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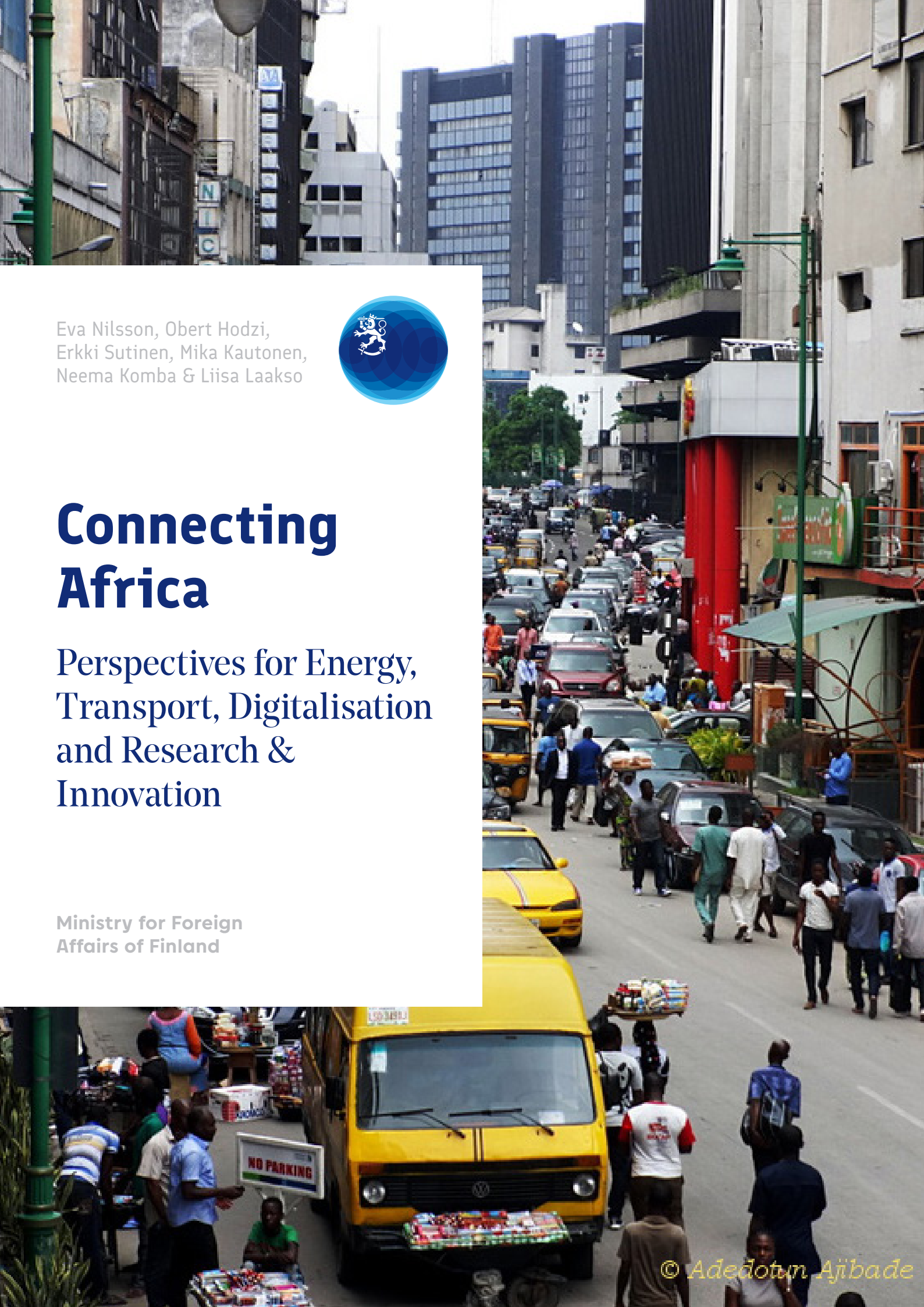
Connecting Africa

Perspectives for Energy, Transport, Digitalisation and Research & Innovation

Ministry for Foreign Affairs of Finland



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Preface

IN 2020, the Ministry for Foreign Affairs of Finland commissioned a development policy related study on Africa's connectivity.

Development policy related studies are not academic research as such. The authors are academically qualified researchers, however, and they base their findings on academic studies. The Ministry for Foreign Affairs chooses authors through a call for proposals organized by UniPID, the Finnish University Partnership for International Development, of the University of Jyväskylä.

The group of researchers chosen to author the current report consisted of Ms. Eva Nilsson, PhD candidate at the Hanken School of Economics, Dr. Obert Hodzi at the University of Liverpool, Ms. Neema Komba, PhD candidate at the Hanken School of Economics, Professor Erkki Sutinen at the University of Turku, Dr. Mika Kautonen at Tampere University and Dr. Liisa Laakso at the Nordic Africa Institute.

The report focuses on Africa's connectivity in the sectors of energy, transport, digitalization and research & innovation. Each chapter includes a summary, an overview of the sector, an overview of the policy and investment environment, and recommendations for Finland and the EU.

These types of reports have an important role in strengthening evidence-based decision-making. Last year the Ministry for Foreign Affairs published two reports on Africa that sparked a lot of interest in the wider public as well. The first deals with political and economic integration in Africa, and the second discusses megatrends in Africa. Similarly to them, the Ministry decided to publish online the current report, Connecting Africa - Perspectives for Digitalization, Energy, Transport and Research & Innovation.

The current Covid-19 pandemic crisis highlights the importance of connecting Africa.

On behalf of the Ministry for Foreign Affairs, I would like to thank the research team and UniPID for an excellent report and commendable cooperation. I hope that this publication on Africa's connectivity finds its way into the hands of an interested readership that can put it to good use.

At the Ministry for Foreign Affairs
on 24 July 2020

Martti Eirola
Senior Adviser on Africa Policy

Contents

Introduction

Obert Hodzi & Eva Nilsson

THIS STUDY ANALYSES the potential of improving connectivity, both in Africa and between Africa and Europe. As societies across the globe depend on flows of goods, services, people and capital, networks that enable these flows – transport, logistics, communications, and electricity networks – have become crucial for the global economy and an essential part of world politics. In addition to physical infrastructure, regulatory frameworks, standards and policies related to connectivity are constantly in the making in all parts of the world, including Africa.

In social science research, connectivity has become synonymous with networks and a common proxy for measuring the intensity of globalisation. Broadly, connectivity describes how different nodes – such as cities, ports and people – are networked physically and virtually (Castells, 2010). Connectivity can be 'formal' or 'informal', the latter encompassing common activities in the informal sector and illegal forms of connectivity, such as illicit financial flows or drug trade (e.g. the Organisation for Economic Co-operation and Development [OECD], 2018). Connectivity, except in its illegal and illicit forms, potentially fosters integration, peace and prosperity.

Connectivity has become a common concept in world politics, especially in relation to Chinese foreign policy and its Belt and Road Initiative (BRI). Europe and Asia have agreed on a common understanding of connectivity which emphasises mutual interests in bringing countries, people and societies closer while narrowing varying gaps in levels of access, development and capacities. In Europe–Asia engagement, the principles of free and open trade, free markets, inclusiveness, fairness, transparency, financial viability, cost-effectiveness and sustainability underpin connectivity (ASEM, 2017).

In this study, we seek to understand how connectivity within Africa and between Africa and the rest of the world has progressed and how it can further improve in an environmentally, economically, fiscally and socially just and sustainable manner. No region can improve its connectivity alone – connectivity encapsulates cooperation and mutual effort, thus, we provide recommendations regarding the role that Finland and Europe can play alongside African countries to enhance their connectivity. We focus on connectivity in the sectors of energy, transport, digitalization, and research and innovation. Our underlying assumption is that greater connectivity is a prerequisite for enhancing Africa's role in the fourth industrial revolution,[1] as well as leading to economic development and prosperity on the continent.

The levels of connectivity in Africa vary. Although some areas – mostly cities such as Johannesburg, Lagos and Mombasa – are globally connected, the overall picture is that, based on global measures, connectivity in sub-Saharan Africa is still low. As the African population is growing quickly, the need for investments to improve connectivity is even more pressing. However, as it stands, current investment levels lag behind population growth. Because of that, for instance, even though internet speed has increased and the cost of access to the internet has decreased, the proportion of people connected to a fixed broadband connection has decreased in Africa. Only about 40 per cent of the population in Africa have access to 4G networks, and the mobile internet penetration was, as of 2018, merely 24 per cent. However, while mobile subscriptions are showing a stabilising trend, fixed connections are on the increase. Undersea cable connections are developing fast and terrestrial cables connect countries to each other better.

Essential to enhancing connectivity is energy supply. In Africa, per capita electricity consumption is rising by 4–6 per cent annually. However, 645 million people still lack access to electricity, and 80 per cent rely on fuelwood and charcoal for domestic heating and cooking. The implication is that Africa is behind other

1 The fourth industrial revolution refers to technology-driven change in which new digital technologies, such as artificial intelligence, become embedded within societies and create entirely new capabilities for people and machines.

regions and, by 2040, an estimated 90 per cent of the global population without access to electricity will be concentrated in sub-Saharan Africa (IEA, 2019). Based on the current levels, it will take sub-Saharan Africa until 2080 for its entire population to have universal access – it would mean considerable investments in energy infrastructure (of about US$43–55 billion annually) to reach universal access by 2040 (UNEP, 2017). Currently, Africa relies heavily on fossil fuels for its energy needs. However, a push to increase Africa's energy connectivity offers great potential to transform the continent's countries into low-carbon economies.

Transport infrastructure is crucial to realising regional integration and the meaningful engagement of Africa within the global production chain. Despite significant investments in road infrastructure, more than half of Africa's roads are unpaved and less than half of the rural population has access to an all-seasons road. In addition, the rail network is either dilapidated or non-existent while Africa's air transport industry is the smallest in the world. The effects of COVID-19 have extinguished prospects of growth in the aviation industry, as had been projected by PricewaterhouseCoopers. Furthermore, reflecting its participation level in the global production and supply chains, Africa has a two per cent share of the global container port traffic. Nonetheless, growth in trade relations with China has led to the construction and refurbishment of port facilities in Djibouti, Mombasa, Dar es Salaam and other regions – significantly connecting Africa with its commodities markets in China and, to a lesser extent, India. In sum, Africa's transport connectivity remains challenging due to the lack of infrastructure, and adequately harmonised and standardised transport policies and regulations.

