public and private industrial development strategies, to include:

- Vocational programs developed in partnership and involving government, employers, and trade unions.
- Effective, accessible, independent, proactive career guidance, backed by solid career information.
- Strong data on vocational programs, including information on vocational programs in international categorizations and labor market outcomes.

The AU recognizes the importance of TVET as a means of empowering individuals to take control of their lives and recommends integrating vocational training with the general education system. It also appreciates that vast numbers of young people are outside the formal school system, and thus recommends integrating non-formal learning approaches and literacy programs with national TVET programs.

5

CRITICAL TECHNICAL SKILLS AND OTHER CAPACITIES NEEDED FOR AGENDA 2063'S FLAGSHIP INITIATIVES AND PRIORITY PROGRAMS

This part presents indicative capacities and skills required for executing the flagship programs and other key continental priority programs of Agenda 2063. These capacity sets have been amply developed and explained in *Capacity Requirements for the New African Vision: Agenda 2063—"The Africa We Want."*

The information in this section is structured by:

- Key purposes, provisions, and features of each flagship initiative or major program.
- Indicative capacity requirements.
- Suggestions for developing CTS capacity, including ideas on seed funding to mobilize for action.

Integrated high-speed train network

Key purposes, provisions, and features

This aims to link African capitals and commercial centers to facilitate movement of goods, factor services, and people, reduce transport costs, and relieve congestion. With one of the Seven Aspirations of Agenda 2063 being political and economic integration in Africa, this world-class rail infrastructure is to crisscross Africa in three phases:

- Phase 1: The high-speed rail will start in Eastern Africa and connect most of Africa's landlocked countries.
- Phase 2: It then connects Southern Africa with West Africa.
- Phase 3: It starts with Egypt and links North Africa with East Africa.

The network aims to build on and enable other continental programs such as PIDA, the Continental Free Trade Area (CFTA), CAADP, African Mining Vision (AMV), the AIDA, and the Boosting Intra-African Trade framework.

This project will be a key catalyst for bringing much-needed political stability, peace, and security to the continent.

Indicative capacity requirements

Table 5.1 lists the indicative capacity requirements for the high-speed train network.

Developing critical technical skills capacity

The following additional approaches are proposed, including estimated seed funding:

- Constitute an implementation taskforce to push forward arrangements and mobilization for the high-speed train network.

Table 5.1 Indicative capacity requirements for the high-speed train network

CTS professionals required	Africa-focused professional skill areas	Proposed sourcing	Composite capacities required	Proposed sourcing
Railway engineers	African mobilization specialists	Member states	Strategic planning	AUC
Civil engineers	Pan-African value systems and ideology specialists	Private sector	Organizational and coordination capability	AUC institutions (NEPAD, Pan-African Parliament [PAP], and so on)
Mechanical engineers	Technical skills training of trainers	Academia	Critical/strategic thinking and results-based management	RECs
Quantity surveyors	Regional integration specialists	CTS professional bodies	Process facilitation and organizational skills (including "functional capacities")	Private sector
Construction project managers	Macroeconomists and development planners	African CTS diaspora	Critical support systems and processes, including using technology and innovation	Key agencies
Infrastructure specialists	Domestic resource mobilization (DRM) specialists	(in China, India, and the west)	Program development	(AfDB, UNECA, and so on)
Land surveyors	Financial investment specialists		Project planning and implementation	
Architects			Financing ownership and DRM	
Electrical engineers			Knowledge systems to speed up the implementation of the project	
Double-coded welders			Risk management and mitigation, and the ability to deal with bumps and shocks	
Boiler makers			Leveraging of assets	
Landscape architects			Negotiation/persuasion abilities	
Industrial mechanic fitters			Stakeholder/partnership-building abilities	
Riggers				
Architectural senior technologists				
Magnetic technology specialists				
Surveying technicians				
Materials testers				
Raise bore foremen				
Raise bore operators				
Quantity surveying technicians				
Draughtspersons				
Structural plasterers				
Fitters and turners				
Pressure welders				
Automotive electricians				
Tool makers				

(continued)

Table 5.1 Indicative capacity requirements for the high-speed train network *(continued)*

Soft capacities required	Proposed sourcing	Change and transformative capacities required	Proposed sourcing	Proposed capacity development (CD) interventions
Ethics and values Spirit of Ubuntu Pan-African perspective—African solidarity/liberation African ownership of its development paradigm African ownership and management of its own resources and agendas Transformative and accountable leadership Responsive institutions Ownership of the African narrative and brand Strong leadership commitment Commitment to development outcomes Proactivity Result orientation (result driven) Accountability (for results, efficiency) Continuous high level of energy/ commitment Teamwork abilities/commitment Trust Problem-solving skills Diligence and thoroughness High sense of energy and drive Heavy workload abilities/hard-working spirit Pan-African spirit and values	To screen individuals/institutions carefully, in search of these attitudinal/predisposition capacities, before their involvement/holding key roles in this major flagship program	Transformative leadership (including visioning) Top leadership and management optimism/commitment Ownership of decision making ICT and technological predisposition Innovation and invention commitment Risk management abilities People motivated for a shared/ inspirational vision Change readiness: creating and maintaining the desire for change Ability for mind-set shifts	To screen individuals/institutions carefully, in search of these attitudinal/predisposition capacities, before their involvement/holding key roles in this major flagship program	1. Identify and establish a possible roster of qualified/suitable African specialists that can be called on in implementing the flagship program 2. Organize, brief, and provide a short orientation training toward the objectives of the program 3. Design and provide refresher training on the composite, soft, and transformative capacity dimensions required to achieve the program's goals 4. Build in a sense of urgency-driven monitoring and tracking on implementation progress and on risk and challenge management

- Agree on a suitable location for the coordination and facilitation of this project.
- Engage with the African diaspora for leveraging critical skills.
- Undertake a resource mobilization drive for project funding.
- Urgently undertake environmental assessments of the cities concerned with this program.
- Seed funding is estimated at $300,000. The private sector is best placed to be the lead of the resource mobilization drive and efforts for this project.

Development of the train network will not be in isolation, as it features in other key continental and regional programs, including the CFTA; the African Passport and Free Movement of People; and the PIDA Transport agenda, which aims to work toward an integrated continent where the transport infrastructure and services enable the free movement of goods and people.

An African Virtual and E-University

Key purposes, provisions, and features

The African Virtual and E-University aims to increase access to tertiary and continuing education in Africa by reaching large numbers of students and professionals in multiple sites simultaneously, and developing relevant and high-quality open, distance, and e-learning resources (often in rural and disadvantaged urban areas) to offer prospective students access to universities from anywhere in the world, anytime.

Through the African Virtual University, at least 70 percent of all high school graduates will have access to tertiary education with 70 percent of them graduating in STI programs.

This e-university will be an integral part of the Pan-African Virtual University and envisages putting in place Internet-based interactive learning (learning at one's own pace, in any place) by designing and developing multimedia courses that are web-enabled and form the curriculum of a fully-fledged degree program.

The African Virtual and E-University also aims to enhance the pedagogical and research capacity of African tertiary educational institutions; raise the global standing of the university; and build and sustain partnerships with institutions that can support the African Virtual and E-University mission.

Indicative capacity requirements

Table 5.2 lists the indicative capacity requirements for an African Virtual and E-University.

Developing critical technical skills capacity

The following additional approaches are proposed, including estimated seed funding:

- Constitute a team of continental higher educational institutions to facilitate, coordinate, and implement the effective use of open, distance, and e-learning.
- Engage with the private sector through various platforms and forums to develop the infrastructure, human, and financial support systems of the an African Virtual and E-University.
- Seed funding is estimated at $250,000. In addition to the above approaches, there are some other programs and projects that will complement an African Virtual and

Table 5.2 Indicative capacity requirements for the an African Virtual and E-University

CTS professionals required	Africa-focused professional skill areas	Proposed sourcing	Composite capacities required	Proposed sourcing
Knowledge and data management specialists Software developers Microsoft system engineers Academics and researchers ICT specialists	African mind-set transformation specialists African mobilization specialists Pan-African value systems and ideology specialists Africa data specialists African education specialists	Academia Private sector Diaspora Youth CTS professional bodies	Critical support systems and processes, including using technology and innovation Stakeholder/partnership-building abilities Program development, project planning, and implementation Process facilitation and organizational skills (including "functional capacities") Knowledge systems to speed up the implementation of the project Project planning and implementation Financing ownership and DRM Risk management and mitigation, and the ability to deal with bumps and shocks	AUC Private sector

Soft capacities required	Proposed sourcing	Change and transformative capacities required	Proposed sourcing	Proposed CD interventions
Ethics and values Spirit of Ubuntu Pan-African perspective—African solidarity/liberation African ownership of its development paradigm Evaluative and performance culture African ownership and management of its own resources and agendas Transformative and accountable leadership Responsive institutions Ownership of the African narrative and brand Commitment to development outcomes Proactivity Result orientation (result driven) Accountability (for results, efficiency) Continuous high level of energy/commitment Teamwork abilities/commitment Trust Diligence and thoroughness	To screen individuals/ institutions carefully, in search of these attitudinal/ predisposition capacities, before their involvement/holding key roles in this major flagship program	ICT and technological predisposition Innovation and invention commitment Risk management abilities People motivated for a shared/ inspirational vision Change readiness: creation of, and maintaining the desire for change Ability for mind-set shifts	To screen individuals/ institutions carefully, in search of these attitudinal/ predisposition capacities, before their involvement/holding key roles in this major flagship program	1. Identify and establish a possible roster of qualified/ suitable African specialists that can be called on in implementing the flagship program 2. Organize, brief, and provide a short orientation training toward the objectives of the flagship program 3. Design and provide refresher training on the composite, soft, and transformative capacity dimensions required to achieve the goals of the flagship program 4. Build in a sense of urgency-driven monitoring and tracking on implementation progress and for risk and challenge management.

E-University. These include the PIDA-ICT vision, which aims to build an information society and an integrated digital economy; the STISA Pillar 3, which focuses on communication and intellectual communication in ICT, and the Pan-African E-Network with a focus on e-applications and services in Africa.

Commodity Strategy

Key purposes, provisions, and features

The Commodity Strategy aims to enable African countries to add value, extract higher rents from their commodities, integrate with global value chains, and promote vertical and horizontal diversification anchored on value addition and local content development.

It will be based on best practices, leading to Africa regaining control of the pricing of commodities of which it is the dominant producer; hedge against price and currency fluctuations in trading these commodities; develop value chains through adding value at various stages of the extraction process; and ultimately shift African economies from exporters of primary produce to exporters of semi-processed and processed goods.

The Commodity Strategy further explores the development of regional and continental value chains in strategic commodities as well as how to integrate small and medium-sized enterprises (most of which are staffed by young people) into these value chains, both for creating jobs and wealth, and boosting intra-African trade.

Indicative capacity requirements

Table 5.3 lists the indicative capacity requirements for the Commodity Strategy.

Developing critical technical skills capacity

The following additional approaches are proposed, including estimated seed funding:

- Develop mechanisms to tackle the issue of African commodity prices. This could involve consultations with the private sector at the national and regional levels on deepening regional commodities markets.
- Engage with the private sector through various platforms and forums to develop the infrastructure, human, and financial support systems of the African Commodity Strategy.
- Seed funding is estimated at $150,000.

The formulation of a Commodity Strategy is buttressed by other programs such as the CFTA, which aims to facilitate the creation of an African Investment Bank and Pan-African Stock Exchange by 2016, an African Monetary Fund by 2018, and an African Central Bank by 2028/34. Pillar 6 further complements the Commodity Strategy in the STISA Framework Document that aims to create wealth through education and human resource development, exploitation and management of mineral resources, forests, aquatics, and management of water resources.

Annual African Forum

Key purposes, provisions, and features

This is designed to bring together, once a year, the African political leadership, representatives of the private sector, academia, and civil society to discuss developments, constraints, and measures to realize the aspirations and goals of Agenda 2063.

Table 5.3 Indicative capacity requirements for the Commodity Strategy

CTS professionals required	Africa-focused professional skill areas	Proposed sourcing	Composite capacities required	Proposed sourcing
Business development managers Regional integration experts Statisticians Trade law specialists	Commodities trade specialists Macroeconomists and development planners Intra-African trade specialists Regional integration specialists	AUC Member states RECs Key agencies (AfDB, ACBF, UNECA, and so on)	Strategic planning Organizational and coordination capability Critical/strategic thinking and results-based management Process facilitation and organizational skills (including "functional capacities") Program development Negotiation/persuasion abilities	AUC AUC institutions (NEPAD, PAP, and so on) ACBF RECs Private sector

Soft capacities required	Proposed sourcing	Change and transformative capacities required	Proposed sourcing	Proposed CD interventions
Ethics and values Spirit of Ubuntu Pan-African perspective—African solidarity/liberation African ownership of its development paradigm Evaluative and performance culture African ownership and management of its own resources and agendas Transformative and accountable leadership Responsive institutions Ownership of the African narrative and brand Political will Commitment to development outcomes Trust Result orientation (result driven) Accountability (for results, efficiency) Continuous high level of energy/commitment Teamwork abilities/commitment Problem-solving skills	To screen individuals/ institutions carefully, in search of these attitudinal/ predisposition capacities, before their involvement/holding key roles in this major flagship program	Top leadership and management optimism/commitment People motivated for a shared/ inspirational vision Ownership of decision making Risk management abilities Ability for mind-set shifts	To screen individuals/ institutions carefully, in search of these attitudinal/ predisposition capacities, before their involvement/holding key roles in this major flagship program	1. Identify and establish a possible roster of qualified/ suitable African specialists that can be called on in implementing the flagship program 2. Organize, brief, and provide a short orientation training toward the objectives of the flagship program 3. Design and provide refresher training on the composite, soft, and transformative capacity dimensions required to achieve the goals of the flagship program 4. Build in a sense of urgency-driven monitoring and tracking on implementation progress and for risk and challenge management

The Annual African Forum will build on the African Development Forum, an UNECA flagship biennial event that has been in place since 1999. The African Development Forum is a multi-stakeholder platform for debating, discussing, and initiating concrete strategies for Africa's development, convened in collaboration with the AUC, ACBF, AfDB, and other key partners "to establish an African-driven development agenda that reflects consensus and leads to specific programs for implementation."

The Annual African Forum will engage leading industry experts, policy makers, legislators, the private sector, academia, civil society, media, women, youth, and religious leaders in a high-level, informal environment of trust to transform dialogue into insights, insights into agendas, and agendas into action. It will use its convening power to improve business processes, and engage its stakeholders to develop significant strategic insights to help shape the global, regional, and industrial agendas.

Finally, the Annual African Forum will build cross-sectoral awareness and cultivate deeper understanding of the role of Africa's citizenry in implementing and improving Agenda 2063 at all levels.

Indicative capacity requirements

Table 5.4 lists the indicative capacity requirements for the Annual African Forum.

Developing critical technical skills capacity

The following additional approaches are proposed, including estimated seed funding:

- Constitute a team of persons/institutions to develop appropriate mechanisms on engaging stakeholders on the continent to execute the flagship projects.
- This team will take responsibility for reporting and raising awareness on implementation progress, as well as for risk and challenges in the flagship projects.
- Seed funding is estimated at $50,000.

The Forum will augment other continental programs such as Silencing the Guns by 2020 and Pillar 5 of STISA, which aim to build a united society where Africans are living together with shared values, Pan-Africanism, regional integration, mobility, citizenry, and a shared history.

Continental Free Trade Area

Key purposes, provisions, and features

The CFTA aims to significantly accelerate growth of trade in general and intra-African trade in particular, and use trade more effectively as an engine of growth and sustainable development. It aims to double intra-Africa trade by 2022, strengthen Africa's common voice and policy space in global trade negotiations, and establish financial institutions within agreed-on timeframes: the African Investment Bank and Pan-African Stock Exchange (2016); the African Monetary Fund (2018); and the African Central Bank (2028/34).

The CFTA, by eliminating barriers progressively, can offer substantial economic and social gains by reducing protectionism and by facilitating trade. It also helps to enhance resilience of African economies to external shocks; improve competitiveness of Africa's industrial products through harnessing the economies of scale of a large continental market; increase the depth and breadth of

Table 5.4 Indicative capacity requirements for the Annual African Forum

Africa-focused professional skill areas	Composite capacities required	Proposed sourcing	Soft capacities required	Proposed sourcing
Macroeconomists and development planners Pan-African value systems and ideology specialists African governance specialists African mind-set transformation specialists Media information specialists	Organizational and coordination capability Critical/strategic thinking and results-based management Stakeholder/partnership-building abilities Process facilitation and organizational skills (including "functional capacities") Program development Negotiation/persuasion abilities	Private sector Key agencies (AfDB, ACBF, UNECA, and so on)	Ethics and African values Spirit of Ubuntu Pan-African perspective—African solidarity/liberation African ownership of its development paradigm Evaluative and performance culture African ownership and management of its own resources and agendas Transformative and accountable leadership Responsive institutions Ownership of the African narrative and brand Teamwork abilities/commitment Pan-African spirit and value Strong leadership commitment Result orientation (result driven) Accountability (for results, efficiency) Trust Problem-solving skills Diligence and thoroughness Heavy workload abilities/hard-working spirit Pan-African spirit and value	To screen individuals/institutions carefully, in search of these attitudinal/predisposition capacities, before their involvement/holding key roles in this major flagship program

Change and transformative capacities required	Proposed sourcing	Proposed CD interventions
People motivated for a shared/inspirational vision Political will Top leadership and management optimism/commitment Ownership of decision making Risk management abilities Change readiness: creation of, and maintaining the desire for change Ability for mind-set shifts	To screen individuals/institutions carefully, in search of these attitudinal/predisposition capacities, before their involvement/holding key roles in this major flagship program	1. Identify and establish a possible roster of qualified/suitable African specialists that can be used in implementing the flagship program 2. Organize, brief, and provide a short orientation training toward the objectives of the flagship program 3. Design and provide refresher training on the composite, soft, and transformative capacity dimensions required to achieve the goals of the flagship program 4. Build in a sense of urgency-driven monitoring and tracking on implementation progress and for risk and challenge management

diversification through geographically based specialization and transformation of the continent's capacity to supply its import needs from within Africa; and boost food security through reducing the rate of protection on trade in agricultural produce among African countries.

Indicative capacity requirements

Table 5.5 lists the indicative capacity requirements for the Continental Free Trade Area.

Developing critical technical skills capacity

The following additional approaches are proposed, including estimated seed funding:

- Hold regional and national consultations to join all regions on the continent in the CFTA.
- Quickly constitute a team at the continental and regional level to facilitate negotiations on the establishment of the CFTA.
- Develop mechanisms leading toward the establishment of the African Monetary Union and its implementation plan.
- Seed funding is estimated at $150,000.

The CFTA is complemented by the PIDA transport agenda toward an integrated continent.

Grand Inga Dam project

Key purposes, provisions, and features

This project aims to transform Africa from traditional to modern sources of energy, ensure access of all Africans to clean and affordable electricity, and help make continental (combined) regional power pools operational.

Building on PIDA, Agenda 2063 envisages providing electricity access to all households by 2063. PIDA, for its part, envisages reducing energy costs and increasing access from 39 percent in 2009 to nearly 70 percent (an additional 800 million people) by 2040. It also envisages developing efficient, reliable, cost-effective, and environmentally friendly regional and continental power generation and transmission projects and renewable energy resources.

The Agenda 2063 and PIDA energy infrastructure program focuses on major hydroelectric projects and interconnects the power pools (continental power pooling) to meet the increasing demand for power.

The optimal development of the Inga Dam will generate 43,200 MW of power to support current regional power pools and their combined service.

The project is in preparation and its first phase, Inga 3, will be equipped for 4,800 MW with a low head dam, and an option of 7,800 MW with a high head dam. It should incrementally reach total capacity of more than 40,000 MW (Inga 3 to 8), which will be developed under the public–private partnership model and designed to supply electricity to the entire continent.

Indicative capacity requirements for the Grand Inga Dam

Table 5.6 lists the indicative capacity requirements for the Grand Inga Dam.

Developing critical technical skills capacity

The following additional approaches are proposed, including estimated seed funding:

- Set up a taskforce to ensure implementation of the project. This taskforce could be

Table 5.5 Indicative capacity requirements for the Continental Free Trade Area

CTS professionals required	Africa-focused professional skill areas	Proposed sourcing	Composite capacities required	Proposed sourcing
Financial investment advisors/experts Intra-African trade specialists Economists Free trade specialists Regional integration specialists Logistics/freight experts Actuaries and risk assessors Trade law specialists	Commodities trade specialists Macroeconomists and development planners Regional integration specialists African capacity building and development specialists African development scenario-building specialists	AUC Member states RECs Private sector ACBF Diaspora Civil society organizations (CSOs)	Strategic planning Critical/strategic thinking and results-based management Leveraging of assets Risk management and mitigation, and the ability to deal with bumps and shocks Organizational and coordination capability Process facilitation and organizational skills (including "functional capacities") Stakeholder/partnership-building abilities Program development Project planning and implementation Financing ownership and DRM Negotiation/persuasion abilities	Private sector Key agencies (AfDB, ACBF, UNECA, and so on)

Soft capacities required	Proposed sourcing	Change and transformative capacities required	Proposed sourcing	Proposed CD interventions
Ethics and African values Spirit of Ubuntu Pan-African perspective—African solidarity/liberation African ownership of its development paradigm Evaluative and performance culture African ownership and management of its own resources and agendas Transformative and accountable leadership Responsive institutions Ownership of the African narrative and brand Strong leadership commitment Commitment to development outcomes Proactivity Result orientation (result driven) Accountability (for results, efficiency) Continuous high level of energy/commitment Teamwork abilities/commitment Trust Problem-solving skills Diligence and thoroughness High sense of energy and drive Heavy workload abilities/hard-working spirit	To screen individuals/ institutions carefully, in search of these attitudinal/ predisposition capacities, before their involvement/ holding key roles in this major flagship program	Transformative leadership (including visioning) Top leadership and management optimism/ commitment Ownership of decision making ICT and technological predisposition Innovation and invention commitment Risk management abilities People motivated for a shared/inspirational vision Change readiness: creation of, and maintaining the desire for change Ability for mind-set shifts	To screen individuals/ institutions carefully, in search of these attitudinal/ predisposition capacities, before their involvement/ holding key roles in this major flagship program	1. Identify and establish a possible roster of qualified/ suitable African specialists that can be used in implementing the flagship program 2. Organize, brief, and provide a short orientation training toward the objectives of the flagship program 3. Design and provide refresher training on the composite, soft, and transformative capacity dimensions required to achieve the goals of the flagship program 4. Build in a sense of urgency-driven monitoring and tracking on implementation progress and for risk and challenge management

Table 5.6 Indicative capacity requirements for the Grand Inga Dam

CTS professionals required	Africa-focused professional skill areas	Proposed sourcing	Composite capacities required	Proposed sourcing
Water specialists/hydrologists	DRM specialists	Member states	Strategic planning	AUC
Chemical engineers	Private sector development specialists	ACBF	Program development	Private sector
Project managers	African mobilization specialists	Private Sector	Project planning and implementation	Key agencies (AfDB, ACBF, UNECA, and so on)
Chemical engineers/technologists	African mind-set transformation specialists	Academia	Stakeholder/partnership-building abilities	
Water resource scientists	African futures specialists	CTS professional bodies	Organizational and coordination capability	
Irrigation specialists		African CTS diaspora (in China, India, and the west)	Critical/strategic thinking and results-based management	
Dam construction and management specialists			Process facilitation and organizational skills (including "functional capacities")	
Aquatic scientists			Critical support systems and processes, including using technology and innovation	
Marine bioscientists			Financing ownership and DRM	
Geologists			Knowledge systems to speed up the implementation of the project	
Toxicologists			Risk management and mitigation, and the ability to deal with bumps and shocks	
Plumbers			Leveraging of assets	
Pipe fitters			Negotiation/persuasion abilities	
Riggers				
Materials testers				
Environmental technologists				
Environmental engineers				
Environmental managers				
Landscape architects				
Landscape contract managers				
Boiler makers				
Pressure welders				

(continued)

Table 5.6 Indicative capacity requirements for the Grand Inga Dam *(continued)*

Soft capacities required	Proposed sourcing	Change and transformative capacities required	Proposed sourcing	Proposed CD interventions
Ethics and African values Spirit of Ubuntu Pan-African perspective—African solidarity/liberation African ownership of its development paradigm Evaluative and performance culture African ownership and management of its own resources and agendas Transformative and accountable leadership Responsive institutions Ownership of the African narrative and brand Commitment to development outcomes High sense of energy and drive Pan-African spirit and values Strong leadership commitment Proactivity Result orientation (result driven) Accountability (for results, efficiency) Continuous high level of energy/commitment Teamwork abilities/commitment Trust Problem-solving skills Diligence and thoroughness Heavy workload abilities/hard-working spirit	To screen individuals/ institutions carefully, in search of these attitudinal/ predisposition capacities, before their involvement/holding key roles in this major flagship program	Transformative leadership (including visioning) Top leadership and management optimism/commitment Ownership of decision making ICT and technological predisposition Innovation and invention commitment Risk management abilities People motivated for a shared/ inspirational vision Change readiness: creation of, and maintaining the desire for change Ability for mind-set shifts	To screen individuals/ institutions carefully, in search of these attitudinal/ predisposition capacities, before their involvement/holding key roles in this major flagship program	1. Identify and establish a possible roster of qualified/ suitable African specialists that can be used in implementing the flagship program 2. Organize, brief, and provide a short orientation training toward the objectives of the flagship program 3. Design and provide refresher training on the composite, soft, and transformative capacity dimensions required to achieve the goals of the flagship program 4. Build in a sense of urgency-driven monitoring and tracking on implementation progress, and for risk and challenge management

led by the private sector with an AU advisory role.

- Engage with the African diaspora for leveraging critical skills for this project.
- Undertake a resource mobilization drive for funding this project.
- Urgently undertake an environmental assessment for implementing the project.
- Seed funding is estimated at $300,000.

The Grand Inga Dam will provide power and energy to the continent and will supplement other continental programs with similar agendas, such as PIDA energy, the AIDA agenda on infrastructure and energy development for industrial processes, and CAADP.

Pan-African E-Network

Key purposes, provisions, and features

This involves a wide range of stakeholders and envisages putting in place strategies that will lead to transformative e-applications and services in Africa, especially the intra-African broadband terrestrial infrastructure; and cyber security, making the information revolution the basis for service delivery in the bio- and nanotechnology industries, ultimately transforming Africa into an e-society.

The African Internet Exchange System; e-Transform Africa, which envisages transforming Africa into an e-society; PIDA; and the manufacturing component parts for e-devices merit priority consideration.

Indicative capacity requirements

Table 5.7 lists the indicative capacity requirements for the Pan-African E-Network.

Developing critical technical skills capacity

The following additional approaches are proposed, including estimated seed funding:

- Constitute a team of persons/institutions to develop mechanisms to establish an e-network across all levels on the continent.
- Seed funding is estimated at $50,000.

Other programs will complement the project, such as STISA Pillar 3, which focuses on communication and intellectual communications; the PIDA-ICT vision, which aims to build an information society and an integrated digital economy; and the African Virtual and E-University ICT with a focus on e-applications and services in Africa.

Silencing the Guns by 2020

Key purposes, provisions, and features

Silencing the Guns is a prerequisite for creating a peaceful and secure Africa and achieving accelerated development and technological transformation.

This flagship project aims to end all wars, civil conflicts, gender-based violence, and violent conflict; to prevent genocide; and to monitor progress in these aims, through establishing and operationalizing an African Human Security Index.

Enduring peace, security, and sustainable development can be realized through systematically and strategically halting all armed conflicts and addressing their causes and consequences. This will require sound governance; better social and economic well-being; expansion of human capabilities; freedom from hunger, deprivation, and physical violence; and the effective mitigation of

Table 5.7 Indicative capacity requirements for the Pan-African E-Network

CTS professionals required	Africa-focused professional skill areas	Proposed sourcing	Composite capacities required	Proposed sourcing
Network controllers Integrated developers (Java, Perl, PHP) ICT specialists Microsoft system engineers IT security specialists Telecommunications engineers/specialists	Pan-African value systems and ideology specialists African mind-set transformation specialists African data specialists	AUC Private sector Youth ACBF Diaspora	Critical/strategic thinking and results-based management Organizational and coordination capability Process facilitation and organizational skills (including "functional capacities") Stakeholder/partnership-building abilities Critical support systems and processes, including using technology and innovation Program development Project planning and implementation Financing ownership and DRM Knowledge systems to speed up the implementation of the project Risk management and mitigation, and the ability to deal with bumps and shocks Leveraging of assets Negotiation/persuasion abilities	AUC Private sector ACBF Continental youth organizations

Soft capacities required	Proposed sourcing	Change and transformative capacities required	Proposed sourcing	Proposed CD interventions
Ethics and African values Spirit of Ubuntu Pan-African perspective—African solidarity/liberation African ownership of its development paradigm Evaluative and performance culture African ownership and management of its own resources and agendas Transformative and accountable leadership Responsive institutions Ownership of the African narrative and brand Commitment to development outcomes Proactivity Result orientation (result driven) Accountability (for results, efficiency) Continuous high level of energy/commitment Teamwork abilities/commitment Trust Problem-solving skills Diligence and thoroughness High sense of energy and drive Heavy workload abilities/hard-working spirit Pan-African spirit and value	To screen individuals/ institutions carefully, in search of these attitudinal/ predisposition capacities, before their involvement/ holding key roles in this major flagship program	Innovation and invention commitment ICT and technological predisposition Transformative leadership (including visioning) Top leadership and management optimism/ commitment Ownership of decision making Risk management abilities People motivated for a shared/inspirational vision Change readiness: creation of, and maintaining the desire for change Ability for mind-set shifts	To screen individuals/ institutions carefully, in search of these attitudinal/ predisposition capacities, before their involvement/ holding key roles in this major flagship program	1. Identify and establish a possible roster of qualified/ suitable African specialists that can be used in implementing the flagship program 2. Organize, brief, and provide a short orientation training toward the objectives of the flagship program 3. Design and provide refresher training on the composite, soft, and transformative capacity dimensions required to achieve the goals of the flagship program 4. Build in a sense of urgency-driven monitoring and tracking on implementation progress, and for risk and challenge management

environmental threats such as drought, desertification, land degradation, deforestation, and climate change.

At the continental level, there is a recognition that political stability, prevalence of peace, good governance, and development are inseparable. The AU, for example, has taken measures including the African Governance Architecture and its Platform, the African Peace and Security Architecture and related frameworks to strengthen governance systems and institutions, and to embed a culture of democracy and peace.

Indicative capacity requirements

Table 5.8 lists the indicative capacity requirements for Silencing the Guns.

Developing critical technical skills capacity

The following additional approaches are proposed, including estimated seed funding:

- Urgently put in place new initiatives to design, promote, and achieve this flagship project in consultation with stakeholders.
- Identify, constitute, and consolidate a small team of "champion" serving and former heads of state for this flagship project.
- Seed funding is estimated at $500,000.

As part of other continental programs toward the Africa we want, this project builds on, for example, STISA Pillar 5, which aims to promote an African society built on citizenship, history, and shared values.

African outer space strategy

Key purposes, provisions, and features

This aims to strengthen Africa's use of outer space to bolster its development. Outer space is important to developing Africa in all fields: agriculture, disaster management, remote sensing, climate forecast, banking and finance, as well as defense and security. Africa's access to space technology products is no longer a matter of luxury and it must speed up access to them. New developments in satellite technologies make these very accessible.

The African Union Ministerial Conference on Science and Technology in Brazzaville in 2012 on aerial space technologies underlines the need for policies to develop the market for space products in Africa.

Indicative capacity requirements

Table 5.9 lists the indicative capacity requirements for the African outer space strategy.

Developing critical technical skills capacity

The following additional approaches are proposed, including estimated seed funding:

- Urgently put in place new initiatives to design, promote, and achieve this flagship project in consultation with stakeholders.
- Design training packages for the CTS identified in this flagship program.
- Seed funding is estimated at $300,000.

African Passport and Free Movement of People

Key purposes, provisions, and features

A common African Passport and Free Movement of People form a pillar of African integration and accelerated growth of intra-African trade and investment. This program aims at transforming Africa's laws, which remain generally restrictive on movement of people despite political commitments, to bring down

Table 5.8 Indicative capacity requirements for Silencing the Guns

CTS professionals required	Africa-focused professional skill areas	Proposed sourcing	Composite capacities required	Proposed sourcing
African conflict resolution specialists Panel of Wise Peacemakers Peace and security experts Conflict and security tracking specialists	African mind-set transformation specialists African mobilization specialists Pan-African value systems and ideology specialists African conflict resolution specialists African peacebuilding specialists	AUC Private sector Diaspora African security institutions	Program development Risk management and mitigation, and the ability to deal with bumps and shocks Critical support systems and processes, including using technology and innovation Stakeholder/partnership-building abilities Strategic planning Organizational and coordination capability Critical/strategic thinking and results-based management Process facilitation and organizational skills (including "functional capacities") Project planning and implementation Financing ownership and DRM Knowledge systems to speed up the implementation of the project Negotiation/persuasion abilities	AUC AUC institutions (NEPAD, PAP, and so on) RECs Private sector Key agencies (AfDB, UNECA, and so on)

Soft capacities required	Proposed sourcing	Change and transformative capacities required	Proposed sourcing	Proposed CD interventions
Ethics and African values Spirit of Ubuntu Pan-African perspective—African solidarity/liberation African ownership of its development paradigm Evaluative and performance culture African ownership and management of its own resources and agendas Transformative and accountable leadership Responsive institutions Ownership of the African narrative and brand Commitment to development outcomes Proactivity Result orientation (result driven) Accountability (for results, efficiency) Continuous high level of energy/commitment Teamwork abilities/commitment Trust Problem-solving skills Diligence and thoroughness High sense of energy and drive Heavy workload abilities/hard-working spirit Pan-African spirit and value	To screen individuals/ institutions carefully, in search of these attitudinal/ predisposition capacities, before their involvement/ holding key roles in this major flagship program	Risk management abilities Transformative leadership (including visioning) Top leadership and management optimism/ commitment Ownership of decision making People motivated for a shared/inspirational vision Change readiness: creation of, and maintaining the desire for change	To screen individuals/ institutions carefully, in search of these attitudinal/ predisposition capacities, before their involvement/ holding key roles in this major flagship program	1. Identify and establish a possible roster of qualified/ suitable African specialists that can be used in implementing the flagship program 2. Organize, brief, and provide a short orientation training toward the objectives of the flagship program 3. Design and provide refresher training on the composite, soft, and transformative capacity dimensions required to achieve the goals of the flagship program 4. Build in a sense of urgency-driven monitoring and tracking on implementation progress and for risk and challenge management

Table 5.9 Indicative capacity requirements for the African outer space strategy

CTS professionals required	Africa-focused professional skill areas	Proposed sourcing	Composite capacities required
Astronauts	African mind-set transformation specialists	AUC	Strategic planning
Space technologists	African mobilization specialists	ACBF	Organizational and coordination capability
Technology and innovation specialists	Pan-African value systems and ideology specialists	Private sector	Critical/strategic thinking and results-based management
Physicists	African futures specialists	Academia	Process facilitation and organizational skills (including "functional capacities")
Satellite positioning and information analysis specialists	Africa's destiny strategic thinkers	CTS professional bodies	Critical support systems and processes, including using technology and innovation
Astronomers		African CTS diaspora (in China, India, and the west)	Program development
			Project planning and implementation
			Financing ownership and DRM
			Knowledge systems to speed up the implementation of the project
			Risk management and mitigation, and the ability to deal with bumps and shocks
			Leveraging of assets
			Negotiation/persuasion abilities

Proposed sourcing	Soft capacities required	Proposed sourcing	Proposed CD interventions
AUC	Ethics and African values	To screen individuals/institutions carefully, in search of these attitudinal/predisposition capacities, before their involvement/holding key roles in this major flagship program	1. Identify and establish a possible roster of qualified/suitable African specialists that can be used in implementing the flagship program
Private sector	Spirit of Ubuntu		2. Organize, brief, and provide a short orientation training toward the objectives of the flagship program
ACBF	Pan-African perspective—African solidarity/liberation		3. Design and provide refresher training on the composite, soft, and transformative capacity dimensions required to achieve the goals of the flagship program
Key agencies (AfDB, UNECA, and so on)	African ownership of its development paradigm		4. Build in a sense of urgency-driven monitoring and tracking on implementation progress and for risk and challenge management
	Evaluative and performance culture		
	African ownership and management of its own resources and agendas		
	Transformative and accountable leadership		
	Responsive institutions		
	Ownership of the African narrative and brand		
	Strong leadership commitment		
	Commitment to development outcomes		
	Proactivity		
	Result orientation (result driven)		
	Accountability (for results, efficiency)		
	Continuous high level of energy/commitment		
	Teamwork abilities/commitment		
	Trust		
	Problem-solving skills		
	Diligence and thoroughness		
	High sense of energy and drive		
	Heavy workload abilities/hard-working spirit		
	Pan-African spirit and value		

borders through removing visa requirements, promoting the issuance of a single visa by member states and ultimately a single African passport to ensure free movement of all African citizens in all African countries.