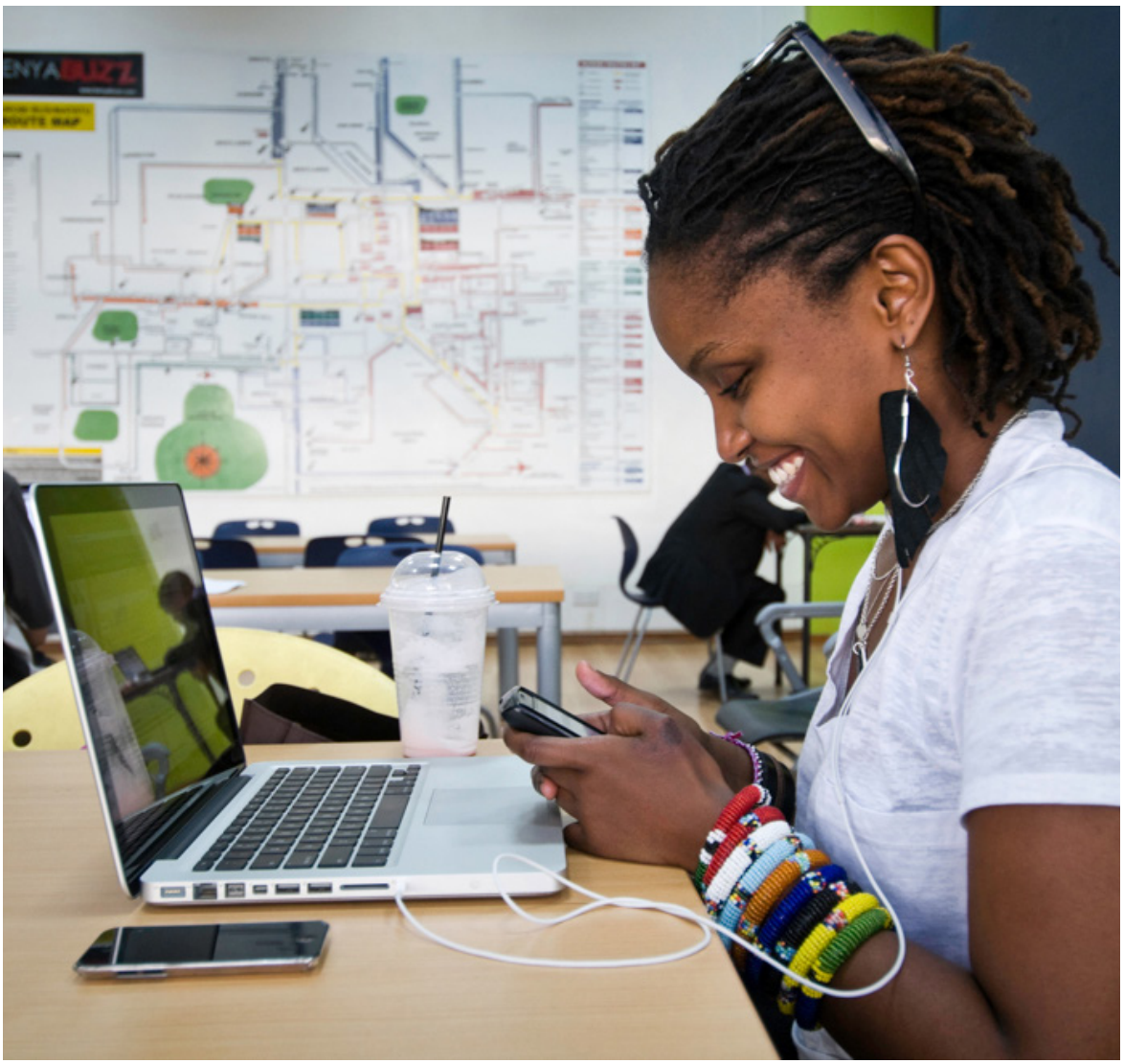
Against this picture, Africa's gross expenditure on research and development (R&D) as a proportion of Gross Domestic Product (GDP) stands at only about 0.5 per cent compared with the world average of 2.2 per cent. Fortunately, the number of higher education institutions (HEIs) has grown rapidly. However, the quality of higher education has not grown in the same pace. The student-to-teacher ratio, research capacity and basic infrastructure are serious concerns all over the continent. While there are a number of graduates from HEIs that become unemployed, there are shortages of skilled labour in the fields of engineering, science, agriculture and health in particular.

A positive trend is that there has been a boom of the start-up culture in several entrepreneurial and innovative hotspots in Africa. In 2010, there were altogether only about USD 20 million venture capital (VC) investments to Africa – nine years later the estimation is that this figure will be as high as USD 1.5 billion. In parallel, there has been a boom of innovation hubs. For these, affordable shared office space, fast internet connections and reliable electricity, which are still in short supply in Africa, are crucial.

The pressure to develop the infrastructure essential to enhancing Africa's connectivity has resulted in some African countries being heavily indebted. African governments have financed over 40 per cent of their own infrastructure needs. They have contracted debt from international debt markets (in particular, Eurobond issuance), domestic markets, multilateral institutions and various countries. According to the World Bank's *Global Economic Prospects*, the average debt-to-GDP ratio in Africa was 61.3 per cent as of 2019. Even with these huge debt burdens, the continent's infrastructure financing gap is approximately US$68–108 billion annually[2] (ICA, 2017). The huge infrastructure gap in the continent means that support from external partners such as the Infrastructure

We focus on connectivity in the sectors of transport, energy, digitalisation, and research and innovation. Our underlying assumption is that greater connectivity is a prerequisite for enhancing Africa's role in the fourth industrial revolution, as well as leading to economic development and prosperity on the continent.

2 Calculations about the financing gap vary. The Infrastructure Consortium of Africa has estimated the gap to in the USD 53–93 billion range and the Brookings Institution has pointed to research that argues that, if public spending on infrastructure was managed better and accompanied by policy and institutional reforms, the financing needs would drop significantly (Devarajan, Gill, & Karakulah, 2019).



IHUB

Youth working at the innovation space iHub in Nairobi, Kenya.

Consortium for Africa members[3] is imperative. For example, in 2019, external partners funded 22.8 per cent of the projects, while most of government-funded projects in Africa relate to transport (55.3%) and energy (20.4%) (Deloitte, 2019, p. 6). In addition, emerging infrastructure development partners, such as China and India, have increasingly provided considerable alternative financing for Africa's infrastructure development.

In particular, China has been Africa's major bilateral lender, external funder and constructor of key infrastructure (such as railways, roads, power plants and ports) in Africa (Coulibaly, Gandhi, & Senbet, 2019). In 2018, China committed US$25.7 billion, which constitutes 26 per cent of the total of US$100.8 billion committed to Africa's infrastructure programmes in 2018. Although this is welcome, there are growing concerns over the increased indebtedness of some African countries and their over-dependence on China. Already, Kenya and Ethiopia have had to request rescheduling of their loans from China. Kenya got Chinese loans to fund the Mombasa–Nairobi Standard Gauge Railway, which cost approximately US$3.3 billion, while Ethiopia got US$4.3 billion for the Addis Ababa Railway. According to media reports, the Chinese embassy in Ethiopia posted on its website in July 2018 that 'the intensifying repayment risks from the Ethiopian government's debt reaching 59 percent of GDP is worrying investors'. Angola owes China about US$21.5 billion, which is half of its external debt. Djibouti owes 59 per cent of its external debt to China. As a result, US senators warned that African countries, such as Djibouti and Zambia, risk losing strategic national assets to China over such un-serviced loans. Although, there is little evidence to suggest that it would be the case, this is a worrying concern.

3 Infrastructure Consortium for Africa members include: Canada, France, Germany, Italy, Japan, the UK, the US, South Africa, the AfDB, the EC, the European Investment Bank, the European Union and the World Bank Group.

Within Africa, geopolitical considerations also affect integration and connectivity between countries.

In response to the debt-trap allegations, China announced that it would adjust its overseas development lending in order that will be more sustainable. However, at the core of this crisis of bilateral debt in Africa is the absence of standard lending practices, particularly between OECD countries and emerging actors like China. Trilateral cooperation between, for instance, the European Union (EU), China and Africa may go a long way in creating uniform working conditions.

Although, both the traditional and emerging development partners agree on the need to enhance Africa's connectivity, their motivations and strategies for achieving that connectivity vary. The World Bank (2019) noted that 'while there is little controversy over the resources that need to be invested in connectivity, there are varying expectations of what connectivity is intended to achieve'. This is partly because connectivity 'influences the distribution of power between the connected parties, be it regions, cities, firms or communities' (World Bank, 2019). The African Union (AU) regards connectivity as essential to continental political and economic integration, and a necessary step to enhancing Africa's role in global governance. On the other hand, China's BRI aims at enhancing China's connection with the rest of the world – to its advantage. Thus, geopolitical and strategic considerations within Africa and between Africa's external partners often underpin connectivity in Africa.

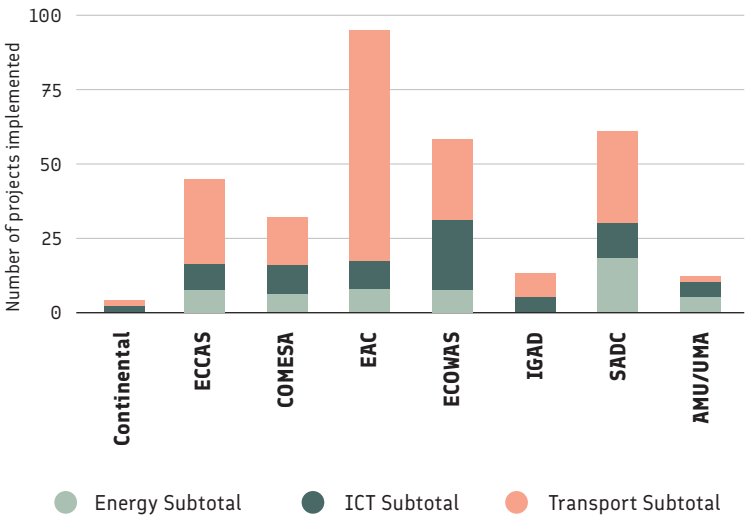
Within Africa, geopolitical considerations also affect integration and connectivity between countries. Support for continental and regional projects seems to be dependent on national interests. Failures to agree on funding and implementation mechanisms also derail critical infrastructure projects, particularly the Trans-African Highway network, a network of transcontinental highway infrastructure development projects connecting African cities, which still has missing links. In addition, despite Africa's energy needs, projects such as Ethiopia's Grand Ethiopian Renaissance Dam, which will be the largest hydroelectric dam in Africa, have stalled due to disputes with Egypt.

At the continental level, the AU is committed to improving connectivity as espoused in Agenda 2063 and through the Programme for Infrastructure Development of Africa (PIDA). PIDA is focused on improving African infrastructure and improving regional interconnectivity. In addition, the African Development Bank (AfDB) is hosting the Infrastructure Investment Consortium, which aims to coordinate efforts made towards improving infrastructure in Africa, and the AFRICA50 investment fund. AFRICA50 funds national and regional projects, mostly energy and transport projects. On the sub-regional level, Africa's Regional Economic Communities (RECs) have some parts of key regional transport and energy corridors missing,

FIGURE 1: REGIONAL AND CONTINENTAL INFRASTRUCTURE PROJECTS BY THE AU 2012–2019.