Free Movement of People is a precondition for expanded intra-African trade, economic growth, and integration.

The issue of migration is often masked by negative reactions, xenophobic fears, and security concerns. As a result, the program involves raising awareness about the importance and benefits of the Free Movement of People.

Indicative capacity requirements

Table 5.10 lists the indicative capacity requirements for the African Passport and Free Movement of People.

Developing critical technical skills capacity

The following additional approaches are proposed, including estimated seed funding:

- Establish high-level teams to undertake sensitize missions at the regional and national levels on Free Movement of People.
- Constitute a team to develop a governance framework, including monitoring mechanisms for managing the free movement of Africans.
- Seed funding is estimated at $200,000.

Programme for Infrastructure Development in Africa

Key purposes, provisions, and features

PIDA aims to promote socioeconomic development and poverty reduction in Africa through improved access to integrated regional and continental infrastructure networks and services. It provides a common framework for African stakeholders to build the infrastructure necessary for more integrated transport, energy, ICT, and transboundary water networks to boost trade, spark growth, and create jobs.

PIDA is a long-term (2012–40) strategic planning program for Africa's regional infrastructure. It comprises priority action plans with about 50 projects and programs grouped into a set of general categories (ICT, energy, transport, and water).

PIDA visions

- *ICT:* A continent on an equal footing with the rest of the world as an information society and an integrated e-economy in which every government, business, and citizen has access to reliable and affordable ICT services.
- *Energy:* To harness all African energy resources to ensure access to modern energy for all African households, businesses and industries by developing efficient, reliable, cost-effective and environmentally friendly energy infrastructure, resulting in poverty eradication and vigorous sustainable development of the continent.
- *Integrated transport:* To work toward an integrated continent where the transport infrastructure and services enable the free movement of goods and people.
- *Water:* Promoting integrated water resource management to develop transboundary water infrastructure projects, strengthen transboundary management frameworks for regional integration, and ensure water security for the socioeconomic development of Africa.

Indicative capacity requirements

Table 5.11 lists the indicative capacity requirements for PIDA's Priority Action Plan.

Table 5.10 Indicative capacity requirements for the African Passport and Free Movement of People

Africa-focused professional skill areas	Proposed sourcing	Composite capacities required	Proposed sourcing	Soft capacities required	Proposed sourcing
Macroeconomists and development planners DRM specialists African mind-set transformation specialists African mobilization specialists Pan-African value systems and ideology specialists	AUC ACBF Member states African Peer Review Mechanism	Process facilitation and organizational skills (including "functional capacities") Strategic planning Organizational and coordination capability Critical/strategic thinking and results-based management Critical support systems and processes, including using technology and innovation Program development Project planning and implementation Financing ownership and DRM Knowledge systems to speed up the implementation of the project Risk management and mitigation, and the ability to deal with bumps and shocks Leveraging of assets Negotiation/persuasion abilities	AUC RECs ACBF Member states	Ethics and African values Spirit of Ubuntu Pan-African perspective—African solidarity/liberation African ownership of its development paradigm Evaluative and performance culture African ownership and management of its own resources and agendas Transformative and accountable leadership Responsive institutions Ownership of the African narrative and brand Strong political will at leadership levels Commitment to development outcomes Proactivity Result orientation (result driven) Accountability (for results, efficiency) Teamwork abilities/commitment Trust Problem-solving skills Diligence and thoroughness	To screen individuals/institutions carefully, in search of these attitudinal/predisposition capacities, before their involvement/holding key roles in this major flagship program

Change and transformative capacities required	Proposed sourcing	Proposed CD interventions
People motivated for a shared/inspirational vision Ability for mind-set shifts Change readiness: creation of, and maintaining the desire for change Transformative leadership (including visioning) Top leadership and management optimism/commitment Ownership of decision making commitment Risk management abilities	To screen individuals/institutions carefully, in search of these attitudinal/predisposition capacities, before their involvement/holding key roles in this major flagship program	1. Identify and establish a possible roster of qualified/suitable African specialists that can be called on in implementing the flagship program 2. Organize, brief, and provide a short orientation training toward the objectives of the flagship program 3. Design and provide refresher training on the composite, soft, and transformative capacity dimensions required to achieve the goals of the flagship program 4. Build in a sense of urgency-driven monitoring and tracking on implementation progress and for risk and challenge management

Table 5.11 Indicative capacity requirements for PIDA's Priority Action Plan

PIDA's Priority Action Plan	CTS professionals required	Africa-focused professional skill areas	Proposed sourcing	Composite capacities required	Proposed sourcing
ICT	Knowledge and data management specialists Software developers Microsoft system engineers Academics and researchers ICT specialists	Futures specialists African data specialists	Academia Private sector Diaspora Youth ICT professional bodies and national ICT commissions	Critical support systems and processes, including using technology and innovation	AUC Private sector ACBF Key agencies (AfDB, UNECA, and so on)
Energy	Energy engineers Renewable energy specialists Solar energy specialists	African regional integration specialists African rural transformation specialists	Academia Private sector Diaspora Youth Energy professional bodies and national commissions	Strategic planning development	AUC Private sector Key agencies (AfDB, UNECA, and so on)
Transport	Logistics and transport specialists Road surveyors Rail engineers and operators	African resources mobilization specialists Rural transformation specialists African private sector development specialists	Academia Private sector Diaspora Youth CTS professional bodies	Project planning and implementation Financing ownership and DRM	AUC institutions RECs Private sector Key agencies (AfDB, UNECA, and so on)
Water	Water specialists Hydrologists Irrigation and dam specialists Ecosystem water-based management specialists Integrated water management specialists	African mind-set transformation specialists African development scenario-building specialists	Academia Private sector Diaspora Youth Water commissions/agencies, bodies	Project planning and implementation Process facilitation and organizational skills (including "functional capacities"	AUC RECs Private sector Key agencies (AfDB, UNECA, and so on)

(continued)

Table 5.11 Indicative capacity requirements for PIDA's Priority Action Plan *(continued)*

PIDA's Priority Action Plan	Soft capacities required	Proposed sourcing	Change and transformative capacities required	Proposed sourcing	Proposed CD interventions
ICT	Proactivity Result orientation (result driven) Accountability (for results, efficiency) Continuous high level of energy/ commitment Teamwork abilities/commitment Trust Diligence and thoroughness	To screen individuals/institutions carefully, in search of these attitudinal/predisposition capacities, before their involvement/holding key roles in this major flagship program	ICT and technological predisposition Innovation and invention commitment Risk management abilities People motivated for a shared/ inspirational vision Change readiness: creation of, and maintaining the desire for change Ability for mind-set shifts	To screen individuals/institutions carefully, in search of these attitudinal/predisposition capacities, before their involvement/holding key roles in this major flagship program	1. Organize, brief, and provide a short orientation training toward the objectives of the program 2. Design and provide refresher training on the composite, soft, and transformative capacity dimensions required to achieve the goals of the program 3. Build in a sense of urgency-driven monitoring and tracking on implementation progress and for risk and challenge management
Energy	Commitment to development to outcomes High sense of energy and drive Pan-African spirit and value Strong leadership commitment Proactivity Result orientation (result driven)	To screen individuals/institutions carefully, in search of these attitudinal/predisposition capacities, before their involvement/holding key roles in this major flagship program	People motivated for a shared/ inspirational vision Political will Top leadership and management optimism/commitment Ownership of decision making Risk management abilities Change readiness: creation of, and maintaining the desire for change	To screen individuals/institutions carefully, in search of these attitudinal/predisposition capacities, before their involvement/holding key roles in this major flagship program	
Transport	Problem-solving skills Diligence and thoroughness High sense of energy and drive Heavy workload abilities	To screen individuals/institutions carefully, in search of these attitudinal/predisposition capacities, before their involvement/holding key roles in this major flagship program	Ownership of decision making Risk management abilities Change readiness: creation of, and maintaining the desire for change	To screen individuals/institutions carefully, in search of these attitudinal/predisposition capacities, before their involvement/holding key roles in this major flagship program	
Water	Strong leadership commitment Proactivity Result orientation (result driven)	To screen individuals/institutions carefully, in search of these attitudinal/predisposition capacities	Ownership of decision making Risk management abilities Change readiness: creation of, and maintaining the desire for change	To screen individuals/institutions carefully, in search of these attitudinal/predisposition capacities	

Science, Technology, and Innovation Strategy for Africa

Key purposes, provisions, and features

The aim of STISA is to help transform the continent by accelerating its transition to an innovation-led, knowledge-based economy.

Strategic objectives of STISA include:

- Enhancing the effectiveness of STI in tackling priority issues.
- Improving technical competencies and institutional capacity for STI development.
- Promoting economic competitiveness through fostering innovation, value addition, and industrial development/entrepreneurship.
- Protecting knowledge production (inventions, indigenous knowledge, and so on) by strengthening intellectual property and regulatory regimes at all levels.
- Facilitating STI policy reforms, harmonization, science diplomacy, and resource mobilization.

To achieve these, STISA has six priorities: eradication of hunger and achievement of food security; prevention and control of diseases; communication (through physical and intellectual mobility); protection of our space; "live together—build the society"; and wealth creation.

STISA also aims to improve STI status on the continent by strengthening human capital, building and/or upgrading research infrastructure; enhancing professional and technical competencies; promoting entrepreneurship and innovation; and providing an enabling environment for STI development.

Indicative capacity requirements

Table 5.12 lists the indicative capacity requirements for STISA.

Comprehensive African Agriculture Development Programme

Key purposes, provisions, and features

CAADP's overall objective is to eliminate hunger and reduce poverty through agriculture, based on four main pillars:

- Pillar 1: Extending the area under sustainable land management and reliable water control systems.
- Pillar 2: Improving rural infrastructure and trade-related capacities for market access.
- Pillar 3: Increasing food supply, reducing hunger, and improving responses to food emergency crises.
- Pillar 4: Improving agriculture research, technology dissemination, and adoption.

CAADP's flagship programs include the Agriculture Climate Change Programme, Gender Agriculture Climate Change, Climate Smart Agriculture Alliance, Terra Africa-Sustainable Land and Water Management, and the NEPAD Climate Change Fund.

An important element in CAADP is that it is a growth-oriented agricultural development agenda, aimed at increasing agriculture growth rates to a minimum of 6 percent a year to create the wealth needed for rural communities and households in Africa to prosper.

By implementing the above, CAADP seeks to enhance the quality of national agricultural policy and planning.

Table 5.12 Indicative capacity requirements for STISA

CTS professionals required	Africa-focused professional skill areas	Proposed sourcing	Composite capacities required	Proposed sourcing
Knowledge and data management specialists ICT specialists System engineers IT security specialists Telecommunications engineers/ specialists Academics and researchers ICT specialists	African mind-set transformation specialists African data specialists	AUC ACBF Private sector Youth Diaspora	Knowledge systems to speed up the implementation of the project Critical support systems and processes, including using technology and innovation	AUC ACBF Private sector

Soft capacities required	Proposed sourcing	Change and transformative capacities required	Proposed sourcing	Proposed CD interventions
Commitment to development outcomes Proactivity Result orientation (result driven) Accountability (for results, efficiency) Continuous high level of energy/ commitment Trust Problem-solving skills Diligence and thoroughness High sense of energy and drive Heavy workload abilities/hard-working spirit Pan-African spirit and value	To screen individuals/institutions carefully, in search of these attitudinal/predisposition capacities, before their involvement/holding key roles in STISA	Innovation and invention commitment ICT and technological predisposition Transformative leadership (including visioning) Top leadership and management optimism/commitment	To screen individuals/institutions carefully, in search of these attitudinal/predisposition capacities, before their involvement/holding key roles in STISA	1. Identify and establish a possible roster of qualified/suitable African specialists that can be used in implementing STISA 2. Organize, brief, and provide a short orientation training toward the objectives of STISA 3. Design and provide refresher training on the composite, soft, and transformative capacity dimensions required to achieve the goals of CAADP

Indicative capacity requirements

Table 5.13 lists the indicative capacity requirements for CAADP.

African Mining Vision

Key purposes, provisions, and features

The AMV is a developmental mining approach that insists that the road to growth is through building economic and social linkages that benefit Africa itself. It is an innovative continental framework in that it goes beyond making improvements to mining regimes in countries, to establishing how mining can better contribute to local, national, and regional development.

The main objective of the AMV has been to shift from the current and dominant "resource-for-development" model, to one that could bring about a structural transformation of African economies by using mineral resources to catalyze broad-based and inclusive growth and development of Africa's resource markets, and to foster economic diversification and industrialization throughout the continent.

The AMV proposes a paradigm shift from a model of extractive resource exploitation based on a high dependency on international export markets that has proven unable to bring socioeconomic development to Africa.

Finally, the AMV addresses the long-standing paradox of a continent endowed with abundant natural resources that still faces high levels of poverty and income disparities.

Indicative capacity requirements

Table 5.14 lists the indicative capacity requirements for the AMV.

Accelerated Industrial Development of Africa

Key purposes, provisions, and features

AIDA is an AU initiative that aims to foster sustainable economic growth, wealth creation, and global integration using manufacturing as a dynamic force. Its Action Plan is mediated through the following seven cluster programs:

- Industrial policy and institutional direction.
- Upgrading production and trade capacities.
- Promote infrastructure and energy for industrial development.
- Human resources development for industry.
- Industrial innovation systems, R&D, and technology development.
- Financing and resource mobilization.
- Sustainable development.

AIDA also embodies 21 programs and 53 projects covering substantial aspects of industrial development.

Indicative capacity requirements

Table 5.15 lists the indicative capacity requirements for AIDA.

Table 5.13 Indicative capacity requirements for CAADP

CTS professionals required	Africa-focused professional skill areas	Proposed sourcing	Composite capacities required	Proposed sourcing
Agricultural engineers Agricultural scientists Agro-processing specialists Food scientists Geographic information systems specialists Climate change specialists	Rural transformation specialists Youth development and employment African capacity building and development specialists African mind-set transformation specialists Commodities trade specialists DRM specialists	AUC ACBF Private sector Youth and women networks Diaspora Academia	Process facilitation and organizational skills (including "functional capacities") Financing ownership and DRM Leveraging of assets	AUC AUC institutions (NEPAD, PAP, and so on) ACBF RECs Private sector Key agencies (AfDB, UNECA, and so on)

Soft capacities required	Proposed sourcing	Change and transformative capacities required	Proposed CD interventions
Commitment to development outcomes Ability for mind-set shifts High sense of energy and drive Result orientation (result driven) Accountability (for results, efficiency)	To screen individuals/institutions carefully, in search of these attitudinal/predisposition capacities, before their involvement/holding key roles in CAADP	Transformative leadership (including visioning) People motivated for a shared/inspirational vision Ability for mind-set shifts Ownership of decision making	1. Identify and establish a possible roster of qualified/suitable African specialists that can be used in implementing CAADP 2. Organize, brief, and provide a short orientation training toward the objectives of CAADP 3. Design and provide refresher training on the composite, soft, and transformative capacity dimensions required to achieve the goals of CAADP

Table 5.14 Indicative capacity requirements for the AMV

CTS professionals required	Africa-focused professional skill areas	Proposed sourcing	Composite capacities required	Proposed sourcing
Mining engineers Metallurgical engineers Electronic engineers/technologists Land and engineering surveyors Satellite positioning and information management specialists Geographic information systems specialists	Private sector development specialists African mobilization specialists African futures specialists Africa's destiny strategic thinkers African mind-set transformation specialists	AUC Member states RECs ACBF Private sector Diaspora CSOs	Critical/strategic thinking and results-based management Leveraging of assets Strategic planning Risk management and mitigation, and the ability to deal with bumps and shocks Stakeholder/partnership-building abilities	Private sector ACBF Key agencies (AfDB, UNECA, and so on)

Soft capacities required	Proposed sourcing	Change and transformative capacities required	Proposed sourcing	Proposed CD interventions
Proactivity Result orientation (result driven) Accountability (for results, efficiency) Continuous high level of energy/ commitment Teamwork abilities/commitment Trust Diligence and thoroughness	To screen individuals/institutions carefully, in search of these attitudinal/predisposition capacities, before their involvement/holding key roles in this AMV	Top leadership and management optimism/commitment People motivated for a shared/ inspirational vision Ownership of decision making Ability for mind-set shifts Change readiness: creation of, and maintaining the desire for change	To screen individuals/institutions carefully, in search of these attitudinal/predisposition capacities, before their involvement/holding key roles in this AMV	1. Identify and establish a possible roster of qualified/suitable African specialists that can be used in implementing the AMV 2. Organize, brief, and provide a short orientation training toward the objectives of the AMV 3. Design and provide refresher training on the composite, soft, and transformative capacity dimensions required to achieve the goals of the AMV

Table 5.15 Indicative capacity requirements for AIDA

CTS professionals required	Africa-focused professional skill areas	Proposed sourcing	Composite capacities required	Proposed sourcing
Industrial specialists Industrial engineering technologists Manufacturing specialists Advanced manufacturing industrial and production specialists Environmental specialists/engineers Industrial machinery mechanics/ operators	Macroeconomists and development planners Intra-African trade specialists DRM specialists Africa's destiny strategic thinkers African mind-set transformation specialists	AUC Member states RECs ACBF Private sector Diaspora CSOs	Critical/strategic thinking and results-based management Organizational and coordination capability Stakeholder/partnership-building abilities Leveraging of assets	ACBF Private sector Key agencies (AfDB, UNECA, and so on)

Soft capacities required	Proposed sourcing	Change and transformative capacities required	Proposed sourcing	Proposed CD interventions
Proactivity Result orientation (result driven) Accountability (for results, efficiency) Continuous high level of energy/ commitment Teamwork abilities/commitment	To screen individuals/institutions carefully, in search of these attitudinal/predisposition capacities, before their involvement/holding key roles in AIDA	Transformative leadership (including visioning) Top leadership and management optimism/commitment Ability for mind-set shifts	To screen individuals/institutions carefully, in search of these attitudinal/predisposition capacities, before their involvement/holding key roles in AIDA	1. Identify and establish a possible roster of qualified/suitable African specialists that can be used in implementing AIDA 2. Organize, brief, and provide a short orientation training toward the objectives of AIDA 3. Design and provide refresher training on the composite, soft, and transformative capacity dimensions required to achieve the goals of AIDA

Other programs and projects in the First 10-year Implementation Plan

The following table lists these.