ECCAS=Economic Community of Central African States, COMESA=Common Market for Eastern and Southern Africa, EAC=East African Community, ECOWAS=Economic Community of West African States, IGAD=Intergovernmental Authority on Development, SADC=Southern African Development Community, AMU/UMA=Arab Maghreb Union

SOURCE: AU-PIDA (2019).



Improved connectivity could have huge development impacts.

hence cross-border energy trade is still very limited. In addition, there are a lack of policies that aim to increase regional connectivity and remove obstacles (such as visa restrictions) in order to enable unhindered cross-border movements by people and goods. Largely, the harmonisation of policies might remain unresolved because the membership of most RECs, especially the Economic Community of Central African States (ECCAS), comprise of low-income and middle-income countries, as well as fragile states and landlocked states – hence they face challenges in accommodating the interests of all parties.

Of all the continents, Africa will probably be the one that is most affected by climate change. Already, floods and droughts have left millions of Africans in financial and food distress. That means transport, energy and digital infrastructure development projects require considerable environmental assessment. This has been a challenge for African states. Environmental and climate change consideration have often come second. For instance, in Kenya, environmentalists have denounced the Mombasa-Nairobi railway for endangering wildlife and their natural habitat. In addition, to meet its energy needs, some African countries remain focused on fossil fuels, with limited transition to sustainable renewable energy (such as solar, wind, thermal and small hydro energy). Ethiopia is a leading example of a country harnessing wind energy to meet its energy needs. Large hydro dams, prioritised across Africa as a source of electrification, have proven to have massive negative environmental and social impacts. As a result, due to limited sources of energy, Africa lags behind the global move toward electric vehicles.

The business environment in Africa is among the world's most cumbersome. Among the bottom 20 economies rated according to the ease of doing business, 12 are in sub-Saharan Africa (World Bank, 2020). The investment and business environment related to connectivity varies from country to country and region to region. Renewable energy markets have, for example, been open to foreign investors in Kenya whereas some countries, such as Ghana, have long-term power purchase agreements (PPAs) with fossil fuel–based independent power producers. The bidding process of many infrastructure projects is less competitive and, according to some analysts, favour Chinese firms (Dezenski, 2020). State officials partly influence the projects from their inception stage. Thus, according to European International Contractors, Chinese firms undercut their competition by at least 20 per cent. They are able to do so because they get subsidies from the Chinese government and considerable preferential treatment from African governments who are keen on maintaining cordial bilateral relations with China.

Furthermore, most of the loans from China have economic conditions tied to them – especially that the materials should be procured in China. Some of the loan conditions attached to Chinese loans are secretive, thus making it even more difficult for open competitive bidding for projects. Beyond the construction of new infrastructure, the focus should also be on the maintenance of the existing infrastructure. For that, Africa has to improve its tax revenues, increase foreign equity investments and improve the sustainability of existing infrastructure. This will reduce the dependence of Africa on bilateral debt from gigantic projects that are unprofitable.

Improved connectivity could have huge development impacts. Access to reliable electricity would change the lives of more than 600 million people who currently lack such access. Better transport infrastructure could improve intra-African trade and lead to domestic manufacturing and more diversified economies. The further development of digital services that also serve low-income earners could have immense impacts on financial inclusion, access to electricity and access to markets, to name but a few impacts. A more connected research and education sector would increase people-to-people exchanges of knowledge and assist mutual learning, equality and partnership building.

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01

ENERGY CONNECTIVITY

Eva Nilsson[1]

1 Eva Nilsson is a PhD candidate at the Hanken School of Economics, Finland. She wishes to thank Joni Karjalainen from Finland Futures Research Centre and Stephen Karekezi, Director of the Energy, Environment and Development Network for Africa, for their insightful comments and suggestions for this chapter.

Summary

THIS CHAPTER DESCRIBES how energy in Africa is generated and how people have access to energy and electricity. It analyses the possibilities for African countries to transform to zero-carbon economies and to reach universal access to electricity.

Africa is rich in energy sources but faces an energy crisis. It produces about nine per cent of the world's oil, six per cent of the world's natural gas and four per cent of the world's coal. It also produces about 18 per cent of the world's uranium for nuclear power. One country, the Democratic Republic of Congo (DRC), provides more than 70 per cent of the world's cobalt for batteries in electronic appliances that are needed for a green energy transition.

While Africa is an important exporter to global energy markets, approximately half of the population in sub-Saharan Africa still lack access to electricity and more than 80 per cent of the population rely on traditional uses of biomass, mainly fuelwood and charcoal, for cooking. Businesses and households that are connected to the grid suffer from its unreliability and regular power cuts.

In all of Africa, fossil energy is by far the largest source for electricity generation and large hydro and natural gas have had most growth in the past years. Despite its huge potential, renewable energy only covers slightly over 20 per cent of the total electricity generation capacity. However, investment into renewable energy is growing fast, especially into solar photovoltaic (PV) energy. Small-scale and off-grid solar solutions have increased rapidly in East Africa and are now expanding to West Africa, with private investors playing a pivotal role. Most of the continent's renewable energy investments take place in South Africa. In addition, Kenya is among the forerunners in having both large-scale and small-scale renewable energy that powers the grid and off-grid areas.

African countries are the main investors in their own infrastructure. The investments are normally financed by loans and, in past years, especially China has emerged as a key lender to African energy infrastructure markets. In addition, other foreign actors – such as the US and multilateral institutions like the African Development Bank (AfDB), the World Bank and the EU – have increased their efforts in building energy infrastructure and reaching universal access to electricity. China operates in many large hydropower projects, the US prioritises natural gas and the EU emphasises renewable energy.

Current understanding of energy connectivity in Africa

THERE ARE LARGE variations in access to electricity across the African continent, between countries and between urban and rural areas. North African countries have achieved universal access to electricity and non-solid cooking fuel. South Africa is the only country in sub-Saharan Africa with rates close to those in North Africa. The lowest levels of access are in rural communities in the Central African region (6%) and several countries across the continent, such as Zambia, Somalia and Liberia, have a rural access rate below five per cent (International Energy Agency [IEA], 2019b).

In sub-Saharan Africa, more than 645 million people lack access to electricity and more than 80 per cent of the population rely on traditional uses of biomass (mainly fuelwood and charcoal) for cooking, drying and heating (IEA, 2019b). The average electricity consumption rate of sub-Saharan Africa, excluding South Africa, is only about 150 KWh/capita per year compared to a global average of 7,000 KWh. Power is inaccessible, unaffordable and unreliable for most people. Only 34 per cent of hospitals have reliable electricity access and about 58 per cent of health facilities have no electricity at all. Human muscle power is the major energy source for agriculture (UNEP, 2017). On average, only 26 per cent of rural communities have access to electricity, while the respective percentage for urban communities is above 70 per cent (IEA, 2019). Worst off are women living in rural areas as they are usually the ones who provide households with energy through gathering fuelwood or paying for energy for cooking, lighting and heating. The poorest households are estimated to spend USD 10 billion annually on charcoal, candles, firewood and kerosene (UNEP, 2017). In addition, the fuelwood or charcoal used for cooking is unsafe and polluting, and has significant health effects, especially on women. Each year approximately 600,000 Africans die of household air pollution (UNEP, 2017).

RUSSELL WATKINS/DEPARTMENT FOR INTERNATIONAL DEVELOPMENT

A shop called Off-grid electric near Arusha, Tanzania.

According to estimates, 90 per cent of the global population without access to electricity will be concentrated in sub-Saharan Africa by 2040 (IEA, 2019), and it will take until 2080 before full access is reached at the current pace (UNEP, 2017). Solving the energy crises therefore requires considerable investments in energy infrastructure. Despite some progress made, current and planned efforts to provide access to energy services barely outpace the fast population growth on the continent. Reaching universal electricity access by 2040 would require tripling the average number of people gaining access every year from around 20 million today to over 60 million people. Against the current $8–9.2 billion, an estimated US$43–55 billion is needed annually in new investment until 2030–2040 in order to meet the total investment needs in the energy sector (UNEP, 2017). The IEA estimates that grid extension and densification would be the least costly option for nearly 45 per cent of the population gaining access by 2030, mini-grids for 30 per cent and stand-alone home systems for about 25 per cent (IEA, 2019a).

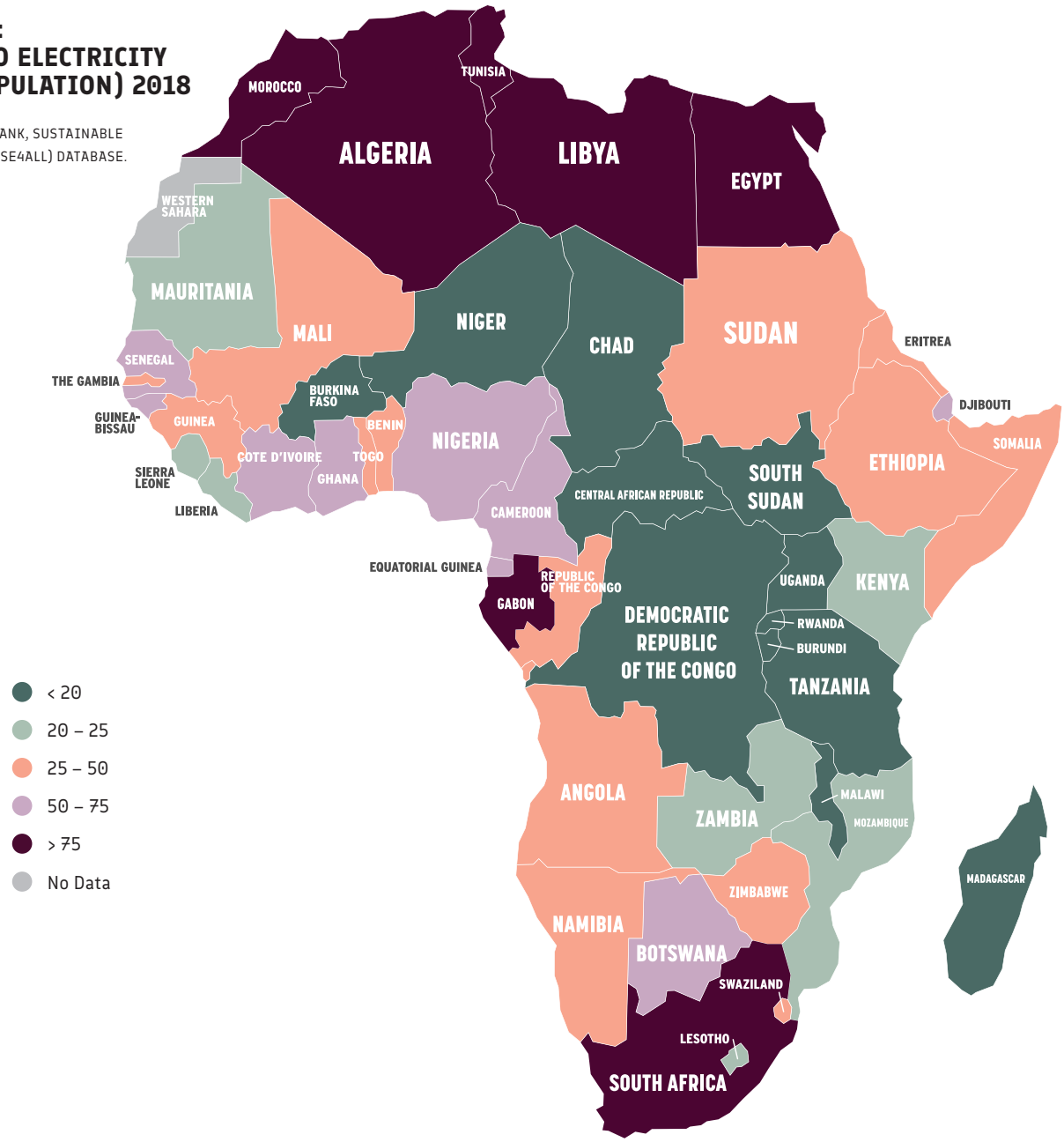
Where grid power is accessible, it is often unreliable**.** More than 30 countries in sub-Saharan Africa experience regular power shortages. Installed grid-based capacity is around 90 GW and, at any one time, as much as one quarter of that capacity is not operational (UNEP, 2017). Electricity is cut about six times per month for about 5.5 hours at a time (Trimble et al., 2016). These shortages could cost African economies 2–4 per cent of GDP annually and more than 70 per cent of businesses in sub-Saharan Africa identify unreliable power as a major constraint for growth (APP, 2015; AfDB, 2015). Due to unreliable electricity, businesses and well-off households own diesel fuel–powered generators. Paying for generator power is a necessary cost of doing business in any sector, ranging from heavy industries to banks and mobile-phone companies. Of the businesses in Kenya and Tanzania, 57 and 42 per cent respectively own their own generations. On average, generator power is at least four times the price of grid power. Because of large energy costs, African markets are uncompetitive with many businesses that operate in other parts of the world (McKinsey & Company, 2015).

Where grid power is accessible, it is often unreliable.

Research also shows that where grid power is accessible, many low-income households still cannot afford to be connected and pay for electricity. Because of this, millions of people in Africa are living 'under the grid', meaning that they could be connected to the main grid but they are not. Only considering Nigeria, Kenya, Tanzania, Ghana and Liberia, 95 million people are estimated to live in under-the-grid areas (Leo et al., 2014). Research shows that reasons behind this are that connection charges are too high, the connection process is long and complicated, poor households have too low-income levels to afford meaningful electricity consumption, income flows are irregular, housing quality is poor and the electricity service is unreliable (Blimpo & Cosgrove-Davies, 2019). Connecting people living under the grid would be a low-hanging fruit in regard to reaching universal energy access.

FIGURE 1:
ACCESS TO ELECTRICITY (% OF POPULATION) 2018

SOURCE: WORLD BANK, SUSTAINABLE ENERGY FOR ALL (SE4ALL) DATABASE.

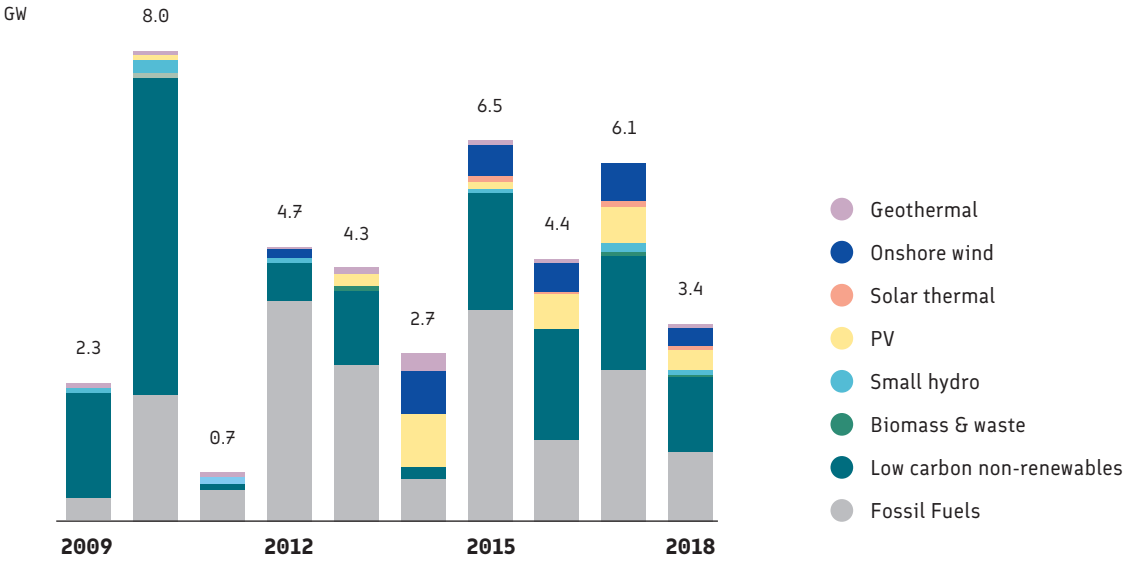


Africa's per capita energy consumption is rising. A significant factor behind the rise of energy consumption is Africa's rapid population growth coupled with rapid urbanisation. Residential demand is growing at a 5.6 per cent annual rate and industrial demand is growing at a 4.1 per cent annual rate (McKinsey & Company, 2015). Fossil energy is by far the largest source for electricity generation (AFREC, 2019). There is steady investment into numerous gas, coal and large hydro projects that are being planned across the continent, and large hydro and gas have seen the most growth in recent years (BNEF, 2020). Within the past decade, large liquefied natural gas discoveries have been made, for example, in Mozambique, Tanzania and Ghana. Coal is heavily present in South Africa, but recently, new plants have been opened in Niger and Senegal. Renewable sources account for about 23 per cent of total installed electricity capacity (Res4Africa, 2018). Calculations about the share of renewable energy vary depending on whether large hydro projects are included or not.

Political will for large hydropower seems evident despite rises in hydropower prices compared to solar and wind energy. The AU's Programme for Infrastructure Development in Africa has identified several dams as priority projects for increasing continental connectivity, of which some are underway and others are being planned. In addition, the AU's Agenda 2063 identified the Grand Inga Dam project on the Congo River as one of its high priorities. This dam, if realised, will be the world's largest hydro power plant.

FIGURE 2: POWER GENERATION CAPACITY ADDITIONS BY SOURCE IN SUB-SAHARAN AFRICA 2009–2018.

SOURCE: BNEF, 2020.



According to research, a 100 per cent renewable energy system is technically and economically a possible and practical solution for sub-Saharan Africa to meet its energy demands (Barasa et al., 2018). Despite the large potential of renewable energy – almost unlimited solar sources (10 TW), abundant hydro sources (350 GW), wind sources (110 GW) and geothermal energy sources (15 GW) – the use of renewable energy other than traditional biomass is still quite limited. In comparison to other emerging markets, sub-Saharan Africa has low levels of renewable energy capacity and commissioning and operating renewable energy is still more costly in Africa than the global average. Some reasons behind this are a lack of enabling environments, political will, currency and default risk, and a lack of access to finance.

However, renewable energy capacity is increasing fast. Currently, South Africa is attracting over 60 per cent of the renewable energy investments coming to sub-Saharan Africa, but the trajectory is also upward in other countries in sub-Saharan Africa (BNEF, 2020). Out of the different sources of renewable energy, solar and wind energy have the most potential due to their constantly falling prices. Prices for solar PV have fallen by around 80 per cent since 2009 while the respective figure for wind is 30–40 per cent (IRENA, 2020b). Whereas the use of wind energy is still very limited in Africa, the use of solar energy has grown fast. The IEA projected that the use of solar PV will grow by more than 3000 per cent between 2018 and 2040 (IEA, 2019).

Off-grid renewable energy capacity in Africa has increased by nearly 360 per cent, from 295 MW to 1.4 GW, during the past decade (IRENA, 2020a). As

The declining costs of solar PV and the simultaneous emergence of pay-as-you-go business models that tap into the widespread availability of mobile phones have been key drivers for growth.

EVA NILSSON

The Ministry of Energy and Minerals in Dar es Salaam, Tanzania.

off-grid power markets are more accessible to companies than on-grid utilities, which are often state owned, the number of renewable energy businesses on the continent has increased. Businesses can make use of pay-as-you-go business models that enable households to make mobile phone–based payments. Pay-as-you-go business models in Africa exemplify the technological convergence of the global megatrends of electrification and digitalisation. Where digital connectivity is available, businesses can, for example, monitor how off-grid systems function and whether payments are made on time.

The declining costs of solar PV and the simultaneous emergence of pay-as-you-go business models that tap into the widespread availability of mobile phones have been key drivers for growth. Off-grid solar energy capacity has rocketed from a tiny 89 MW to 998 MW in ten years. Solar mini-grid capacity has increased, particularly in North Africa (Algeria), whilst solar lights and small solar home system capacity has increased, especially in Eastern Africa, in countries such as Kenya, Tanzania, Uganda and Rwanda (IRENA, 2019, 2020a). In 2019, the fastest increase of solar pay-as-you-go unit sales was seen in West Africa, where many companies are expanding or licensing from East Africa. Solar home systems can be the cheapest power option where power demand is low and households are dispersed.

In addition to household systems, solar powered household appliances – especially TVs and fans – are becoming a major driver of the sector. Globally, most solar powered TVs are sold in East Africa (Lighting Global, 2020). However, solar powered agricultural and productive appliances, such as pumps or refrigeration appliances, are still few. In addition, the uptake of solar off-grid energy by industrial parks, shopping malls, public institutions and other commercial and industrial actors has remained slow despite its potential to substitute for the expensive diesel generators that are used as backups for unreliable grids (Bhamidipati & Gregersen, 2020).

Furthermore, the number of micro-grids is increasing fast globally and research shows that they could now be the best scalable option to solar home systems and grid extension. Currently, the largest share of the world's planned micro-grid investments are in Africa (World Bank, 2019). Many countries require some form of license to set up distributions systems and sell power to customers, but several countries are excluding the smallest projects from certification requirements. Micro-grids are still reliant on subsidies and different results-based financing schemes are entering the field (BNEF, 2020).

Climate change does not only spur renewable energy markets it also has more diverse effects on Africa's energy economy. As a transition towards greener energy production takes place globally, demand for fossil fuels might decrease and cut revenues of African countries exporting oil and gas, such as Nigeria and Angola. In contrast, the demand for minerals that are needed for battery technology in power grids or electric cars, for example, is growing heavily. This means that the cobalt-exporting DRC will see a steady flow of export revenue as the country provides over 60 per cent of the world's cobalt. Other African countries that export minerals that are needed for battery technology are Guinea, Gabon, Mozambique and Madagascar. While current mineral sources will not be enough to cater for the needs in the global battery technology market, the circular economy (i.e. the reuse and recycling of minerals) becomes ever more crucial (Hund et al., 2020). These trends underscore the need for African countries to diversify their economies and to think strategically about the continent's energy future.