Table 5.16 Other programs and projects in the First 10-year Implementation Plan

Other continental programs (operation year)	CTS professionals required	Africa-focused professional skill areas	Proposed sourcing
African Renaissance Institute	African international banking specialists Financial managers	Mind-set transformation specialists	Private sector Key agencies (AfDB, UNECA, and so on)
Continental TV Station (2023)	Telecommunications specialists Satellite positioning and information management specialists	Africa media specialists	Private sector Diaspora
Pan-African Institute of Statistics (2020)	Statisticians, actuarial scientists	African data specialists	AUC Private sector RECs
Africa Space Agency	Space technology specialists Radar specialists	Mind-set transformation specialists	Private sector Diaspora
Agency for Diaspora Affairs	Diaspora engagement specialists	African mobilization specialists	AUC RECs Member states Diaspora
African Centre for Disease Control and Prevention	Tropical disease specialists Medical professionals	African mind-set transformation specialists	Private sector Diaspora
African Education Accreditation Agency	African education specialists	Development scenario-building specialists	Academia Member states
Pan-African Intellectual Property Organization	Entrepreneurial development specialists	Development scenario-building specialists	AUC Member states Private sector
Continental Early Warning System (2018)	Conflict and security tracking specialists African data specialists	African conflict resolution specialists	AUC Member states RECs
African Standby Force (2018)	African peacebuilding specialists	Development scenario-building specialists	AUC Member states RECs
Encyclopaedia Africana Project (2023)	African arts and culture promotion specialists Pan-African value systems specialists	African mind-set transformation specialists African writers	AUC Member states RECs Private sector Diaspora
Africa Centre for Blue Economy (2017/18)	Oceanographists Hydrologists Marine specialists Marine biologists	Private sector development specialists Macroeconomists and development planners	AUC Member states RECs Private sector
Strategic development initiatives and programs of each member state	CTS and other capacities to be identified to suit the context of needs in each member state		
Additional initiatives being undertaken by the private sector			
Additional initiatives being undertaken by youth and women networks	CTS and other capacities to be identified to suit the context of needs in each stakeholder group		
Additional initiatives being undertaken by CSOs			
Additional initiatives being undertaken by academia			
Additional initiatives being undertaken by grassroots organizations			

(continued)

Table 5.16 Other programs and projects in the First 10-year Implementation Plan *(continued)*

Composite capacities required	Proposed sourcing	Soft capacities required	Proposed sourcing	Change and transformative capacities required	Proposed sourcing	Proposed CD interventions
Strategic planning Critical/strategic thinking and results-based management Leveraging of assets Risk management and mitigation, and the ability to deal with bumps and shocks Organizational and coordination capability Process facilitation and organizational skills (including "functional capacities") Stakeholder/partnership-building	To screen individuals/ institutions carefully, in search of these attitudinal/ predisposition capacities, before their involvement/ holding key roles in these major flagship programs	Strong leadership commitment Commitment to development outcomes Proactivity Result orientation (result driven) Accountability (for results, efficiency) Continuous high level of energy/ commitment Teamwork abilities/commitment Trust Problem-solving skills Diligence and thoroughness High sense of energy and drive Heavy workload abilities/hard-working spirit Pan-African spirit and value	To screen individuals/ institutions carefully, in search of these attitudinal/ predisposition capacities, before their involvement/ holding key roles in these major flagship programs	Transformative leadership (including visioning) Top leadership and management optimism/ commitment Ownership of decision making ICT and technological predisposition Innovation and invention commitment Risk management abilities People motivated for a shared/inspirational vision Change readiness: creation of, and maintaining the desire for change Ability for mind-set shifts	To screen individuals/ institutions carefully, in search of these attitudinal/ predisposition capacities, before their involvement/ holding key roles in these major flagship programs	1. Identify and establish a possible roster of qualified/suitable African specialists that can be used in implementing these programs 2. Organize, brief, and provide a short orientation training toward the objectives of these programs 3. Design and provide refresher training on the composite, soft, and transformative capacity dimensions required to achieve the goals of these programs 4. Build in a sense of urgency-driven monitoring and tracking on implementation progress and for risk and challenges

6

THE AFRICAN DIASPORA AND CRITICAL TECHNICAL SKILLS

Figuring out diaspora numbers

The AU has defined "diaspora" as "peoples of African descent and heritage living outside the continent, irrespective of their citizenship, and who remain committed to contribute to the development of the continent and the building of the African Union."[10]

African sources have hardly any data available on the diaspora, crucially not emigration numbers, age groups, gender composition, destinations, or categories. From a capacity perspective, they have no organized data on diaspora skill sets, qualifications, and professional specializations. The information below has been compiled by the Capacity Team from a variety of "hard-to-access" sources. While it may not provide the full picture, it serves as a starting point.

The second part of this chapter looks at intra-African migration and mobility.

Diaspora in the US

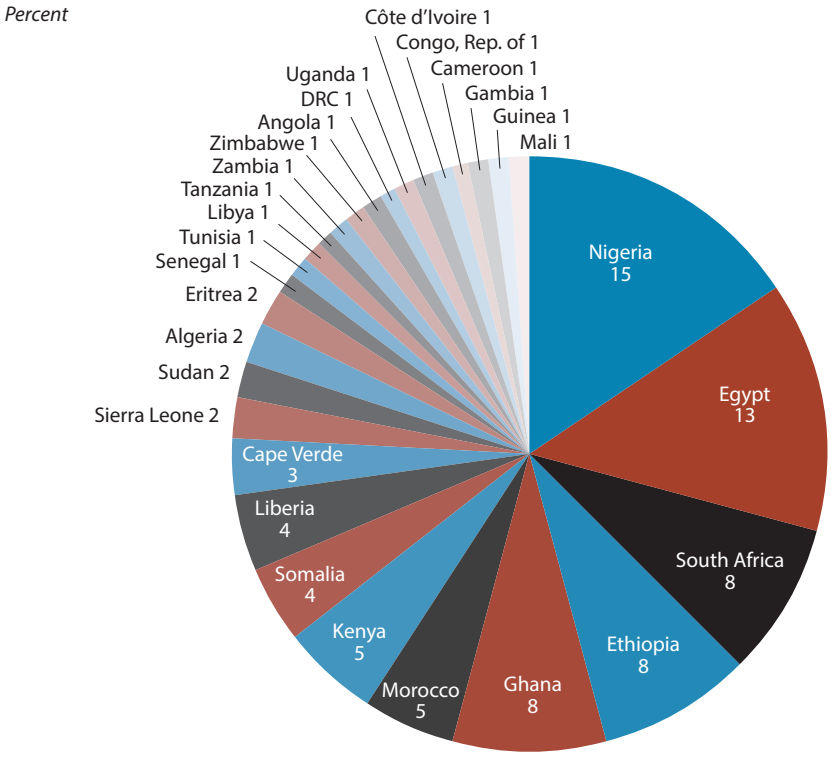
Background. The transatlantic slave trade brought large numbers of Africans to the US as forced migrants from the 16th to 19th centuries. Significant voluntary migration from Africa to the US only began in earnest in the 1980s. Although African immigrants account for a small fraction of the total foreign born, the share of African-born immigrants has increased over the past 50 years: from 0.4 percent in 1960, to 1.4 percent in 1980, to 1.8 percent in 1990, and to 2.8 percent in 2000.

*Estimated numbers and geographic distribution.10*In 2011, Africans made up an estimated 3.9 percent of the US's 38.5 million immigrants (figure 6.1).[11] On these figures, almost two-thirds of African diaspora immigrants were from Eastern and Western Africa, with the top five countries of origin Nigeria (15 percent), Egypt (13 percent), Ethiopia (8 percent), South Africa (8 percent), and Ghana (8 percent).

Some points:

- There were 3.5 million self-identified members of the African diaspora residing in the US in 2009.
- More than 860,000 African immigrants gained lawful permanent residence in the US between 2001 and 2010.
- African immigrant men outnumbered women in 2009.
- Nearly half of all immigrants who received green cards through the diversity visa lottery program in 2010 were born in Africa.
- From 2001 to 2010, African nationals accounted for 28.4 percent of refugee arrivals and 21.2 percent of persons granted asylum.

Figure 6.1 Diaspora shares in the US (from selected countries), 2011



Source: Adapted from McCabe (2011).

- More than one-third of all African immigrants lived in New York State, California, Texas, and Maryland.

In 2009, West Africa was the leading region of birth (table 6.1).

Diaspora education: Skills and capacity. On educational enrollment and performance, compared with the foreign-born overall, African immigrants reported higher levels of English proficiency and educational attainment in 2009, and were more likely to be of working age and in the labor force. Yet African immigrants were also more likely to be recent arrivals to the country and to live in households with an annual income below the poverty line. Further:

- African-born adults were more likely than the native-born to have a bachelor's degree or higher level of education.
- More than 30 percent of employed African-born men worked in service occupations and in construction, extraction, and transportation.
- African immigrants of both genders were more likely to participate in the civilian labor force than foreign-born men and women overall.

Table 6.1 African immigrants in the US by region of birth, 2009 (%)

Region	2009
East Africa	28.4
Central Africa	4.4
North Africa	17.7
Southern Africa	5.7
West Africa	36.3
Africa with no specific region	7.5

Source: Adapted from McCabe (2011).

- More than seven out of 10 African immigrants spoke only English or spoke English "very well."

Diaspora in Canada[12]

Background. Prior to 1961, the number of Africans migrating to Canada was a mere trickle, at under 5,000 a year. After 1970, however, the number shot up, from 54,600 in 1971 to 139,770 in 2001, taking the number of immigrants of African origin to 282,600.

Estimated numbers. Some two-thirds of the African population in Canada originates from Egypt (12 percent), South Africa (12 percent), Morocco (8 percent), Algeria (7 percent), Kenya (7 percent), Somalia (7 percent), Ghana (6 percent), and Tanzania (6 percent) (figure 6.2).

Education and occupation of the diaspora in Canada.[12] Canada increasingly relies on immigration as a source of skills. Using data from the 2001 census, Statistics Canada reports that immigrants who landed during the 1990s and were in the labor force in 2001 accounted for 70 percent of the net labor force growth in Canada during 1991–2001. The statistics body also estimated that in 2011, more than 60 percent of net labor force growth in Canada came from immigration.

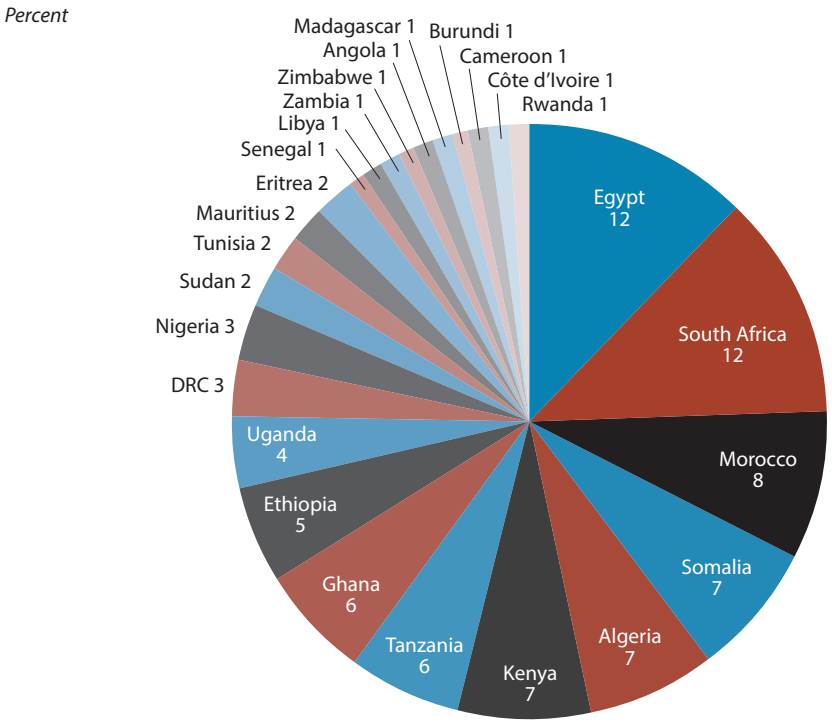
By educational level, in 1996 a higher proportion (56 percent) of African-born male immigrants possessed a bachelor's degree (or higher), compared with 45 percent of Asian men, 29.8 percent of US/European men, 26.7 percent of Caribbean/Latin American men, and 26.6 percent of native-born Canadian men. Further, 8.5 percent of African immigrant men had less than a high school diploma compared with 24.7 percent of Caribbean/Latin American, 23.1 percent of Asian, 23 percent of US/European, and 23.7 percent of Canadian-born men.

A higher proportion (46 percent) of African women possessed a bachelor's degree (or higher) in 1996 compared with 41.3 percent of Asian, 24.8 percent of Caribbean/Latin American, 31.3 percent of US/European, and 31.2 percent of Canadian-born women. Like their male counterparts, fewer female African immigrants (9.7 percent) had less than a high school education, against 23.7 percent of Asian, 22.2 percent of US/European, 20.1 percent of Caribbean/Latin American, and 16.5 percent of Canadian-born women. Thus African-born immigrants had a higher level of education than either the native-born or other immigrant groups.

As for skills and employment, 43.4 percent of African-born immigrant men were employed in high-skilled occupations compared with 30.8 percent of US/European men, 29.1 percent of Asian men, 25.3 percent of Canadian-born men, and 19 percent of Caribbean/Latin American men. Further, 8.4 percent of African immigrant men were employed in low-skilled occupations, compared with 12.4 percent of Asian men, 9.7 percent of US/European men, 14.3 percent of Caribbean/Central American men, and 10.5 percent of Canadian-born men.

Of African-born immigrants, 32 percent were employed in high-skilled occupations, against

Figure 6.2 Diaspora in Canada (from selected countries), 2005



Source: Adapted from Wisdom and Korbla (2005).

26.5 percent of native-born Canadians, 26.4 percent of US/Europeans, 19.8 percent of Asians, and 19.1 percent of Caribbean/Latin Americans. Further, 9.6 percent were employed in low-skilled occupations compared with 15.9 percent of Asians, 14.7 percent of Caribbean/Latin Americans, 10.8 percent of US/Europeans, and 10.5 percent of the Canadian born.

Diaspora in Europe

Background. From the mid-19th century until the 1960s, colonialism contributed to cultural and economic exchanges between Europe and Africa, which later facilitated migration and the creation of a diaspora. Large numbers of the diaspora are thus in former colonial countries (Belgium, France, Germany, Italy, Netherlands, Portugal, Spain, and the UK). Post-independence, many Africans voluntarily left the continent to seek better working or educational opportunities, often in Europe. In 2009, it was estimated that members of the diaspora in the European Union (EU) numbered around 3.3 million, of whom more than *2 million were from North Africa.*

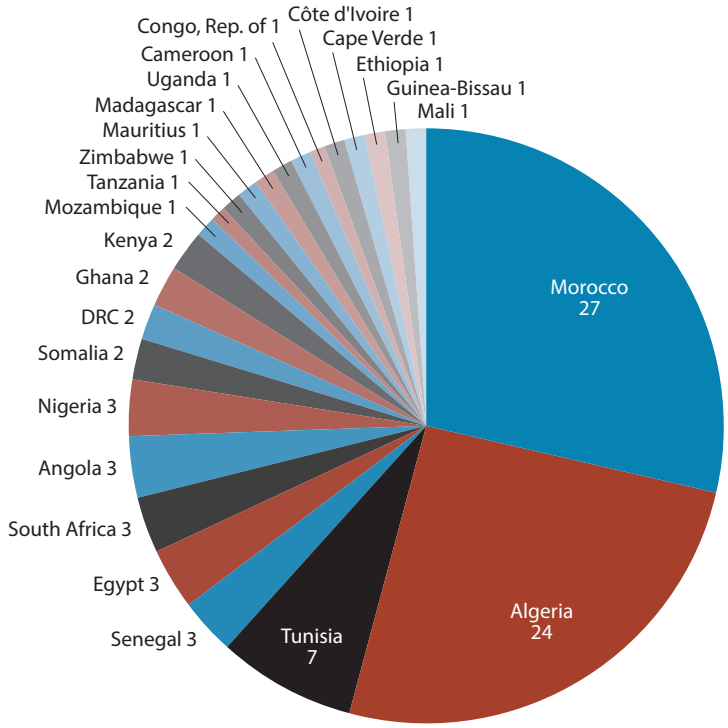
Estimated numbers. Of the Africans in Europe in 2005, more than 60 percent came from North Africa: Morocco 27 percent, Algeria 24 percent, Tunisia 7 percent, and Egypt 3 percent (figure 6.3). Sub-Saharan Africa accounted for about 1 million.[13]

Diaspora in Asia

Recent years have seen a growing number of Africans (Africans in Asia comprise 1.3 percent of the diaspora population) in Asia.