Policy and investment environment of energy connectivity

THERE IS AMPLE political commitment to improve energy access in Africa. This commitment is spelled out in continental and Africa-led initiatives aiming for improved energy access and achieving interconnections between national grids. The Program for Infrastructure Development in Africa (PIDA, with its Africa Power Vision (APV), the Africa Renewable Energy Initiative (AREI) by the AU and the New Deal on Energy for Africa (NDEA) by the AfDB are the main drivers of African energy policy and integration.

The AU's and AfDB's energy visions are largely connected around increasing regional energy integration and implementing critical energy projects. Many of these are large hydro power projects. The PIDA programme has identified 15 priority projects, mostly dams and regional transmission lines. These are estimated to cost about US$40 billion (PIDA energy vision, n.d.). In addition, the AU's Agenda 2063 defined the Grand Inga Dam project in the DRC as one of its high priorities.

China is the largest bilateral foreign financier of the African power sector, mainly through loans.

The AREI aims at increasing renewable energy generation capacity by 2030 to 300 GW through promoting socially and environmentally appropriate solar, wind, hydro, biomass, geothermal and marine power. The AfDB has, for example, a Desert to Power Programme that aims to light up and power the Sahel

region by building 10 GW worth of solar systems via public, private, grid and off-grid projects by 2025.

There are five regional power pools in Africa. These are the Central Africa Power Pool (CAPP), the Comité Maghrebin de l'Electricite (COMELEC), the Eastern Africa Power Pool (EAPP), the Southern Africa Power Pool (SAPP) and the West Africa Power Pool (WAPP). Electricity production and consumption is highest in COMELEC, followed by SAPP, EAPP and WAPP. CAPP produces the least electricity. COMELEC is linked to the Middle East and Europe. Cross-border power trade in the power pools is still very limited and mainly takes place within SAPP. In 2014 EAPP and SAPP launched a regional initiative, the Africa Clean Energy Corridor, which promotes renewable energy potential and cross-border electricity trade between the two pools.

Were energy integration to deepen, Africa could save significantly in investments and the cost of electricity. The IEA has estimated that full integration would mean a US$43 billion per year or a 21 per cent saving in the cost of electricity (World Energy Outlook, 2019). However, there are a number of constraints that hinder power pool development and operation in Africa. These include inadequate capacity and reserve margins, difficulties in mobilising investment, low levels of public and private funding, policies that constrain or fail to incentivise investment, regulation that distorts the market, a lack of human resources and a lack of information and data about the energy situation. Regions lack harmonised legislation and compatible grids (UNEP, 2017). Ultimately, it is a question about national priorities and interests. In many countries, power supply plans are nation-centric and state monopolies dominate them. In some cases, regional energy projects can even lead to disputes, as is the case with Ethiopia, Egypt and Sudan in regard to the Grand Renaissance Dam on the Nile.

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On a national level, a combination of enabling policies and investments has put some countries on track to reach universal energy access by 2030. These include, for example, Gabon, Ghana, Kenya and Ethiopia. South Africa, Cape Verde, Ghana, Kenya and Gabon have made significant progress in rural electrification. In these countries, on average at least 40 per cent of rural populations are connected to the grid (UNEP, 2017). Kenya has made significant progress in a transformation towards renewable energy and in 'last mile connectivity', that is, connecting every household within 600 meters of distribution transformers. Renewable energy – wind, solar, hydro and geothermal energy – now accounts for 70 per cent of the installed electricity generation capacity in the country (Res4Africa, 2018).

The majority of African countries have not separated electricity generation, transmission and distribution into separate operating units. However, different national constellations vary. In a study by the World Bank in 2016, 19 countries had complete state monopoly of all three utilities. Only four countries – Ghana, Nigeria, Uganda and Sudan – had unbundled the sector into separate units and had the most developed energy markets. However, these markets were not competitive. The same study estimated that, out of a sample of 39 countries, only Uganda and the Seychelles had financially viable electricity sectors. Only 19 countries covered operating expenditures and several countries lost, on average, US$0.25 per KWh sold. The main reasons for these losses were found to be under-pricing, transmission and distribution costs, bill collection inefficiencies and overstaffing (Trimble et al., 2016).

Many countries have made long-term power purchase agreements (PPAs) with fossil fuel–based independent power producers (IPPs). These can heavily limit governments' ability to diversify their power supply in the short term, increase sovereign debt and hence keep the retail price of power high. Some governments, such as those of Ghana and South Africa, are trying to renegotiate long-term PPAs (BNEF, 2020).

In general, energy policies have been changing slowly. Renewable energy is mainly supported with targets and tax exemptions. Net metering and carbon pricing are limited to just a few countries. In sub-Saharan Africa, 23 countries have implemented import duty and VAT exemptions. Renewable energy feed-in tariffs, which have been popular globally, have been rare in Africa. The recently introduced renewable energy auctions have been more successful in reaching competitive prices. So far, auctions have taken place in 16 countries across the continent. Seven countries have a policy in place but no bids yet. Some auctions, such as those in Senegal and Zambia, have resulted in large-scale renewables projects with some of the world's lowest prices (BNEF, 2020).

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Among the most important supporters of Africa's energy and electricity sectors are China, the US, the EU and multilateral development banks. Other countries, such as India and Russia, remain marginal but have increased their presence in the continent's energy markets. Indian companies are, for example, operating in solar energy and Russia is promoting its nuclear industry in order to gain investments in Africa.

China is the largest bilateral foreign financier of the African power sector, mainly through loans. China has a Global Interconnectedness Initiative, which aims at creating the world's first global electricity grid (Kynge & Hornby, 2018). In 2017 China committed more than US$9 billion to the African power sector while the World Bank, the International Finance Corporation, the EC, the European Investment Bank, the Islamic Investment Bank and Afreximbank, together with all the G8 countries, made commitments of about US$5.8 billion to the sector (ICA, 2018). The extension of national grids is likely to receive the most foreign investments during 2018–2030. Micro-grids will receive the second largest share, followed by solar home systems (BNEF, 2020).

In addition to lending, Chinese companies have been awarded many infrastructure projects through public procurement. In 2019 there were 242 power projects in Africa for which contracts had been awarded for stages ranging from

planning to execution. Of these projects, 63 had Chinese companies as the main contractors (Power Technology, 2019). Chinese contractors operate in many hydropower projects. More than half of the new hydropower capacity will be built by Chinese contractors, followed by coal projects (29.3%) and gas projects (10.7%) (Power Technology, 2019). Nowhere else does China engage as much in the hydropower sector as in Africa (Gallagher, 2019).

While many international lenders are turning away from coal due to climate change, Chinese banks continue to act as last resort lenders for coal plants, also in Africa. China has new coal projects in 10 African countries. Some of these projects involve coal mining in addition to plants (IEEFA, 2019). Despite their engagement in fossil energy, Chinese companies also invest in renewable energy and have been awarded the construction a wind park in Ethiopia, a solar farm in Ghana, a solar power plant in Zimbabwe and the world's largest solar farm in Egypt (Power Technology, 2019).

Financing for renewable energy, excluding large hydro projects, comes mainly from multilateral institutions such as the World Bank, the EU, the UN and the AfDB. Most foreign direct investment into renewable energy comes from European companies. The US is the largest bilateral financer through its Power Africa Initiative (BNEF, 2019, 2020). Although the country prioritises the development of liquefied natural gas (LNG), it also funds solar, wind, biomass and geothermal projects in both grid and off-grid settings. In addition to supporting renewable energy projects, OECD countries share an interest in developing energy market regulation and in liberalising energy markets.

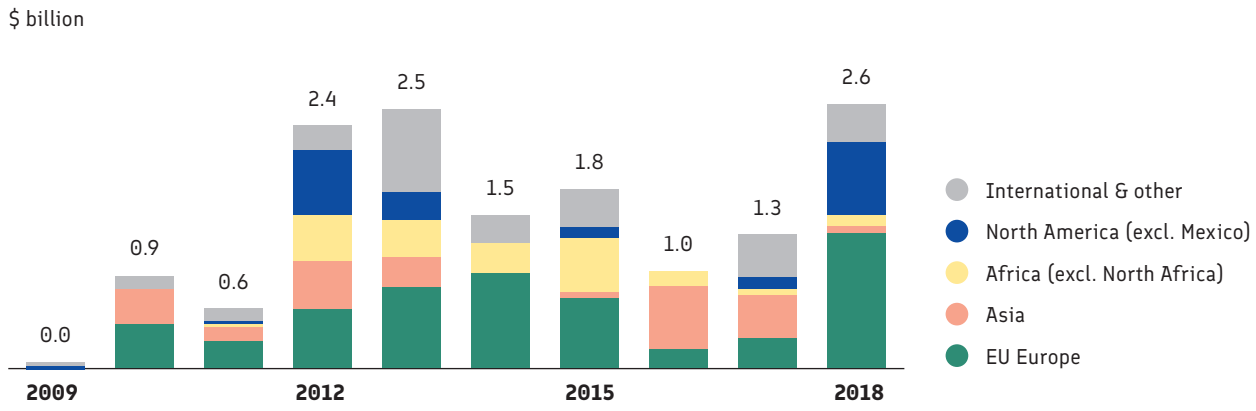
The EU has had an energy partnership with Africa since 2007. The aim of the EU's cooperation has been to enable access to electricity for 30 million people and to add the energy generation capacity of 5 GW (EU, 2018). In its recent strategy with Africa, the EC emphasises cooperation in renewable energy and plans to launch a Green Energy Initiative. The EU wants to see Africa on a low-carbon green growth trajectory that resists new investment in coal power (EU/EEAS, 2020).

While European countries, the US and China are pulling in somewhat different directions in their energy cooperation with Africa, companies from these countries cooperate in different power projects. For example, the US firm General Electric and Power China have been working together in several power projects in Nigeria (Sun, 2018).

On the other hand, Africa has a role in fulfilling China's, the US's, Europe's and other countries' energy needs. Chinese involvement in oil and gas exploration and production in Africa has increased heavily during the 2000s. Currently China receives more than 25 per cent of its oil supply from Africa. China Petroleum & Chemical Corporation Sinopec, China National Petroleum Corporation and China National Offshore Oil Corporation are present in nearly 20 countries in Africa and are estimated to invest over US$15 billion in the continent during 2019–2023. This is more than they invest in any other region in the world (Africa Oil Week, 2019). In contrast, only Nigeria and Libya are among Europe's top ten crude oil import countries, and sub-Saharan African oil exporters have a quite marginal share of the total. Also, the US has shown a decline in Africa's share of its total oil imports.

FIGURE 3: FOREIGN DIRECT INVESTMENT INFLOWS TO RENEWABLES PROJECTS IN SUB-SAHARAN AFRICA BY REGION OF ORIGIN

SOURCE: BNEF, 2020.



Recommendations for Finland and the EU for supporting sustainable energy connectivity

THE DEVELOPMENT IMPACTS of universal access to sustainable and affordable energy are extensive. Reliable electricity generation would support Africa's will to industrialise and to be part of the fourth industrial revolution. The provision of reliable electricity could even spur government legitimacy to collect more tax revenue and increase public funding by creating an implicit fiscal pact between citizens and their governments (Blimpo et al., 2018).

Furthermore, energy is tightly connected to climate change. Although Africa's global share of CO2 emissions is only about three per cent, its energy investments affect and are affected by climate change. On one hand, an energy transformation to renewable energy would cut Africa's CO2 emissions and put the continent on a path towards sustainable economic development. The continent's vast solar resources equal 90–100 million tonnes of oil per year (UNEP, 2017). On the other hand, the heavy energy dependence on fuelwood and charcoal, combined with climate change, creates a vicious circle for households in sub-Saharan Africa. Both are connected to deforestation and vegetation loss, which restrict the access to more fuelwood and charcoal. Droughts caused by climate change can also lead to increased power shortages in regions that depend on hydropower. The driest climate scenarios could entail losses of hydropower revenues of between 5–60 per cent and increases in consumer expenditure on energy of up to three times (Cervigni et al., 2015). The Zambesi river is likely to be worst hit by droughts due to climate change and affect the power supply of Zambia and Zimbabwe (BNEF, 2020).

In light of the current and future understanding of energy connectivity in Africa, this report makes the following recommendations:

- **Connecting people to electricity is crucial.** As technology is developing fast, reliable access to electricity plays a crucial role for inclusion in society. A low hanging fruit for increasing connectivity to electricity could be to support access for the millions of Africans who live under the grid in growing urban areas but cannot, for various reasons, afford to connect. As grids all over Africa remain very unreliable, investing money in connectivity can become a risk not worth taking for many low-income earners. Improving the operation and maintenance of existing and future power plants would tackle large operational losses that currently occur in energy provision. Including a component on long-term maintenance in any new energy investments could deliver significant benefits in terms of improved reliability. Sufficient funding for ongoing maintenance in the long term should be ensured. In addition to grid connectivity, decentralised off-grid solutions can be important for providing access to rural populations and also serve as back-ups for public and commercial actors that suffer from grid unreliability and use diesel-powered generators. Small-scale solutions that operate on mobile and pay-as-you-go platforms could also be broadened to cover devices that generate income and enhance productivity. Examples of such devices are solar pumps and refrigerators.

- **Continued support for a sustainable transformation towards a zero-carbon economy is needed.** The recovery measures of the COVID-19 pandemic could be used for supporting such a transition**.** Research indicates that in the long term, renewable energy is economically and environmentally the best option for fulfilling Africa's energy needs and that its potential in Africa is unlimited. Political will for large-scale hydro energy is strong, but more diversified renewable energy sources – solar, wind, geothermal, biomass sources – would make energy generation in Africa less vulnerable to droughts and avoid the social and ecological destruction caused by dams. Despite the large potential of linking agro-industries and the energy sector together, biomass energy on different scales is still very undeveloped and only limited flows of funds and efforts are flowing to the sector. Mobile platform companies have also yet to engage in the sector. Large-scale agro-based biomass co-generation could increase the productivity and income levels of rural farmers.

- **An energy transformation from fossil fuel use to renewable energy requires commitment, political will, skills and capital from all parties**. A more decentralised approach to energy planning, grid flexibility and the integration of renewable energy technology, both on grid and off grid, are necessary enablers for a green transition to take place. Renewable energy auctions, and in some cases also feed-in-tariffs, can be successful for reaching competitive prices and making important initial steps towards an energy transformation through large-scale renewable energy projects.

- **For an energy transformation to take place, Africans have to have ownership of the process.** Energy investments have to support local institutions, knowledge, markets and private sector development and energy planning has to be done locally. Sufficient knowledge and skills in energy planning, technical modelling and economics are required or else the interventions will remain in the hands of foreign investors, donors and other actors. In many countries, capacity for and skills in renewable energy already exist but are scattered and hence not sufficiently mobilised and operationalised. Universities can play a key role in sustaining skills and knowledge networks on a national level that can support creating long-term energy visions for their countries. Where there is a lack of skills, programmes to support institutional capacity can be useful. Furthermore, financial support for energy investments have to support local companies and entrepreneurs in Africa to grow and expand. This could be done with direct funding to local actors, with joint projects between local and foreign companies, with co-ownership models and with mutual learning in every project.

- **Social and environmental sustainability must be key principles in all energy investments.** Whether energy investments are in fossil fuels or renewable energy, they can have large negative social and environmental impacts. They can spur social opposition and conflicts, and have negative impacts on ecosystems. Large-scale investments that require large areas of land are often met with opposition from the communities who reside on those lands and whose livelihoods are dependent on them. This can also happen in relation to renewable energy investments, such as investments in solar and wind farms, even though they are perceived as otherwise sustainable (e.g. Rignall, 2015). Furthermore, large hydropower dams have caused massive socioeconomic and environmental damages in many parts of the world (Moran et al., 2018). A review of 67 infrastructure projects in Africa show that almost 80 per cent have been delayed due to environmental and social issues. Social opposition and environmental concerns have been more common reasons for project delays than problems related to commercial issues (Res4Africa, 2018). This means that human rights due diligence processes must be put in place and that free, prior and informed consent has to be ensured from the people affected by an investment.

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02

TRANSPORT CONNECTIVITY

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Summary

THIS CHAPTER FOCUSES on the state of transport connectivity in Africa and suggests modes of cooperation to facilitate the achievement of sustainable and climate-friendly transport connectivity between the continent and other regions, and within the continent. In Africa, transport infrastructure has the biggest share of investment from internal and external sources; however, there is still a large gap in both the quality and quantity of transport infrastructure needed to realise Africa's connectivity goals. Therefore, Africa needs to address investment, structural and implementation gaps to enhance connectivity and integration. Among other partners, the EU can leverage its expertise and experience to enhance the sustainability of Africa's connectivity agenda.

There is still a large gap in both the quality and quantity of transport infrastructure needed to realise Africa's connectivity goals.

Current understanding of transport connectivity in Africa

FOR AFRICA, transport connectivity is crucial for the reduction of trade costs, enhancing economic growth and promoting regional integration. To achieve that, the AU estimates that improved infrastructure (including energy, transport and Information and Communications Technology (ICT) infrastructure) will increase intra-African trade from the 15.2 per cent of the period 2015–2017 to 50 per cent by 2045 and Africa's share of global trade will increase from 2 per cent to 12 per cent (UNECA & NEPAD, 2016). Although much has improved in the past two decades, intra-Africa transport connectivity is still low and characterised by missing links. The connectivity between modes of transport and between countries is also poor due to irregular maintenance. The underdeveloped transport infrastructure, non-tariff barriers and inefficiency at customs and border crossings effectively increase transportation costs in Africa by 50–175 per cent compared to other regions. In addition, erratic energy supplies lower Africa's business competitiveness and hamper the electrification of railways and investment in electric vehicles. Accordingly, the interconnection and interoperability of transport remains the biggest obstacle to integration in Africa.

However, there are efforts to increase transnational road corridors to enhance the efficient and secure movement of goods and people across borders and link landlocked countries to maritime ports. Ambitious transport infrastructure programmes, such as PIDA, reflect continental attempts to harness diverse funding modalities and the institutional capacities of regional and international financial institutions, development partners, the private sector and governments in order to boost Africa's transport infrastructure. For instance, in 2018, the AfDB approved funding for 1084 km of transnational roads, and by 2019, the continent had realised about 30 per cent of its overall infrastructure goals. In addition, Africa has made eight per cent

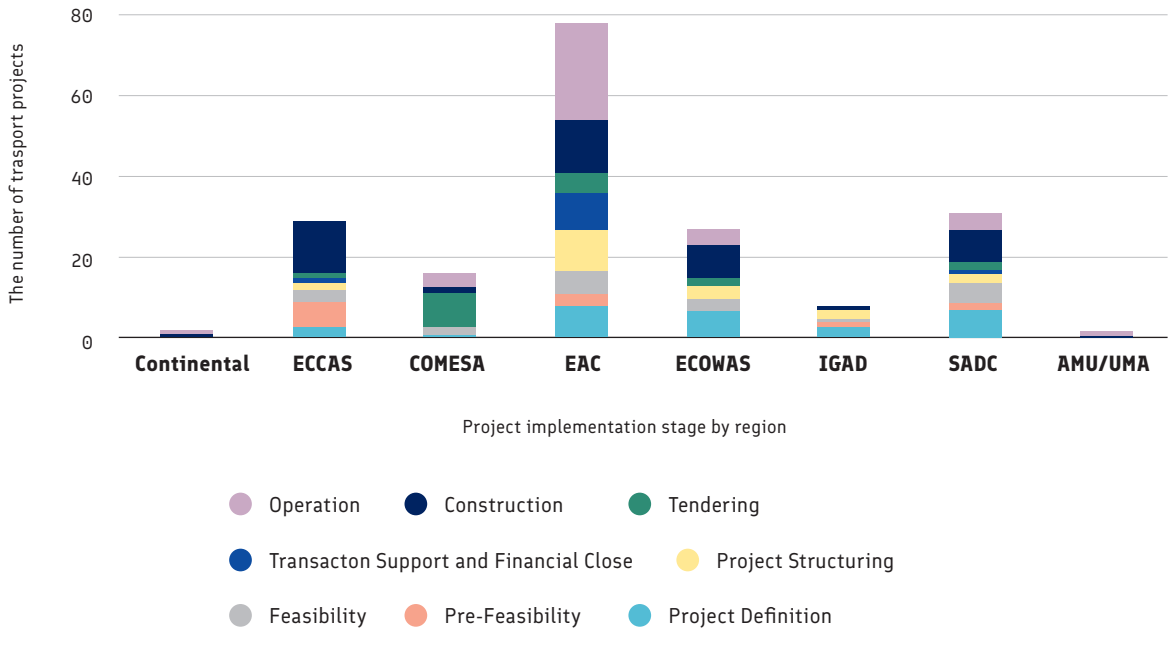
progress in building its high-speed rail network, 16 per cent progress in opening up African skies and 29 per cent progress in building the Trans-African Highway (NEPAD, 2020). The underlying objective is that improved transport connectivity will bolster Africa's industrialisation, tourism development, regional integration and competitiveness.

African countries through the AU and RECs are prioritising transport infrastructure as a facilitator for development and integration. PIDA, which the AU inaugurated in 2012 with the New Partnership for Africa's Development (NEPAD) and AfDB, is the most important continent-wide project. It combines existing and previous continental infrastructure initiatives, such as the NEPAD Short-Term Action Plan, the NEPAD Medium- to Long-Term Strategic Framework and the AU Infrastructure Master Plans, into one coherent programme. According to the AU Commission (2012, p. 1), it 'affords proper weight to the value of local ownership, the necessity of both hard and soft interventions, the need for diverse financing and the importance of sound implementation strategies.' Accordingly, through its Priority Action Plan, PIDA presents actionable infrastructure development projects and programmes that foster regional integration.