Figure 6.3 Diaspora in Europe (from selected countries), 2005

Percent



Source: Compiled by ACBF Capacity Team from Dumont, Spielvogel, and Widmaier (2010).

Economic and political ties, especially with China, India, Japan, Malaysia, and the Republic of Korea, underpin the rise.[14] Morocco is the biggest source (10 percent), followed by Algeria (9 percent), Egypt (9 percent), Mali (6 percent), Angola (5 percent), and Burkina Faso (5 percent) (figure 6.4).

Diaspora in Latin America

The transatlantic slave trade formed a connection between the two continents. But given the geographical distance, only 0.2 percent of Africans left the continent for Latin America. The top five source countries were Angola (19 percent), Egypt (14 percent), Morocco (7 percent), Algeria (6 percent), and Mozambique (5 percent) (figure 6.5).

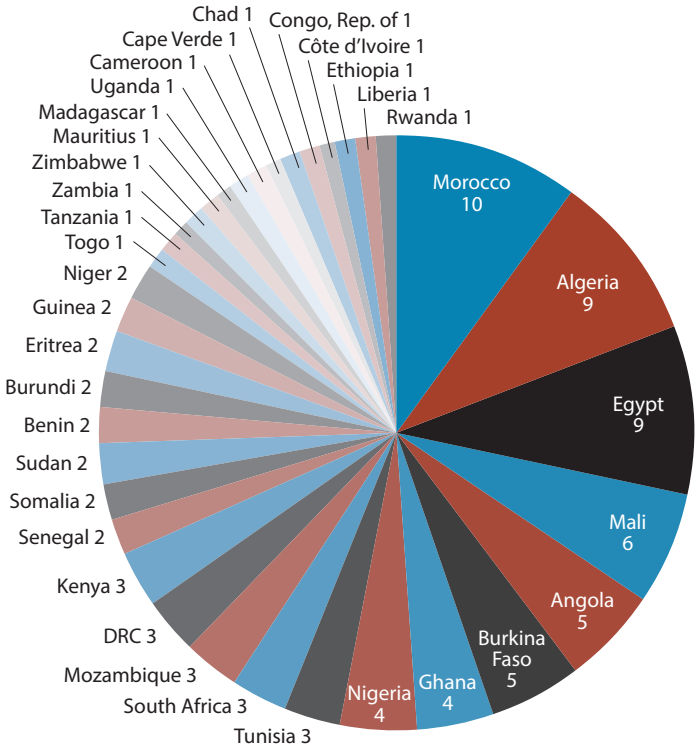
Potential of the diaspora to contribute to Agenda 2063

Skills and experience. Data on diaspora qualifications, skills, and capacity are extremely hard to pin down. Many diaspora members seem to have obtained good educational qualifications (see above on the US and Canada), including in CTS, but the data need to be identified and assessed, in the context of Agenda 2063, urgently. Particular attention should be paid to the children and youth of the diaspora.

An important capacity dimension of the diaspora's potential role in Agenda 2063 is the transfer of ideas, technology, information, experience, and business funding. Diaspora

Figure 6.4 Diaspora in Asia (from selected countries)

Percent



Source: Compiled by ACBF Capacity Team from various sources, including . Zapatero (2015).

communities are well positioned to influence developments in their home countries by increasing their presence on many levels. In a 2005 estimation, there were more than 300,000 highly qualified Africans outside Africa, of whom 30,000 had PhDs (Shinn, 2008).

According to the *Migration and Remittances Factbook 2011,* the stock of international emigrants from African nations totaled 30.6 million in 2010 (World Bank 2011).

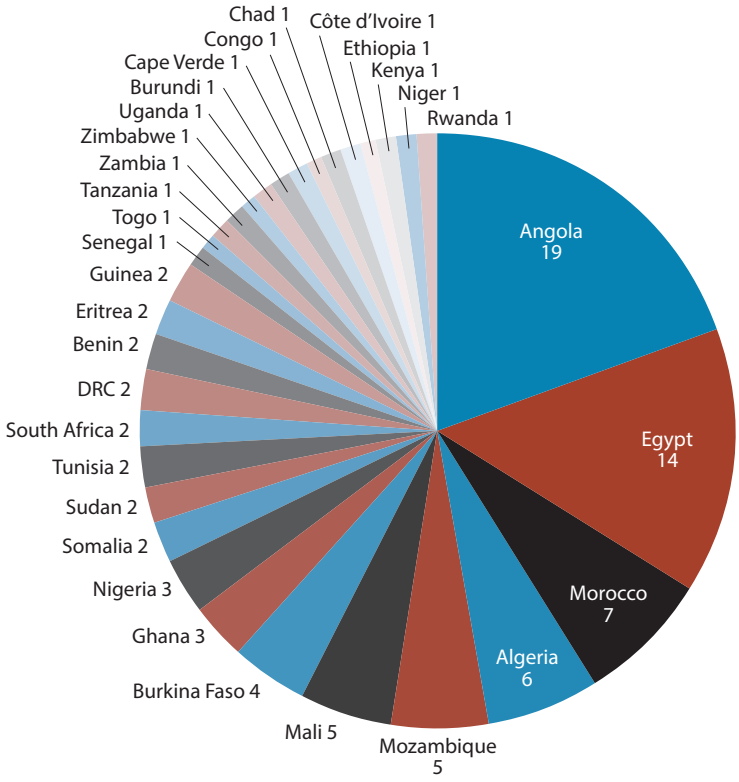
The diaspora has set up many professional networks, for many critical technical and sector-specific skill areas. This human capacity capital holds enormous potential for Agenda 2063, and must be leveraged.

Resources. According to a report by the World Bank, in 2010 the diaspora was estimated to be sending over $40 billion in remittances to their countries of origin (World Bank 2011). Because of this massive cash transfer, diaspora-initiated remittances are now referred to as the "fourth development aid" (after that from international organizations, governments, and other development organizations). In 2005, remittances from Kenyans abroad officially came to about $500 million .

Hence the irony of Africa paying an estimated $5.6 billion a year employing foreign specialists. Some African countries such as Nigeria have enough skilled workers at home not to have to hire expatriates for abandoned job positions.[15]

Figure 6.5 Diaspora in Latin America (from selected countries)

Percent



Source: Compiled by ACBF Capacity Team from various sources, including . Zapatero (2015).

Intra-African migration and mobility

We adopt four broad categories: migrants, students, professionals (serving on cross-country assignments with international, continental, and regional organizations and institutions), and mobile traders and business operators. They serve as a starter to take the discussion to its next level, which is particularly pressing given the ongoing work toward intra-African visa-free travel and visa-exempt passports.

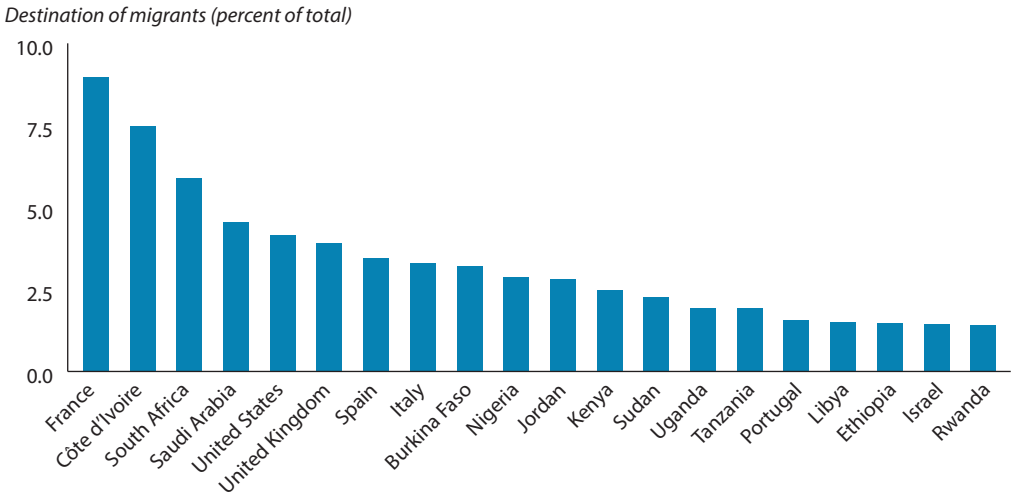
The continent itself is an attractive destination for most African migrants. In 2013, intra-African migrants in Africa were estimated at 16.3 million.[16] Of the top 20 destination countries for African migrants in 2010, 55 percent were in Africa, even if six of the top eight were in Europe or North America (figure 6.6).

Diaspora and intra-African capacities

Given the difficulties of accessing data on the African diaspora, it is urgent to build on this exercise and collect more accurate and up-to-date information on the following:

- African professionals in the diaspora and the kinds of qualifications they possess.

Figure 6.6 Intra-African migration, 2010



Source: World Bank (2011).

- Diaspora members pursuing further studies, engaging in high-skilled jobs, and so on.
- African children in the diaspora.
- CTS that diaspora Africans possess.
- Intra-African migration and mobility, including CTS.
- Skills migration and mobility (the "brain drain" or "brain circulation"), through a capacity lens, as a base for new policies.
- Capacity and skills retention and utilization —African countries need to build data on outflows, reverse flows, and intra-African circulation.

7

TECHNOLOGY, INNOVATION, AND RESEARCH IN CRITICAL TECHNICAL SKILLS

Technology and innovation: The new capacity frontiers

This chapter looks at the current technological front and the capacity needed to deliver on Agenda 2063. It identifies ascending disruptors that will most likely change human life.

The technology scene

The "triumph-of-the-nerds" is real (PBS, 1996). All facets of our lives are increasingly integrated to some form of digital code, with a sharpening focus on computing speed, production costs, and environmental sustainability. But not every emerging technology will affect our everyday lives.

Five *key technologies could offer Africa the means to match its current resources to Agenda 2063's aspirations* and to build capacity on the continent. We start with mobile gadgets.

Mobile gadgets. In just a few years, the mobile phone has transformed from a luxury for a few to a way of life for hundreds of millions in Africa (box 7.1). Ubiquitous handheld gadgets and mobile Internet connectivity are reshaping information access and sharing with the world, alongside perceptions of that world. Kenya is hailed as a "base-of-pyramid mobile model": in finance, m-pesa, with other innovate mobile payment solutions, allows users to send and receive money using their phones, boosting financial inclusion from 28 percent in 2007 to 76 percent in 2014 (GSMA, 2014). In health, the mobile phone has revolutionized maternal care, chronic disease prevention, management of Ebola and malaria epidemics, and quality assessment of pharmaceutical products. Mobile health innovations improve efficiency in patient tracking, health data collection, and remote access to rural areas. Other areas benefiting from mobile innovation are governance, education, and humanitarian efforts.

The frontier of mobile technology is evolving fast. Africa's areas of application in the future include voting in "non-elections" between official elections.

Box 7.1 Africa's Internet and mobile subscription rates

2015
Global Internet penetration:
3.1 billion/40% of population
African Internet penetration:
308 million/26.6% of population

2015
Global unique mobile subscriptions:
3.7 billion
African mobile subscriptions:
726 million

Source: Compiled by ACBF Capacity Team.

Cloud technology. Through the cloud (a model for delivering services where resources are retrieved from the Internet through web-based tools and applications rather than a direct physical connection to a server) any data can be delivered over a network or the Internet, with minimal or no local software or processing power required. IT resources (such as computation and storage) are made available as needed—without requiring up-front investment in new hardware or programming.

The cloud is enabling the explosive growth of Internet-based services in Africa by humanitarian workers, and those involved in mobile health, map making, logistics, security, and customs clearance (box 7.2).

Genomics. Advances in genomics combine the science of sequencing genetic material with superior data analytics capabilities. Today, a human genome can be sequenced in a few hours and for a few thousand dollars, a task that took 13 years and $2.7 billion to accomplish during the Human Genome Project.

The impact has been a better understanding of how genetic variations affect traits and diseases. Relatively low-cost desktop sequencing machines can be used in routine diagnostics, potentially improving treatments by matching them to patients. The next step is synthetic biology—the ability to customize organisms by "designing" DNA. This will have a direct impact on medicine, agriculture, and biofuels. Africa and its growing population stand to benefit from these advances, especially if researchers from the continent are involved, to avoid dependency on the traditional powerhouses in scientific innovation.

Renewable energy. Energy is one of the leading barriers to unlocking infrastructure projects in Africa. A report by the International Energy Agency (2014) states that energy demand in Sub-Saharan Africa grew by about 45 percent from 2000 to 2012, but the region accounts for only 4 percent of global demand while being home to 13 percent of the world's population.

The dilemma of energy production is to match ever-growing demand without harming the environment. Renewable energy sources such as solar, wind, hydroelectric, and ocean waves hold the promise of an endless source of power without stripping resources, contributing to climate change, or competing for fossil fuels. Solar cell technology is progressing particularly fast: Between 1995 and 2015, the cost of power produced by solar cells dropped by 90 percent, from nearly $8 per watt of capacity. Energy storage is another frontier. Lithium-ion batteries and fuel cells are already powering electric and hybrid vehicles, along with billions of portable consumer electronics devices, and their capacity and longevity are continually improving.

Box 7.2 Impact of the cloud on border management: Chirundu border operations

The cloud can be leveraged to improve off-site operations like revenue collection at border points, a major bottleneck for intra-African trade. Between 2007 and 2011, the average share of intra-African exports in total merchandise exports was 11% compared with intraregional trade of 70% in Europe. According to a 2014 study by the Ibrahim Index of African Governance, the average customs transaction involves 20–30 different parties, 40 documents, 200 data elements, and the re-keying of 60–70% of all data at least once.

Cloud technology offers a real opportunity to ease this nightmare. A One-Stop Border Post that uses a cloud-based database solution was piloted at the Chirundu border between Zambia and Zimbabwe. Lorries that used to take 48–72 hours to clear now take 2 hours, and the post has served a record 268 in one day.

Source: United Nations Conference on Trade and Development (2013).

Energy storage coupled with renewable sources holds promise for both macro-project expansion and micro-lifestyle changes in Africa.

Advanced materials. Manmade materials technology has over the decades focused more on durability and cost of production compared with natural ones. Plastics, ceramics, and crystals are examples. Nanomaterials in particular stand out for their high rate of improvement and wide scope of potential applicability. Housing, pharmaceuticals, household lifestyles and computing stand to benefit greatly.

Building capacity to maximize gains from the new technological frontier

To maximize these technological opportunities, physical investments, human skills, and government policies must be promoted and consolidated.

Technical capacity. While ICT international connectivity in many African countries has substantially improved since the start of this decade, interconnectivity between African towns and villages remains poor.

Nor has the investment in submarine cables been matched by progress on terrestrial "backhaul" infrastructure, owing especially to slow regulatory approval; and when projects are finally approved, there is not enough value for private companies to lay out cables, particularly in low-income rural areas, which ultimately depend on cash-tight governments to lay the "last-mile" of cable.

Dedicated departments within government to handle connectivity has the potential to create a platform to accelerate effort. An enabling environment for private investment in the telecom industry, government oversight, and clear policies on the ICT industry can also drive connectivity in Africa. Policy makers ought to increasingly connect with players. Tech communities are usually accessible and their inclusion in policy making helps to build support during the implementation phase.

Human capacity. Human resources in Africa will either make or break Agenda 2063. The preparedness of the knowledge industry to equip Africans for the future of work is critical. Advances in technology and innovation have created possibilities for mobile and online learning, virtual classrooms, and "blended" models that can access global content to complement teachers as guides (rather than holders of all knowledge on a subject). Africa will still, crucially, have to develop its own educational content, allowing it to translate lecture room solutions to the field.

As a way to bridge technical needs and current supply, at an early age all children in Africa should mandatorily learn how to code. This will cultivate their interest in technology regardless of which lines of expertise they ultimately follow. As more young minds join STEM, the pool available for steering development on continental programs and projects will be enriched. Programs such as the Tech-innovation Challenge, which trains teenage girls to build software solutions to challenges they face in their communities, prepares the next generation to explore technology as an option for their future. Initiatives such as the African Institute for Mathematical Sciences (AIMS) is a Pan-African network of centers of excellence for postgraduate education, research, and outreach in mathematical sciences. Substantial investments in programs like AIMS will expand Africa's capability for technology preparedness.

Institutional capacity. The 54 member states of the AU are some of the major transformation drivers of the Agenda 2063 vision. Their regulatory frameworks, policy processes, and budgetary allocations to key agenda issues are agents. Their ability to expand their

economies, raise good governance, and harmonize efforts through RECs will be the litmus test for attaining Agenda 2063.

In building technology capacity, what has worked and how do we scale it up? A relatively free market for technology, ideas, and start-ups gives citizens—especially students—the space to tinker around with code and user-focused software. Innovation centers are a tested way of pooling funds, ideas, and creating technology and entrepreneurship communities. The Innovation Centre in Pretoria South Africa, the planned Konza City in Kenya, the operational iHub and mLab in Kenya, and CoCreation Lab in Nigeria have been successful primarily because governments have supported them and opened opportunities for their innovate ideas to scale up.

The overlapping nature of technology in all fields of development calls for a relook at how it is conceptualized. It should be less of a separate field and more of a core component in all thinking in governments, education curricula, and companies.

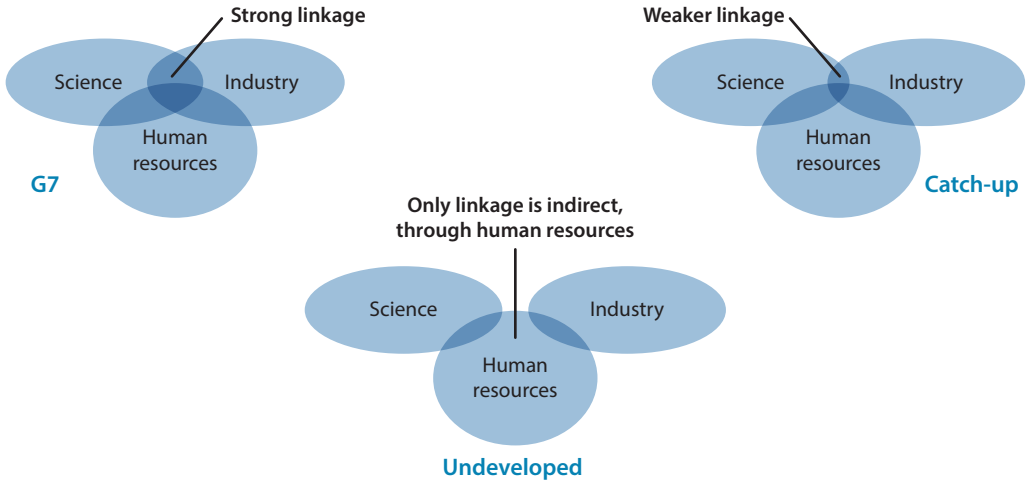
Democratic regimes are more likely to promote Internet access and with it, the opportunities of connectedness, than authoritarian regimes. As Agenda 2063 will be delivered by member states, their governance systems should incorporate as many citizens as possible in policy design and implementation.

To build capacity, ultimately, is to invest in young citizens' future skills. Educational systems must realign to match demand with supply in the future of work.

Generating knowledge, developing firms, and linking the two sides: Universities and technology parks

Creating links between knowledge generation and enterprise development is one of the most important challenges facing Africa (a theme picked up in the next chapter). Figure 7.1 shows the nature of these developments in the G7 countries, a catch-up scenario for East Asian economies, and an undeveloped scenario in which all African economies are stuck.

Figure 7.1 Scale dependence of science–industry linkages



Source: ACBF Capacity Team.

Key functions in the emergence of the entrepreneurial state in East Asian economies include identifying emerging techno-economic paradigms; creating open economies that are part of global competitiveness strategies; forming entrepreneurial capacity; promoting knowledge flows among actors in national innovation systems; and creating the conditions that support business incubation and scale-up.

African universities can contribute radically to meeting this challenge on their continent. They can undertake entrepreneurial activities that aim to improve regional or national economic and social performance. They can get involved with their communities, gaining direct knowledge about social needs, some of which could be addressed through R&D activities. They can conduct industrial R&D; create spin-off firms; participate in capital formation projects, such as technology parks and business incubator facilities; introduce entrepreneurial training and internships into their curricula; and encourage students to take research from the university to companies. African universities need to be transformed to play these roles. Eventually, new institutions need to be created that focus on business incubation and community development.

Reshaping African universities to contribute to enterprise and economic development will require modifications in curricula, changes in schemes of service, transformations in pedagogy, shifts in the location of universities, and the creation of a wider institutional ecology that includes other parts of the development process. National development plans will need to incorporate new links between universities, industry, and government. These changes are likely to have an impact on the entire national innovation system, including companies, firms, R&D institutes, and government organizations.

Such revamping will also require deep changes in enterprises—private and public—so that they can become strong demanders of the universities' capabilities, helping transform these capabilities into capacities. Governments will need to act as careful facilitators, or "honest brokers," of interactions between these two sets of actors. If this is achieved the "loneliness syndrome" that has for so long affected African universities will be redressed, allowing them to contribute to economic growth and social development.

Technology parks provide environments in which small and medium-size enterprises tend to flourish, and have been the most popular kind of technology incubators. They have proliferated in developed economies and more recently in Southeast Asia and Latin America. Such parks have strong R&D components in their organizational structure. They are based on the possession of property and usually include university and research institutions, which ensure access to research facilities, simplify technology transfer operations, and allow the incubation of spin-off enterprises that can be launched by faculty or researchers from research institutions. In the US, Silicon Valley in California is near Stanford University and Stanford Research Park. In Massachusetts, the industrial cluster along Route 128 is near the Massachusetts Institute of Technology. In Taiwan, the Hsinchu Science-Based Industrial Park is near the National Tsing-Hua and National Chiao Tung universities; that Park has helped reverse the brain drain from Taiwan, and has exerted positive spillover effects on the surrounding area. The congregation of high-tech firms has enhanced competition between traditional and high-tech industries. These parks contribute to reindustrialization, regional development, and synergies. Within them are numerous variations according to services offered based on their objectives, which define types and levels of R&D and other

technological capabilities required to create and sustain them.

Technology parks facilitate networking. By encouraging interactions, feedback, and awareness through bringing people from different institutions together physically, they facilitate the transfer of technology from university and research institutions to enterprises. They also stimulate innovation through the cross-fertilization of ideas between researchers and entrepreneurs. The clustering of universities and research institutions and enterprises is expected to yield more efficient use of innovation resources and to link basic research to commercialization through applied research.

Research capacity and output

An AU document on research capacity and output has provided an understanding of African scientific knowledge production. For an economy to grow and develop, the number of research publications in peer-reviewed scholarly and technical journals is sometimes seen as the gauge of high-quality scientific knowledge production. Africa as a whole has been slow to develop its science and technology sectors and to commercialize its innovations. For example, about 0.45 percent of the continent's GDP is allocated to R&D, far from the global average of 1.70 percent and way below Brazil 2.08 percent—and even distant from the 1 percent target set by the Lagos Plan of Action and the AU 2007 initiative (table 7.1).

Africa accounts for 13.4 percent of the world's population yet only 1.1 percent of scientific "production." Thus a leap to this 1 percent target is needed to foster growth. Areas in which Africa scores above the average of relative citations received by the AU (indicated by the bold grey AU ARC line in figure 7.2) include the built environment and design; enabling and strategic technologies; biomedical research; clinical medicine; earth

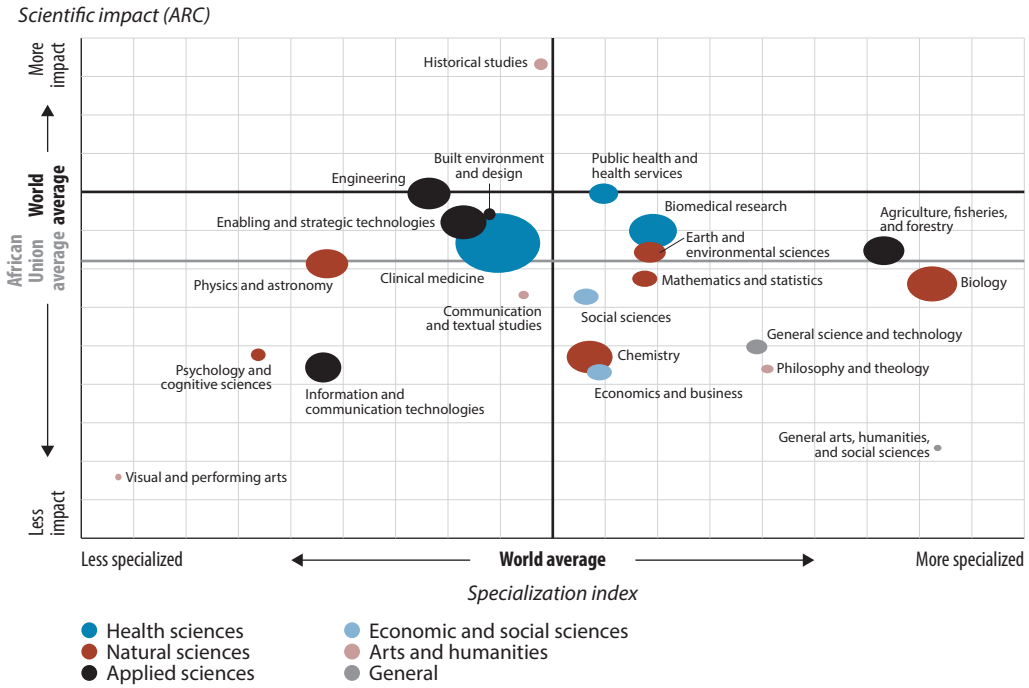
Table 7.1 World share of expenditure on R&D

	GERD (PPP$ billion)				Share of world GERD (%)				GERD as share of GDP (%)				GERD per capita (in PPP$)				GERD per researcher (PPP$ thousands)			
	2007	2009	2011	2013	2007	2009	2011	2013	2007	2009	2011	2013	2007	2009	2011	2013	2007	2009	2011	2013
World	1,132.3	1,225.5	1,340.2	1,477.7	100.0	100.0	100.0	100.0	1.57	1.65	1.65	1.70	169.7	197.3	191.5	206.3	176.9	177.6	182.3	190.4
Africa	12.9	15.5	17.1	19.9	1.1	1.3	1.3	1.3	0.36	0.40	0.42	0.45	13.5	15.5	16.2	17.9	86.2	101.8	98.6	106.1
Sub-Saharan Africa	8.4	9.2	10.0	11.1	0.7	0.7	0.7	0.8	0.42	0.42	0.41	0.41	11.0	11.4	11.7	12.4	143.5	132.2	129.4	135.6
South Africa	4.6	4.4	4.1	4.2	0.4	0.4	0.3	0.3	0.88	0.84	0.73	0.73	92.9	87.1	79.7	80.5	238.6	224.0	205.9	197.3
Brazil	23.9	26.1	30.2	31.3	2.1	2.1	2.3	2.2	1.40	1.70	1.84	2.08	87.0	125.4	161.2	209.3	—	147.0	167.4	195.4
China	116.0	169.4	220.6	290.1	10.2	13.8	16.5	19.6	1.40	1.70	1.84	2.08	87.0	125.4	161.2	209.3	—	147.0	167.4	195.4
India	31.1	36.2	42.8	—	2.7	3.0	3.2	—	0.79	0.82	0.82	—	26.8	30.5	35.0	—	171.4	—	201.8	—

Source: UNESCO (2015).

GERD = Gross domestic expenditure on R&D; PPP = purchasing power parity.

Figure 7.2 Scientific production in Africa



Source: AOSTI (2014).

and environmental sciences; and agriculture, fisheries, and forestry. Africa is better at biology and agriculture, fisheries and forestry, as it is responsible for more of the world's papers in these fields than expected for its overall share of world scientific production.

In a nutshell, Africa has been slow to develop its science and technology sectors and commercialize its innovations. It needs to boost its scientific research output as it continues with the First 10-Year Implementation Plan of Agenda 2063.

8

THE ROLE OF AFRICAN UNIVERSITIES IN EXPANDING EDUCATION AND TRAINING IN CRITICAL TECHNICAL SKILLS AND AFRICA-FOCUSED PROFESSIONAL SPECIALTIES

African universities: A new agenda

How well Africa harnesses knowledge and innovation will shape its future and the fortunes of younger generations for many decades to come. The AU Agenda 2063 and the African Common Position on the Post-2015 Development Agenda identify STI as key pillars for Africa's progress. As the continent pursues its agenda of "an integrated, prosperous and peaceful Africa driven by its own citizens and representing a dynamic force in the global arena" (AU 2015), success will depend on its accumulating skills and technology for innovation.

Although most African governments recognize the importance of knowledge generation and innovation, the continent still has an acute skills deficit in areas critical for structural transformation. That a significant number of engineers and science graduates are unemployed in Africa further underlines the many facets (including the slow pace of structural transformation) of the mismatch between the demand for and supply of skills. The proliferation since the 1950s of institutions of higher learning and think thanks devoted to addressing the challenges of Africa's development has not greatly narrowed the continent's skills–innovation gap. Nor has it enhanced the employability of the labor force.

Instead, while opportunities for new economic activities and entrepreneurship have expanded in recent years, the skills mismatch has made it impossible, in particular for youth and women, to derive direct benefits from economic growth. Consequently, the relevance of the knowledge proffered by African institutions of higher learning is increasingly being called into question. African countries are well aware that their development hinges on how fast and well they acquire technological competences. But closing the technology and innovation gap in Africa has also been hampered by the lack of coherent national innovation policies (including appropriate regulatory frameworks and incentive regimes), the dearth of strategic public–private partnerships in education and skills development, and too few policies to boost supplies of venture capital.

The importance of soft infrastructure for economic transformation cannot be overstated. For African enterprises to develop and influence the breadth and depth of industrial linkages, they will need skills and technologies to upgrade production processes and identify market opportunities. Similarly, entering global supply and value chains means that African enterprises will need to

upgrade operational competitiveness, meet global technical standards, and adopt world-class manufacturing practices—in many cases these require a level of expertise that is not readily available. Much has been said about Africa capitalizing on its commodities to drive industrialization and structural transformation. Here too, the issue of skills, technology, and innovation is paramount as backward linkage development to the hard commodity sector is particularly demanding of technological capabilities to compete with global suppliers, unlock the potential of newly discovered resources (such as oil and gas) and rely on greener avenues of growth.

The pace of skills and technology development and of innovation has been slow in Africa, mainly because of the absence of a critical mass of university-educated labor, the lack of high-quality laboratories and scientific equipment, paucity of long-term finance, and weak private sector initiatives and managerial capacity. Africa's stock of graduates is still highly skewed toward the humanities and social sciences, while the share of students enrolling in science, technology, engineering, and mathematics averages less than 25 percent (part 1, chapter 2). Moreover, women are underrepresented in science and technology-related courses and professions, meaning that the continent is doubly disadvantaged because it stands to fail to mobilize a huge slice of its human resources in its drive for sustainable and inclusive growth.

Building the necessary skills will require coordinated action by governments and economic actors to develop national innovation systems encompassing continuous investments in education, R&D, structured on-the-job skills development programs, and technical training institutes that are closely linked to industry and emerging technical entrepreneurs. New and strategic partnerships between the public and private sectors and between industries will likely need to be forged at national, subregional, and regional levels to boost the skills and innovation necessary to drive and sustain Africa's economic transformation. Bearing in mind that Africa is seeking to transform at a time of rapid global developments in technology and innovation, governments will also need to devise strategies to harness these shifts to realize the potential of Africa's youth bulge.

Universities are at the heart—and stand at the apex—of higher education; they are rightly regarded as drivers of development (but not in Africa; see part 1, chapter 3). Through their mandates of doing research, teaching, and community service, university staff and students can ideally bring to light new and emerging challenges facing society—poverty, malnutrition, disease, maternal and child health, and so on—and develop new technologies to ameliorate them.

Weakening economic relevance of Africa's universities

Multiple sources contend that African university education is in crisis and in a state of stagnation and irrelevance to Africa's economies, concerning the type of programs offered and graduates produced, and the relationship between universities and society (AAU 2004). This view can be attributed to several factors, including the disinvestment by governments in World Bank structural adjustment programs. In 1995, the World Bank challenged the relevance of university education and suggested that investing in university education has limited returns and thus proposed to governments to increase investment in primary education. Universities were advised to design alternative funding strategies, which led to the commercialization of university education and opened the door to new stakeholders, including the business

community, parents, students, and donors, in addition to government. Demands by these stakeholders steered universities from the function of basic skills development, and greatly affected their performance.

African universities are supposed to be engines of sustainable development. Universities were established principally to aid newly independent states build up their capacity to develop and manage their resources, alleviate the poverty of the majority of the people, and close the gap between these states and the developed world. It is within this framework that politicians and other stakeholders demand "relevance," which has overshadowed universities' role as providers of solutions. Governments demand that universities should produce human resources. Students and parents demand that universities provide education programs that guarantee employment after graduation, while the market (businesses) demands that universities produce graduates that solve their problems without further training. Thus firms no longer focus on general ability but on vocational skills as the basis of employment. Responding to these demands, the higher purpose of universities—conducting research and training researchers—is being skirted.

African universities have also been criticized as ivory towers that churn out graduates and research irrelevant to the needs of employers and the social, economic, and technical challenges facing African economies. There is a growing perception that the knowledge and skills acquired by students at African universities do not meet the requirements of industry and the wider economy. This mismatch, coupled with under-training in the critical skills of problem-solving, analytical thinking, and communication is blamed, at least in part, for the emerging high graduate un- and underemployment in many parts of Africa. There is a need to bring together universities with productive sector representatives to update and upgrade curricula to ensure that students graduate with relevant skills for the workforce. It is increasingly recognized that universities should play a pivotal role in applying research and innovation to address socioeconomic problems and promote innovation for economic growth by forging strategic partnerships with the productive sector of the economy and national innovation systems.

Universities have long been recognized as sources of knowledge creation, innovation, and technological advances Assie-Lumumba (2006). Across the globe, from developed countries in the west to China, Brazil, and other emerging economies, universities are being positioned as strategic assets in innovation and economic competitiveness, and as problem-solvers for socioeconomic issues affecting their countries. In order to fully capitalize on the potential of universities in this aspect, governments and institutions are actively pursuing strategies to strengthen university linkages with industry (and for that matter the productive sector in general), through research and other forms of collaboration. African universities face considerable constraints that affect their internal economies, political environments, and institutional research capacity, yet many of them are taking steps to initiate and accelerate measures to strengthen institutional capacity to support linkages with industry and the broader productive sector. Data, however, are lacking to provide a comprehensive picture of what steps African higher education institutions have already taken and what is needed to provide a more comprehensive platform for promoting, building, and managing synergetic partnerships with that sector.

Globalization and the emergence of the knowledge economy have given rise to new challenges to which many higher education systems are responding. Facing these

challenges, specific knowledge and skills—human capital—play an increasingly important role in development efforts, as do research, innovation, and technological development. Knowledge production, accumulation, transfer, and application have become major factors in socioeconomic development and are increasingly at the core of national development strategies for gaining competitive advantage in the global knowledge economy. Higher education institutions are seen by many as playing a key role in delivering the knowledge requirements for development.

A condition for effective university contributions to development is broad agreement between government, universities, and the main socioeconomic actors over the role of universities in development. As an apex knowledge institution, universities can only participate in the global knowledge economy and make a sustainable contribution to development if their academic core is strong numerically and qualitatively.

For linking universities to development, a country needs to coordinate its knowledge policies, just as the linkage between the larger policy context, universities, and development (including industry—see next section) is crucial. The university's unique contribution to development is via knowledge transmitted to individuals who will join the labor market and contribute to society in many ways (including teaching), and produce and disseminate knowledge that can lead to innovation or be applied to the problems of society and economy (such as research or engagement).