So far, the first phase of PIDA (PAP I), which ran from 2012 to 2020, was estimated to cost US$67.9 billion but has so far spent US$81.6 billion. PIDA PAP I consists of 232 transport infrastructure projects which cost US$34 billion in total, 41.7 per cent of the entire PIDA PAP I expenditure. The projects are at different levels of implementation, with 9.3 per cent of the projects at the tendering stage, 23.8 per cent under construction and 19.2 per cent in operation. The second phase (PIDA PAP II) starts from 2021 and runs to 2030, focusing on projects proposed by RECs and member countries. The second phase will use a data-driven multi-infrastructure corridor approach that is more gender inclusive, creates jobs and is climate friendly. The emphasis is on high-capacity and efficient transport corridors that are especially important for the 16 landlocked countries on the continent to connect with each other and the world.

FIG. 1. THE AU'S REGIONAL AND CONTINENTAL TRANSPORT PROJECTS

SOURCE: AU-PIDA, 2019.



Road transport is the most dominant mode of transport in Africa – transporting 80–90 per cent of the continent's passengers and freight traffic.

Road transport

Road transport is the most dominant mode of transport in Africa – transporting 80–90 per cent of the continent's passengers and freight traffic. The AfDB estimates that 53 per cent of roads in Africa are unpaved, less than half of the rural population have access to an all-seasons road and one-fifth of global casualties from road accidents occur in Africa despite it having one of the lowest traffic densities in the world (4.2%). Of the paved roads, most are in bad condition due to the lack of regular maintenance. The World Bank estimates that a US$12 billion investment in maintenance in the 1990s would have saved Africa about US$45 billion in subsequent road reconstruction costs. To increase their maintenance capabilities, 35 African countries created policies enabling the creation of second-generation road funds to oversee maintenance. Nonetheless, 80 per cent of these countries are unable to collect enough levies to meet the minimum financial requirements to perform preventive maintenance in a timely fashion (Kaba & Assaf, 2019).

The quality of African roads, therefore, lags behind other regions. Table 1 below shows the difference in road quality scores.

Within Africa, there are disparities in road access and the quality of roads between countries. For example, Egypt and the Seychelles score over 50 on the AfDB Transport Composite Index, measured as a weighted average of the total paved roads per 10,000 inhabitants and the total road network of exploitable land area. In contrast, Chad scores 0.2 on the index and the DRC, Somalia, Nigeria and Eritrea score below 2 on the index (AfDB, 2020).

With roads dominating African cities, rapid urbanisation and a growing African middle class are resulting in traffic congestion that is worse than in the cities of developing countries that have

TABLE 1: A COMPARISON OF TRANSPORT INFRASTRUCTURE QUALITY

SOURCE: WORLD BANK (2018) AND WORLD ECONOMIC FORUM (2019). SSA = SUB-SAHARAN AFRICA; SA = SOUTH ASIA; MENA = THE MIDDLE EAST AND NORTH AFRICA; LAC = LATIN AMERICA AND THE CARIBBEAN; EAP = EAST ASIA AND PACIFIC

Indicator	Years of comparison	Region				
		SSA	SA	MENA	LAC	EAP
World Economic Forum (Road Quality Score: 0 = worst, 7 = best)	2006	2.4	3.0	4.2	3.1	4.5
	2019	3.7	4.0	4.9	4.0	4.7
Paved roads (% share of paved roads)	1990	17%	45%	54%	18%	58%
	2010	16%	53%	79%	24%	71%

higher private vehicle ownership. For example, in Lagos, Nigeria, road transport accounts for approximately 95 per cent of passenger trips and 12 million trips per day. African urban mobility is therefore the main source of urban air pollution due to the increased use of mostly second-hand imported vehicles with low vehicle emission standards. A 2019 report by UNICEF notes that deaths in Africa from outdoor pollution increased by 60 per cent, from 164,000 in 1990 to about 258,000 in 2017, and is leading to an annual GDP loss of approximately US$215 billion. In addition, only 41 African cities track air quality. Nearly 80 per cent of the vehicle fleet in African countries is imported, and half of the continent has no restrictions on vehicle importations (UNEP, n.d.). Existing vehicle regulatory gaps between developed and developing countries hinder the goal to lower emissions and efforts to curb climate change, thus air pollution–related health complications contribute to increased mortality in Africa. Despite these challenges, road infrastructure receives more investment for new construction and maintenance than other modes of transport.

Rail transport

Rail transport has the greatest potential to increase energy efficiency and minimise greenhouse gas emissions in Africa, but it remains the least developed form of transport (AfDB, 2015). Statistics by the International Union of Railways (UIC) suggest that Africa's global share of rail passenger-kilometres is one per cent, its share of freight (tonne-kilometre) is two per cent and it has a seven per cent of the rail lines and tracks (in terms of length). In total, Africa has approximately '84,000 kilometres of rail track, for a surface of about 30 million square kilometres, and most of it is in Southern and Northern Africa' (AfDB, 2014, p. 51). Of that, only 84 per cent is operational and it is often outdated and characterised by low-speed, inefficient and undercapitalised rail lines.

With the exception of South Africa and Egypt, which have electrified and double-tracked rail networks, the rest of Africa has an inefficient and poor rail infrastructure. Egypt accounts for an estimated 85 per cent of the passengers

The average rail network density for the majority of African countries is between 30 and 50 kilometres per million people, which is far below Europe's average of about 200–1000 kilometres per million people.

EVA NILSSON

A bicycle passes a truck in the mining region in Shinyanga, Tanzania.

carried on the continent while South Africa accounts for most of the freight with upwards of 80 per cent of the total freight transported by rail in Africa. The average rail network density for the majority of African countries is between 30 and 50 kilometres per million people, which is far below Europe's average of about 200–1000 kilometres per million people. In Africa, only South Africa, Gabon and Botswana have more than 400 kilometres per million people.

Cross-border railway connections between African countries are still underdeveloped and mostly non-existent. This is partly because, according to the AU, 'sixteen countries still do not have railway lines or sections of international lines.' Those with national railway networks are not interconnected, except for parts in Eastern, Western and Southern Africa, most notably Burkina Faso – Cote d'Ivoire, Senegal-Mali and the recently completed Ethiopia–Djibouti railway. The Standard Railway Gauge, mostly funded by loans from the China EXIM Bank, will connect Kenya, Rwanda, the DRC, Uganda and South Sudan by the end of 2025. Despite these railway infrastructure developments, what continues to hinder interconnectivity and interoperability is the lack of harmonisation and standardisation of technical standards and specifications, including gauges (metric and standard), which are different across Africa.

Some African countries have introduced railway concession policies to attract private investment, and emerging economic powers like China are granting loans, at the request of African countries, for rail and light rail construction. For example, Chinese loans funded the construction of the light railway in Addis Ababa, Ethiopia, the Abuja–Kaduna railway in Nigeria, the Lobito–Luau railway in Angola, the Nairobi–Mombasa railway in Kenya and the Addis Ababa–Djibouti railway linking Addis Ababa to the port in Djibouti, Djibouti. While the completion of the Nairobi–Mombasa railway and the new Addis Ababa–Djibouti railway is a success, they costed upwards of US$4 billion each. Both are operating below capacity, which forced the two governments to request the Chinese government to reschedule their loans from a 10-year to a 30-year repayment period.

In addition to Chinese loans, private operators now manage over 70 per cent of the railway transport activities, and as of 2019, railway investments significantly increased (World Bank, 2019). Motivations for these projects vary across countries. Recent studies indicate that some political leaders implement the projects with Chinese loans in order to achieve personal political objectives; in Ethiopia, the light rail and the Addis Ababa–Djibouti rail are part of the country's national development plans.

Air transport

Africa's aviation industry has grown relatively stronger over the past decade due to the sustained economic growth that has given rise to rapid urbanisation and an African middle class. Nonetheless, Africa's air transport industry is the smallest in the world, though it has potential to become the next frontier for growth

FIGURE 2: 2019 WORLDWIDE AIR TRAFFIC FLOW

SOURCE: ICAO

(PWC, 2015). World Air Transport Statistics show that, in 2018 (as shown in Fig. 2), Africa's share of the global scheduled passenger and freight traffic was the lowest, at just 2.2 per cent, compared with Latin America's 4.5 per cent and the Middle East's 10.4 per cent. Although the freight volumes carried by African airlines remained stable in 2018, following a 24 per cent growth in 2017, airlines in Africa face a challenging operating environment (WATS, 2019). In addition to the effects of the COVID-19 pandemic, aviation in Africa faces weak and outdated infrastructure that is unable to support growth in passenger and cargo volumes. Most of the infrastructure, such as airports, is managed by government entities or regulatory bodies that discourage private investment, leading to poor connectivity, a lack of liberalisation and high ticket prices (El-Houry, 2019).

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Only five African countries – South Africa, Egypt, Morocco, Algeria and Ethiopia – have achieved between 50 per cent to 64 per cent connectivity, which is a measure of the degree of integration with the global air transport network. Other countries – such as Lesotho, Eswatini, Burundi, the Gambia, Guinea, Benin, Malawi, Chad, Mauritania and Burkina Faso – are the worst connected, with a degree of connectivity ranging from 5.8 per cent to 15 per cent (IATA, 2019). Africa, alongside Asia and South America, presents opportunities for new route development and network expansion for global airlines that may result in lower prices for both passenger and cargo air transport. The International Air Transport Association (IATA) estimates that a one per cent increase in air cargo connectivity can lead to a six per cent increase in trade for a country – mostly through enhanced access to markets, tourism and the flow of human and investment capital across borders.

To improve air transport connectivity, Africa needs efficient airlines and an enabling regulatory environment. To meet the expected annual growth in passenger and cargo traffic of 5.2 per cent for the next two decades, most of the existing 731 airports on the continent need to be modernised. Investment in the aviation sector is much needed, particularly in maintenance and air control technology – for that, African countries need to spend not less than 0.1 per cent of their GDP on airport infrastructure (GIH, 2017). However, because African governments play a dominant role in both airport and airline investment and management, private investments in airports is still rare. Nonetheless, unlike airport infrastructure, airport services across the continent have benefited from the participation of private players, such as Swissport, which operates airport ground services in 42 airports across Africa.

Over 400 airlines from across the world operate in the African aviation industry. European and other foreign carriers account for 70 per cent of current air travel in the continent, resulting in unnecessary routings through Europe and the Middle East, which does not enhance intra-Africa connectivity. In particular, Emirates and Turkish Airlines dominate the African market. South African Airways, Ethiopian Airways and Kenya Airways have the rest of the market share. Smaller private carriers operate domestic routes but without government subsidies and bailouts, they are negligible. Although most airlines in Africa are government owned, public-private investments are emerging. Kenya Airlines and Rwanda Air are examples of such airlines.