Strengthening university–economy links

In a knowledge economy, tertiary education can help economies keep up or catch up with more technologically advanced societies. Higher education graduates are likely to be more aware of and better able to use new technologies. They are also more likely to develop new tools and skills themselves. Their knowledge can also improve the skills and understanding of non-graduate coworkers, while the greater confidence and know-how inculcated by advanced schooling may generate entrepreneurship, with positive effects on job creation.

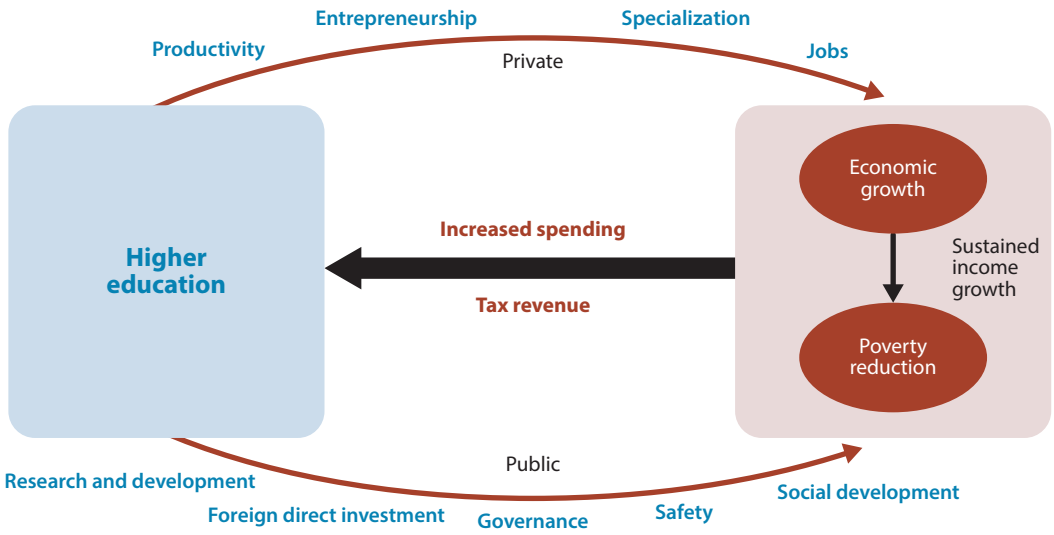
Higher education can lead to economic growth through private and public channels (figure 8.1). The private benefits for individuals are well established and include better employment prospects, higher salaries, and a greater ability to save and invest. These benefits may result in better health and improved quality of life, thus setting off a virtuous spiral in which life expectancy gains enable individuals to work more productively over a longer time, further boosting lifetime earnings. Public benefits are less widely recognized, which explains why many governments neglect tertiary schooling as a vehicle for public investment.

Nevertheless, individual gains can also benefit society as a whole. For example, higher earnings for the well educated raise tax revenue for governments and ease demands on state finances. They also translate into greater consumption, which benefits producers from all educational backgrounds.

The state of university–economy links in Africa

Many countries in Africa lack an enabling environment for reorienting and aligning universities and other higher education institutions toward a more entrepreneurial role. Apart from perhaps the Maghreb region and South Africa, most of Africa lacks high-tech industries and a true technology culture. Many of Africa's industries are often small to medium-scale firms producing for local markets, while the relatively larger ones are

Figure 8.1 Channels of higher education benefiting the economy



Source: ACBF Capacity Team.

subsidiaries of transnational companies, which draw upon in-house R&D. Other constraints include a lack of awareness of research results and new technologies among industry, the absence of strong involvement of users in defining the research agenda, and the irrelevance of some university research.

Despite the challenges inherent in establishing linkages with Africa's economies—especially the productive sector—many African universities are responding to these new roles and expectations. Most of the literature highlights the weak state of current links across the continent and the lack of conducive conditions, but most of these criticisms fail to highlight the ongoing reconceptualization of the role of African universities and the corresponding measures taken to strengthen institutional capacity.[17]

Proposed interventions for improving links

There is a strategic need for African universities to strengthen links with the productive sector, not just for additional funding but also for their products (graduates) to be employed. But for an optimal relationship, attempts must be made to develop interventions to address the issues such as low numbers of qualified faculty, including doctorate degree holders; the brain drain, aging faculty, and other issues associated with staff retention; low enrollment in mathematics, engineering, and other science-related disciplines against large enrollment in social sciences and humanities; inadequate research infrastructure at many universities and lack of access to up-to-date publications; funding constraints; and teaching rather than research-focused mandates. These elements, however, should not be considered as a deterrent to strengthening the relationship with the productive sector, but should be taken into account in devising the best way forward.

University management must develop networks with the productive sector, in the process, creating opportunities to bring

together university faculties and private sector representatives to the same table to help foster and forge stronger linkages, promote clearer understanding of mutual needs and constraints in meeting those needs, and stimulate greater demand on the part of industry. The private sector must also reach out. A strong productive sector requires robust input from universities and other higher education institutions for knowledge generation and skills development of the workforce.

Governments must create a conducive, incentivized environment for strengthening such linkages by putting in place policy frameworks for science and technology strategies, legislation on intellectual property rights, and funding for R&D, among other items. But many governments in Africa have not yet turned their pledges into concrete actions, which could include the following steps:

Funding

- Advocating for increased funding and support for strengthening the capacity of African higher education institutions, so as to develop partnerships and linkages with industry and the broader productive.

- Targeting multiple stakeholders, particularly national governments, private sector entities, and local and international development collaborates for these funds.

Capacity building in skills and policy development

- Supporting training, entrepreneur-in-residence programs, exchanges, and other means to develop entrepreneurial skills among academic staff.

- Building institutional expertise in intellectual property management.

- Supporting institutions to develop and/or strengthen existing strategic plans and develop realistic and implementable action plans.

- Promoting opportunities to learn from African and international higher education institutions with strong histories of engagement with the productive sector.

Science parks and technology incubators

- Supporting their establishment and management for technology transfer.

- Supporting training of faculty in business and management skills to run the parks and incubators.

Higher education curricula and a refocus on indigenous knowledge systems: "Africanization"

The discourse on African higher education that has appeared in the last decade depicts the inappropriateness and irrelevance of curricula introduced during the colonial era. This has led to calls to Africanize higher education, which can be understood as adapting the subject matter and teaching methods to the physical and cultural realities of the African environment. This discourse forms part of the larger, continuing debate on restructuring and transforming higher education institutions.

Refocusing on indigenous knowledge systems

While most of the scholars writing on Africanization seem to agree on what Africanization entails, there are differing views on its practical application. Over the years, the debate has been deliberately associated with the movement for African

Renaissance, a term popularized by former South African president Thabo Mbeki in 1997 that captures his vision of a new wave of cultural and economic development. In a cultural sense, the renaissance is closely tied to the "revalidation" of indigenous knowledge.

Higher education courses in the global south are often taught without due recognition of the historical context and cultural practices of the students enrolling in university courses. The emphasis is usually on the context of the rise of the various disciplines in Europe, dealing with issues that bear little historical relevance or meaning to students.

The new African university, in contrast, must make a strong case for knowledge produced on the continent. Higher education must be made relevant to the material, historical, and social realities of the communities in which universities operate. This can be done by drawing on the philosophical traditions and discourses in these communities for relevant concepts and theories. This forms part of creating a learning environment free of "academic dependency" and ethnocentrism. The call for Africanization is neither advocacy to be anti-west, nor is it discouragement to learn from the west; rather, it is encouragement to learn *from* the west, but in a selective and constructive manner.

As an alternative discourse, Africanization is conscious of the relevance of its surroundings. It will require adaptation and reorganization that will be arduous as professional self-images, academic identities, affiliations, and publication strategies are all at stake. This retooling will also affect teaching and learning, because the dominant perspectives from the global north have become embedded in the graduate programs producing the next generation of academics and scholars.

Africanizing higher education

Africanization of higher education may be considered to encompass changes in four areas: composition of student, academic, and administrator bodies; syllabuses (contents); curricula; and criteria for what constitutes excellent research.

The Pan-Africanist leader, Kwame Nkrumah (1956), alluded to the elements of an Africanized higher education when he stated, "We must in the development of our universities bear in mind that once it has been planted in the African soil it must take root amidst African traditions and cultures." For the African university to be truly relevant to Africa—and the world—it has to be grounded in African communities and cultures (Makgoba & Seepe, 2004: 19)

Given Africa's history of colonial subjugation, the basic idea to Africanize education encapsulating a quest for relevance is plausible; Africanization makes sense not only because curricula are alienating, but also because of past injustices in African societies.

The curricula have been partly blamed for prohibiting African universities from effectively contributing to the sustained socioeconomic development of the continent, a role expected of them by governments. Curricula designed for the post-colonial era have run their course and, to meet the challenges—and achieve the rewards—presented by globalization and to ensure that students make a meaningful contribution to their societies, they must be rethought.

African higher education and its contribution to development

What is the current contribution of Africa's higher education to development?

This contribution is mediated through and has outcomes in four broad areas.

Research. Africa's higher education (AHE) provides the basis for the "big ideas," "evidence base," and "what works" demands of the development sector. Research within higher education generates the knowledge required to address issues like poverty, food security, disease, and climate and environmental change. More than 100,000 foreign experts are employed to address Africa's problems, costing about $4 billion a year, mostly from aid budgets. Much of this expertise could be more efficiently and sustainably provided if resources were redirected to postgraduate training, research, and university capacity building within Africa itself (Hayter, 2015).

Professional and technical education. Training professional engineers, health workers, teachers, public administrators and policy makers, technologists, and scientists whose work is crucial to improving people's lives, is vital. The notion of pro-poor professionalism has also gained a foothold. Teachers, engineers, architects, agronomists, and public sector professions have seen recent initiatives to advance the idea of "developmental" professionalism, responding to critical issues with a focus on social responsibility and ethics.

Democracy and good governance. AHE is important in educating professional public journalists, activists, and intellectuals, promoting social debate, and deepening democracy.

Human development and capability. There is an intrinsic value in AHE and its contribution to making a good society based on humanistic ideals and to fostering capabilities for humans to flourish.

What should the contribution of Africa's higher education be?

An entrepreneurial workforce. A renewed agenda for AHE must focus on skilled human resources, especially in science and technology, for economic growth. Rural development, manufacturing industries, extractive industries, and export-oriented development require skilled workers to produce employable graduates in areas the labor market needs them. Africa has the lowest proportion of global graduates: Though growing, tertiary enrollment stands at only 7 percent, so a considerable increase is required. Employability is a shared concern in developing and advanced economies, but African countries have the highest proportion of young people, coupled with high levels of youth unemployment, including among graduates. (Mohamedbhai, 2013).

Which points to a fundamental dilemma: Africa has a tiny share of the world's graduates, but even as it strives to expand that share, its economies struggle to absorb even the few graduates available. Analysis of the "absorption" problem focuses on whether AHE is doing enough to ensure employability. Perhaps the problem is a gap between how employability is understood by AHE and the kinds of employment actually or potentially there?

Suggested solutions lean heavily toward entrepreneurialism. They advocate less expensive, non-university routes to TVET and the inculcation of soft skills that employers want. They encourage entrepreneurship education, and expect AHE to make itself more open to business and industry by introducing business influences into curricula, employing adjunct faculty from the business sector, and increasing industry placements and contact. The private sector is considered the primary audience and beneficiary of AHE, while the government's responsibility is to subsidize and incentivize that sector.

Good governance and developmental leadership. Some researchers are disappointed with AHE's marginalized role in

promoting democracy, good governance, and developmental leadership. They see it as a missed opportunity to bring AHE's proven influence to bear on wider governance, state-building, and transformative leadership. In Ghana, for example, secondary and higher education contributed to leaders' core values, leadership characteristics, and technical skills (box 8.1). These were directly relevant to several areas of developmental reform: democratic restoration, economic recovery, public sector reforms, and media liberalization. Ghana's improving governance was partly attributed to the cultivation of debate, critical thinking, meritocracy, tolerance, and positive leadership skills, all of which enabled educated leaders to contribute, individually and through developmental coalitions. Skills, values, and networks were required to effect sustained change (Jones, Jones, & Ndaruhutse, 2014).

This example suggests that post-2015 education policy need not be restricted to narrow conceptions of poverty reduction. It could also address formative and strategic aspects of development leadership and good governance. Though STEM is vital for economic development, the essential role of the humanities and social sciences in creating transformative leadership is less well known. The most common subjects studied by Ghana's developmental leaders were law, economics, politics, and journalism.

African citizenship. A broader AHE should educate people to form and interpret ideas that are key to sustainable development, such as social inclusion, equity, ethics, and political contestation; research and analysis conducted within AHE serves to inform and reform social policy and governance. Quality AHE should be conceptualized to offer rich opportunities to develop core values as well as technical skills, and to enable individuals and coalitions to explore political beliefs and activism within their educational experience. Some progressive donors recognize that AHE does more than develop a skilled workforce for economic growth, seeing that a critical mass of researchers and institutes is needed to inform decision makers and the public about trends and issues. In a changing landscape, AHE should also contribute to a critical mass

Box 8.1 Beyond STEM in Ghana

According to the concept of capabilities-based professionalism, professional training for the public good involves developing eight professional capabilities: vision, affiliation, resilience, struggle, emotions, knowledge, imagination and skills, integrity, and confidence.

A study on Ghana looks back on a period characterized by inclusive access to quality education, during Nkrumah's post-colonial government. The key Ghanaian reform coalitions of the 1980s and 1990s had roots in campus networks formed in this earlier period. Most of the leaders in this study were positively affected by educational policies of widening meritocratic access to quality institutions, and this access made Ghanaian elites more meritocratic.

Academic status motivated individuals to join reform coalitions, while academic freedom provided some protection for democratic causes. Educational experiences inculcated key values of public service and national unity, helping to form a consensus for democratization.

Source: Compiled from Jones, Jones, and Ndaruhutse (2014).

of independent-thinking citizens, necessary for knowledge societies to function as open and democratic policies.

The new African university for the Africa we want: Some ways forward

Enabling skills in an open knowledge society

A key role for AHE is to provide enabling (analytical, quantitative, IT, and communication) skills for people to solve the problems of society. But given the conditions of globalized society, these skills need to be developed in a networked and open manner quite different from that practiced within traditional formats and structures. African higher education must foster adaptability and innovation, especially through the capacity for research. Skills acquisition cannot be viewed as neutral and isolated from knowledge content and knowledge intention. The hope is that open higher education can lead to knowledge and skills being applied in ways that will move the whole system toward sustainable development.

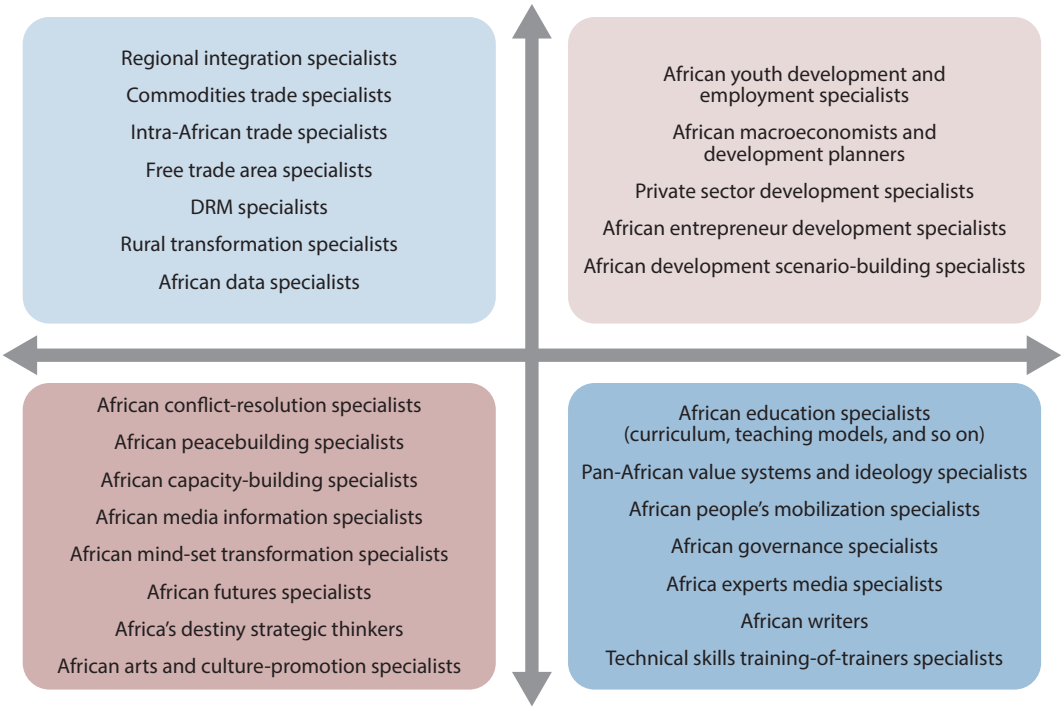
Africa-focused professional specialties

The new African university should develop and provide degree and certificate offerings in a wide range of issues and disciplines urgently needed for Africa (figure 8.2).

Strategic steps for universities

As the pace and complexity of our society increase, there is an urgent need to realign the

Figure 8.2 Indicative list of Africa-focused professional skill areas



Source: ACBF Capacity Team.

design and infrastructure of education with the needs of the people. Universities must break free from outmoded paradigms if they hope to continue contributing to meaningful progress. Some strategic steps include:

- African universities (public and private) should regroup and provide top leadership on reinventing African education and for a new critical technical skills agenda, as a way of helping to enhance implementation of the flagship and other programs. In each region, this could take the form of Agenda 2063 roundtable transformation dialogues on African universities. Initial conversations could be organized by working language groupings, to facilitate matters.

- These dialogues could evolve in concentric circles that progressively become larger to include other key participants, such as policy activators and policy makers, key private sector/industry leaders, and select representatives of the youth and women vibrant networks, as well as top diaspora academic leaders.

- Universities might consider designing and mobilizing funding for an accompanying program, which could be dubbed "building the capacity of capacity builders" in African education.

- Academia and African think tanks should explore initiatives to lay the groundwork of Africa's education on an intergenerational dialogue, bound by our current existential imperative and a new Pan-African ethos and mind-set transformation.

- Universities in Africa must adapt and innovate. Contemporary universities have a responsibility to transcend traditional disciplinary limitations in pursuit of intellectual fusion, and develop a culture of academic enterprise and knowledge entrepreneurship. They must also be prepared to begin delivering higher education at scale —in a manner that bestows status upon universities based upon the outcomes they achieve and their breadth of impact rather than the exclusivity and quality of their incoming freshman class.

- Universities in Africa must embrace their cultural, socioeconomic and physical setting. It is imperative that universities be socially embedded, thereby fostering development through direct engagement. Universities must work creatively and be willing to take risks to become even greater forces of societal transformation.

- Universities in Africa must focus on the individual. They need to foster student success by becoming student-centric—rather than faculty-centric. Successful universities will be those capable of being nimble, anticipatory, imaginative, and reactive. They must provide unique environments that prepare students to be "master thinkers" able to grasp a wide array of skills and become the most adaptable workforce Africa has ever known.

- Universities in Africa must become effective partners for Africa's development. Only through the proliferation of networks between like-minded alliances can transformation occur at the scale immediately needed to advance Africa's knowledge economy. African university communities must open their eyes to this imminent future and transform their thinking to see universities not as self-indulgent "people factories" but as valuable idea generators with vast influence and the potential to manifest technologies and concepts that can change lives the world over.

Demands for cognitive justice

The new African education agenda must put African justice in the spotlight, but can only do

this with "cognitive justice"—an innovative and Africanizing effort to "radically broaden African understanding of whose knowledge counts and how knowledge is used for the benefit of all" (Hall & Tandon 2013).

Africanized AHE calls for a revolution in knowledge, curricula, and relationships between African universities to produce differently relevant African knowledge and learning, by including previously excluded voices, knowledge, and interests. A participatory education approach should underpin the creation of knowledge democracy through new ecologies of knowledge that enable greater cognitive justice. AHE is challenged to be more democratic, creative, and flexible, to fulfill community-based as well as country-specific imperatives, while promoting inclusive, non-discriminatory, confident, and locally owned versions of education and development.

NOTES

1. Hard skills refer to qualifications, skills, and experience. They include technical expertise in the traditional occupational categories such as engineering, ICT, and scientific fields. Soft skills include the attitudinal and predisposition levels of performance (sense of commitment, degree of proactivity, Pan-Africanist passion, and so on) in addition to what we have described as "composite" capacities (policy formulation, strategic planning, program conceptualization and design, implementation programming, coordination, facilitation, and result-based management).

2. The full reference for these documents are listed in the bibliography

3. The full reference for these documents are listed in the bibliography

4. Some 40–80 percent of Africa's regional science and technology innovation publications are with external partners, with the majority in fields of most interest to international donors. Inter-African collaborations account for just 2 percent, 0.9 percent, and 2.9 percent of all East African, West and Central African, and Southern African total research output. Khumbah (2015).

5. Alliance for a Green Revolution in Africa (2013).

6. AfDB, OECD, UNDP, and UNECA (2012).

7. *Higher institution* refers to private and public universities.

8. Kigotho (2014).

9. Kathure and Mbijjiwe (2014).

10. African Union, Definition of the African Union. The AU defines the African continent as having six geographical regions: Central Africa, East Africa, North Africa, South Africa, West Africa, and the diaspora (the sixth region).

11. Kristen (2011).

12. Ibid.

13. Information in this section has been compiled from Wisdom and Korbla (2005).

14. Ibid.

15. Lammers (2009).

16. Zapatero (2015).

17. Homecoming Revolution (2013).

18. Zapatero (2015).

19. For example, the International Institute for Water and Environmental Engineering in Burkina Faso has 27 formal partnerships with companies, has established a technology incubator to help students launch their own innovative businesses, and more than 90 percent of its graduates find employment within six months of completing their studies.

REFERENCES

AAU (Association of African Universities). 2004. Accra, Ghana: Working Group on Higher Education-Association of African Universities.

AfDB (African Development Bank). 2012. *African Economic Outlook: Promoting Youth Employment.* Paris: OECD Publishing.

———. 2014. *Human Capital Strategy: 2014–2018.* Abidjan, Côte d'Ivoire: AfDB.

AfDB, OECD (Organisation for Economic Co-operation and Development), UNDP (United Nations Development Programme), and UNECA (United Nations Economic Commission for Africa). 2008. *Access to Technical and Vocational Education in Africa.* Paris: OECD Publishing.

Ajayi, J., L. Goma, and G. Ampah Johnson (eds.). 1996. *The African Experience with Higher Education.* Oxford: James Currey; Accra, Ghana: Association of African Universities.

Alliance for a Green Revolution in Africa. 2013. *Africa Agriculture Status Report: Focus on Staple Crops.* Nairobi, Kenya: Alliance for a Green Revolution in Africa.

AOSTI (African Observatory of Science, Technology, and Innovation). 2014. *Assessment of Scientific Production in the African Union, 2005–2010.* Malabo, Equatorial Guinea: AOSTI. http://aosti.org/index.php/report/finish/5-report/15-assessment-of-scientific-production-in-the-african-union-2005–2010 (accessed October 30, 2015).

AU (African Union). n.d. Definition of the African Union. http://www.au.int/en/ (accessed October 30, 2015).

———. 2007. *Strategy to Revitalize Technical and Vocational Education and Training (TVET) in Africa.* Addis Ababa, Ethiopia: African Union. http://info.worldbank.org/etools/docs/library/243614/TVET%20Strategy%20in%20Africa.pdf

———. 2014. *Science, Technology, and Innovation Strategy for Africa 2024.* Addis Ababa, Ethiopia: African Union. http://www.hsrc.ac.za/uploads/pageContent/5481/Science,%20Technology%20and%20Innovation%20Strategy%20for%20Africa%20-%20Document.pdf

———. 2015. Vision and Mission. http://www.au.int/en/about/vision

AUC (African Union Commission). 2015a. *Agenda 2063: First Ten-Year Implementation Plan 2013–2023.* Addis Ababa, Ethiopia: African Union.

———. 2015b. *Agenda 2063 Framework Document.* Addis Ababa, Ethiopia: African Union.

Assie-Lumumba, N. T. 2006. *Higher education in Africa: Crises, Reform, and Transformation.* Dakar, Senegal: Council for the Development of Social Science Research in Africa.

Blom, Andreas, G. Lan, and M. Adil. 2016. *Sub-Saharan African Science, Technology, Engineering, and Mathematics Research.* Washington, DC: World Bank.

Cloete, N., T. Bailey, P. Pillay, I. Bunting, and P. Maassen. 2011. *Universities and Economic Development in Africa*. Wynberg, South Africa: Centre for Higher Education Transformation.

Dumont, J., and G. Lemaitre. 2005. "Counting Immigrants and Expatriates in OECD Countries: A New Perspective." OECD Social, Employment, and Migration Working Papers, No. 25. Paris: OECD Publishing.

Dumont, J., G. Spielvogal, and S. Widmaier. 2010. "International Migrants in Developed, Emerging, and Developing Countries: An Extended Profile." OECD Social, Employment, and Migration Working Papers No. 114. Paris: OECD Publishing.

Gau, J., S. Segaller, and P. Sen. 1996. *Triumph of the Nerds.* United States: Public Broadcasting Service. http://www.pbs.org/nerds/tvdes.html

GSM Association. 2014. *State of the Industry: Mobile Financial Services for the Unbanked.* http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2015/03/SOTIR_2014.pdf

Hall, B., and R. Tandon. 2013. "No global justice without global cognitive justice." London: Assocation of Commonwealth Universities. https://beyond2015.acu.ac.uk/submissions/view?id=30

Hayter, E. 2015. "From technical expertise to empowerment: why higher education matters." London: Association of Commonwealth Universities. https://beyond2015.acu.ac.uk/submissions/view?id=133 (accessed July 10, 2015).

Homecoming Revolution. 2013. African Diaspora Statistics. http://homecomingrevolution.com/blog/2013/10/10/african-diaspora-statistic/ (accessed October 30, 2015).

ILO (International Labour Organization). 2010. *A Skilled Workforce for Strong, Sustainable, and Balanced Growth.* Geneva: ILO. https://www.oecd.org/g20/summits/toronto/G20-Skills-Strategy.pdf

———. 2011. *Empowering Africa's Peoples with Decent Work.* Geneva: ILO. http://www.ilo.org/wcmsp5/groups/public/@ed_norm/@relconf/documents/meetingdocument/wcms_161396.pdf

Institution of Engineers Rwanda. 2015. List of Approved Engineers. http://www.engineersrwanda.org/list.php (accessed October 30, 2015).

International Energy Agency. 2014. *Africa Energy Outlook: A Focus on Energy Prospects in Sub-Saharan Africa.* https://www.iea.org/publications/freepublications/publication/WEO2014_AfricaEnergyOutlook.pdf

Jere, T. N. 2011. *The African Science, Technology, and Innovation Indicators Initiative.* Johannesburg, South Africa: New Partnership for Africa's Development. http://euroafrica-ict.org/wp-content/plugins/alcyonis-event-agenda//files/The_African_Science_Technology_and_Innovation_Indicators_Initaitve.pdf

Jones, A., C. Jones, and S. Ndaruhutse. 2014. «Higher Education and Developmental Leadership: The Case of Ghana." Birmingham, UK: The Developmental Leadership Program. http://publications.dlprog.org/Executive%20Summary%20-%20Higher%20Education%20and%20Developmental%20Leadership%20in%20Ghana.pdf

Juma, C., K. Fang, D. Honca, J. Huete-Perez, V. Konde, S. H. Lee, J. Arenas, A. Ivinson, H. Robinson, and S. Singh. 2001. "Global Governance of Technology: Meeting the Needs of Developing Countries." International Journal of Technology Management 22(7/8), 629–55.

Kathure, C., and J. Mbijjiwe. 2014. "Vocational Skills Development for Youths in the Informal Sector of the Economy in Africa." *IOSR Journal of Business and Management* 15(6), 81–87. http://www.iosrjournals.org/iosr-jbm/papers/Vol15-issue6/L01568187.pdf

Khumbah, N. 2015. "STEM Education and African Development." *Pan African Visions.* November 4. http://panafricanvisions.com/2015/stem-education-and-african-development/ (accessed November 10, 2015).

Kigotho, W. 2014. "Universities must share blame for critical skills shortage." *University World News.* March 28. http://www.universityworldnews.com/article.php?story=20140327191835351 (accessed October 30, 2015).

———. 2015. "A continental quest for scientific independence." *University World News.* October 11. http://www.universityworldnews.com/article.php?story=20151009134227394 (accessed October 30, 2015).

Kristen, M. 2011. *African Immigrants in the United States.* Washington, DC: Migration Policy Institute. http://www.migrationinformation.org/USfocus/display.cfm?ID=847 (accessed October 30, 2015).

Lammers, E. 2009. "Bridge Builders." *The Broker.* May 30. http://www.thebrokeronline.eu/Articles/Bridge-builders (accessed October 30, 2015).

Link, A. N., and J. T. Scott. 2003. "U.S. Science Parks: The Diffusion of an Innovation and its Effects on the Academic Missions of

Universities." *International Journal of Industrial Organization* 21(9), 1323–56.

Makgoba, M., and S. Seepe. 2004. "Knowledge and Identity: An African Vision of higher education transformation." In Seepe, S. (ed.), *Towards an African identity of higher education.* Pretoria: Vista University.

McCabe, K. 2011. *African Immigrants in the United States.* Washington, DC: Migration Policy Institute.

Mohamedbhai, G. 2013. Transforming African higher education for graduate employability. Association for Commonwealth Universities. https://beyond2015.acu.ac.uk/submissions/view?id=31

Nkrumah, K. 1956. Opening Address. University College. Accra, Ghana.

Nyasa Times. 2011. "Malawi engineers body elect Mtumbuka as president." *Nyasa Times.* August 29. http://www.nyasatimes.com/2011/08/29/malawi-engineers-body-elect-mtumbuka-as-president/ (accessed October 10, 2015).

OECD. 2012. *Better Skills, Better Jobs, Better Lives: A Strategic Approach to Skills Policies. Paris:* OECD Publishing.

Rasekoala, E. 2015. "Science Communication in a post-2015 World: The nexus of transnational, multidisciplinary and sociocultural contexts." Presentation at the International Science & You Conference, June 2–5, 2015, Nancy, France.

Sawyerr, A. 2002. "Challenges Facing African Universities: Selected Issues." Paper presented at the 45th annual meeting of the African Studies Association. Washington, DC, December 5–8.

Shinn, D. H. 2008. "African Migration and the Brain Drain." Paper presented at the Institute for African Studies and Slovenia Global Action. Ljubljana, Slovenia, June 20. https://sites.google.com/site/davidhshinn/Home/african-migration-and-the-brain-drain

The South African Department of Higher Education and Training. 2009. *Human Resource Development Strategy for South Africa 2012–2030* (as approved, March 18, 2009). Pretoria: Government Printer. http://www.cathsseta.org.za/wp-content/uploads/2013/04/hrds-sa-edited-final.pdf

———. 2014. National Scarce Skills List: Top 100 Occupations in Demand (South African Government Gazette No. 37678, May 23). Pretoria: Government Printer.

Swan, G. 2011. "Addressing the veterinary shortage." *Farmer's Weekly.* November 16. http://www.farmersweekly.co.za/article.aspx?id=10886&h=Addressing-the-veterinary-shortage

Torres, M. A. n.d. "Brain Drain across the Globe: Country Case Studies." http://www.mundus.amu.edu.pl/EHEW2/book/Brain%20drain%20-%20gain%20country%20studies.pdf

UN (United Nations). 2015. *World Population Prospects.* New York: UN. http://esa.un.org/unpd/wpp/publications/files/key_findings_wpp_2015.pdf (accessed October 30, 2015).

UNDESA (United Nations Department of Economic and Social Affairs). 2015. List of African countries by Population (2015). http://statisticstimes.com/population/african-countries-by-population.php (accessed October 30, 2015).

UNESCO (United Nations Educational, Scientific, and Cultural Organization). 2010. *Engineering: Issues Challenges and Opportunities for Development*. Paris: UNESCO.

———. 2013. *Status of TVET in the SADC Region*. Paris: UNESCO.

———. 2015. *UNESCO Science Report Towards 2030.* Paris: UNESCO.

UNESCO Institute for Statistics. 2015. Education and Literacy Rate. Montreal, Canada: UNESCO Institute for Statistics. http://data.uis.unesco.org/Index.aspx?queryid=166 (accessed October 30, 2015).

UN-Habitat (United Nations Human Settlements Programme). 2014. *The State of Planning in Africa: An Overview.* Nairobi, Kenya: UN-Habitat. http://unhabitat.org/the-state-of-planning-in-africa/ (accessed October 30, 2015).

Wilkinson, K., and S. Chiumia. 2014. Factsheet: Africa's population and projections. Paris: AFP Foundation. http://africacheck.org/factsheets/factsheet-africas-population-projections/ (accessed October 30, 2015).

Wisdom, J. T., and P. P. Korbla (eds.). 2005. *The African diaspora in Canada: negotiating identity and belonging*. Calgary, Canada: University of Calgary Press. http://dspace.ucalgary.ca/bitstream/1880/48644/5/UofCPress_African Diaspora_2005.pdf (accessed October 30, 2015).

World Bank. 2011a. *Diaspora for Development in Africa.* Washington, DC: World Bank.

———. 2011b. *Migration and Remittances Factbook 2011.* Second Edition. Washington, DC: World Bank. http://siteresources.worldbank.org/INTLAC/Resources/Factbook2011-Ebook.pdf

———. 2011c. *World Development Indicators.* Washington, DC: World Bank.

———. 2014. *Skills Development in Sub-Saharan Africa.* Washington, DC: World Bank.

World Economic Forum in collaboration with Mercer. 2015. *The Human Capital Report 2015: Employment, Skills, and Human Capital Global Challenge Insight Report.* Cologny, Switzerland: World Economic Forum. http://www3.weforum.org/docs/WEF_Human_Capital_Report_2015.pdf (accessed November 30, 2015).

World Health Organization. 2014. Global Health Workforce Statistics Database. Geneva: World Health Organization.

Zapatero, P. 2015. *The African Diaspora: Introduction to the African Diaspora across the World.* Berlin, Germany: Institute for Cultural Diplomacy. http://www.experience-africa.de/index.php?en_the-african-diaspora

The June 2015 AU Ministerial Retreat of the Executive Council and the Summit in Johannesburg, South Africa emphasized the importance of the capacity dimensions for delivering on Agenda 2063. The Executive Council proposed that the finalized capacity assessment work should highlight the critical skills needed and the role of universities in providing training.

The work on Capacity Dimensions for Agenda 2063 was initiated by the AUC, with close support of the ACBF, which has produced three documents:

- *African Critical Technical Skills: Key Capacity Dimensions Needed for the First 10 Years of Agenda 2063.*
- *Capacity Requirements for the New African Vision: Agenda 2063—"The Africa We Want."*
- *Capacity Development Plan Framework: Buttressing Implementation of the First 10-Year Plan—"The Africa We Want."*

This report focuses on the critical technical skills (CTS) needed to implement the flagship projects and AU priority programs in support of Agenda 2063. Its purpose is to complement the work done in the Capacity Needs Assessment review, by taking a close look at CTS issues slowing progress in the First 10-year Implementation Plan as well as Agenda 2063 overall. It therefore provides an initial framing of CTS, provides an illustrative listing of such skills, and captures information on multiple dimensions tightly linked to CTS.

The report stresses the importance and urgency of identifying and prioritizing CTS for the continent and provides an indicative listing of CTS areas for the First 10-year Implementation Plan.

THE AFRICAN CAPACITY BUILDING FOUNDATION | FONDATION POUR LE RENFORCEMENT DES CAPACITES EN AFRIQUE

2 Fairbairn Drive, Mount Pleasant
Harare, Zimbabwe

Tel: (+263-4) 304663, 304622, 332002, 332014
Cell: +263 772 185 308 - 10
Fax: (+263-4) 792894, 702915,
E-mail: root@acbf-pact.org
web site: www.acbf-pact.org

ISBN: 978-1-77937-063-1
EAN:9781779370631

ISBN 978-1-77937-063-1