To improve air transport connectivity, Africa needs efficient airlines and an enabling regulatory environment.

To enhance air transport connectivity, African governments initiated the Yamoussoukro Decision, which entered into force in 2000. The decision, based on the Yamoussoukro Declaration of 1988, seek to deal with the restrictive and protectionist intra-African regulatory regime based on bilateral air services agreements. By establishing a Single African Air Transport Market, the Yamoussoukro Decision will deepen the African air service market, ease intra-Africa connectivity, increase efficiency, reduce costs and improve tourism. However, the implementation of the decision is slow, and national markets are characterised by protectionist policies that hinder free competition, leaving the African air transport market with disproportionately high airfares, inefficient services and poor intra-African connectivity.

An increase in Africa's trade with China has led to an upsurge in public and private investments in port projects.

The effects of COVID-19 on the continent might further derail implementation of the Yamoussoukro Decision as governments seek to keep their national airlines afloat. The IATA estimates a loss of US$6 billion to African Airlines due to a 51 per cent decline in traffic (IATA, 2020). The World Tourism Organisation, a specialised agency of the UN (UNWTO) estimates a 20–30 per cent decline in international tourism receipts worldwide due to the pandemic. Overall, although improving air transport connectivity is imperative for Africa's growth and integration, it is critical to note that aviation expansion will come with a significant environmental impact, further affecting many countries that are already vulnerable to climate change.

Sea transport

Maritime transport is the key mode of moving freight to and from Africa, but according to PricewaterhouseCoopers (PwC) (2018, p. 2), the expansion of ports and expenditure on port assets is not keeping up with the increase in Africa's foreign trade. In 2018, Africa only had a four per cent share of the global container port traffic, slightly ahead of the Oceania, which had a two per cent share. Africa's paltry share of the global container port traffic reflects its participation level in the global production and supply chains. In terms of percentage share in world tonnage, Africa constituted seven per cent of the total goods loaded and five per cent of the total goods unloaded – the lowest percentage compared to other regions. The most connected ports in Africa are in Egypt, Morocco and South Africa, South Africa being the most dominant – four of the top 10 ports in Southern Africa are in South Africa, namely Durban, Cape Town, Coega and Port Elizabeth (UNITCAD, 2019).

Western Africa has relatively low connectivity due to its geographical position. However, Lomé, Togo, has become the leading hub port in West Africa. The emergence of Togo as an important hub was the result of modernisation reforms and direct services from China, as well as being a result of congestion at the port of Lagos. Djibouti is Africa's leading port in the Red Sea and an important gateway for international trade. Port Louis, Mauritius, is the best-connected port in East Africa because Mombasa and Dar es Salaam have been relatively stagnant due to high congestion. Reforms and investment are required to modernise existing ports, build new ones, encourage competition between ports and improve interconnectedness between ports and hinterland countries.

An increase in Africa's trade with China has led to an upsurge in public and private investments in port projects. Port investments worth US$4.9 billion across 15 countries were recorded in 2019. For instance, the Lekki Deep Sea Port Phase I. Lekki Port, with a 1200 TEU capacity, is expected to become one of the largest deep-water ports in West Africa, changing the dynamics on the continent. However, unlike road transport, foreign investment dominates the revitalisation of Africa's ports (World Bank, 2019). The Bagamoyo Port project in Tanzania, which would have been the biggest in the region, stalled because of unfavourable Chinese conditions for investment – suggesting the complexities of investment in and funding of transport infrastructure in Africa.

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The infrastructure gap on the African continent varies from country to country and within countries. Between countries, the World Bank illustrated that it costs approximately US$625 and on average 12 days to export a container from Egypt but that it costs nine times as much and takes four times as long to transport the same container from the Central African Republic. In terms of road density (km/km^2), sub-Saharan Africa has a road density of 0.14 km/km^2, which is among the lowest of any geographic region. However, within Africa, the disparities in road density per country are glaring. For instance, in 2011, Mauritania had a road density of 1.1 km per 100 km^2 of land compared to Kenya's 27.7 km per 100 km^2.

The Infrastructure Consortium for Africa (ICA)[3] estimates that Africa needs an injection of US$34–47 billion annually to meet the transport infrastructure needs of its growing urbanised population and to meet its economic growth needs. However, there is an annual gap of about US$4–16 billion. Approximately, 80 per cent of the investment goes towards maintenance, while 20 per cent goes toward new projects. Over 50 per cent of national infrastructure budgets go towards transport yearly. The investment gap in African infrastructure is only two per cent of the estimated global need, and it is low in comparison to the investment opportunities in African and global capital markets. With public funds failing to plug the gap in transport infrastructure investment, there is need for strong public investment, private sector involvement and institutional investors, as well as development partners.

The 2030 Agenda for Sustainable Development and the Addis Ababa Action Agenda on Financing for Development, known as the Addis Ababa Action Agenda, underscore the need for increased private sector engagement in the financing and implementation of infrastructure projects in Africa. Among other things, it recognised the need to harness domestic public resources, domestic and international private business and finance, international development cooperation and international trade as engines for development and sources of financing in order to plug Africa's infrastructure gap. To reinforce the local ownership of transport infrastructure, African governments funded 42.1 per cent of the US$62.5 billion allocated for infrastructure development in Africa. The ICA provided nearly 30 per cent of the infrastructure financing in 2016. The rest came from the private sector and bilateral partners such as China.

African governments fund most of the infrastructure from their national budgets. Most do that through issuing Eurobonds in international bond markets in addition to external loans and grants, which account for nearly 90 per cent of their infrastructure budget. For instance, since 2000, China has provided Djibouti with nearly US$1.5 billion in financing for major infrastructure projects including port facilities, a railway and two airports. The Johns Hopkins SAIS China–Africa Research Initiative estimates that from 2000 to 2017, Chinese loans to Africa amount to US$145.7 billion – much of it financing transport infrastructure. This has raised concerns about debt sustainability. According to the World Bank, in sub-Saharan Africa, the average debt-to-GDP ratio increased from 40 per cent in 2010 to 59 per cent in 2018. Furthermore, most of the funding agreements, particularly with China, are secretive and lack transparency. The assessment of funds from ICA[1] members to Africa between 2015 and 2017 has shown that 73.4 per cent of infrastructure investment was debt and only 12.1 per cent was grants. In 2018, the proportion of debt decreased to 70.8 per cent and the proportion of grants decreased to 11.9 per cent.

South Africa is one of the few African countries with eight per cent of its national roads developed and managed by private parties on thirty-year terms. The private parties build the roads, manage them and collect tolls for the duration of the term, then handover the roads to the government-owned South African National Roads Agency SOC Limited. Despite there being potential for private sector investment in transport infrastructure, the lack of appropriate policy, legal and regulatory frameworks inhibit the financing of transboundary infrastructure projects. Nonetheless, PwC suggest that sub-Saharan Africa has the fastest growing regional infrastructure market with a projected increase in transport spending of over 11 per cent per year from 2015 to 2025. However, despite the high demand

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3 The ICA is a consortium launched at the G8 Gleneagles Summit in 2005 in order to facilitate the financing of infrastructure projects and programmes in Africa. Members include the G8 countries, South Africa, multilateral agencies (World Bank, International Financial Corporation, European Commission, European Investment Bank, Islamic Development Bank, Afreximbank), African institutions (Africa Development Bank, Development Bank of Southern Africa, West African Development Bank, the African Union Commission, UN Economic Commission for Africa, African Union Development Agency- New Partnership for Africa's Development).

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Light trail vehicle in Addis Ababa.

for private capital to fund Africa's public infrastructure, the lack of bankable and financially viable projects mean that the infrastructure gap persists.

The AfDB is central to financing transport infrastructure in Africa. For instance, it initiated the African Infrastructure Investment Fund (AIIF), now in Phase 3. Phase 3 of AIIF (AIIF3) is an equity vehicle with a fund size of US$750 million. Between 2004 and 2018, the AfDB injected US$8 billion in transport and urban development in Africa. It financed 12,700 km of regional highway roads on 17 road corridors and built 26 One-Stop Border Post (OSBP) facilities. While public funds are the dominant source of infrastructure investment, African countries face several challenges in collecting and spending public funds. Africa's failure to collect domestic revenue efficiently stems from its inability to tax the informal economy, inefficiencies in revenue collection and leakages of potential revenue due to endemic corruption. The informal economy is sub-Saharan Africa is, on average, 40 per cent of GDP. In countries like Tanzania, Benin and Nigeria, it can be 50–65 per cent (Medina, Jonelis, & Cangul, 2017).

While public funds are the dominant source of infrastructure investment, African countries face several challenges in collecting and spending public funds.

Recently, there is increasing diversity in infrastructure funding sources for the continent, which potentially empowers African governments to determine the nature of infrastructure investment they need and the terms thereof. Overseas development aid from multilateral development banks and bilateral agreements, individual African governments and bilateral partners such as China are the main sources of infrastructure funding. India and Turkey are also supporting infrastructure investments in Africa through loans and grants. For instance, India provided US$513 million for transport projects in Africa – most of it being loans and grants from the Export–Import Bank of India. In addition, India has used Buyer's Credit under the Government of India's Buyer's Credit - National Export Insurance Account (BC-NEIA) programme to support transport infrastructure development in Africa. In 2018,

India provided about US$1.25 billion for projects such as the Tema–Akosombo railway line construction in Ghana; Lusaka City Decongestion Project in Zambia; the supply of buses to Côte d'Ivoire, Senegal and Tanzania; and the supply of vehicles and spares to Côte d'Ivoire, Tanzania and Zimbabwe (Export–Import Bank of India, 2018).

Stakeholders – such as the AfDB, the AU, and other regional and global bodies – have been instrumental in the conception and de-risking of new funding mechanisms for infrastructure projects such as guarantee schemes that enable public-private partnerships and co-investment schemes with Multilateral Development Banks (MDB). A number of key players, such as the ICA, established a Project Preparation Facilities Network in order to increase the capacity of countries to present infrastructure projects. Nonetheless, the emphasis has been on seeking funding for individual projects. Not enough efforts are directed toward creating a market-based platform for raising sustainable project funding from global players.

In 2013, the AfDB issued the first green bond and it has to date floated eight more to support climate-friendly projects in Africa. Other players, such as the Industrial Development Corporation (IDC) and Nedbank, have issued green bonds in South Africa. The AfDB's green bonds financed clean transportation infrastructure – such as the expansion of railways in South Africa, Morocco and Senegal – as well as building the rapid bus transit in Dar es Salaam, Tanzania. The UK funded Financial Sector Deepening Africa (FSD Africa) works with African financial institutions to build their capacity to develop ecosystems for green bond financing. However, there is need to increase sustainable financing platforms and mechanisms. The anticipated COVID-induced contraction or slowdown of the global economy will likely lead to a decline in tax revenue, official development assistance (ODA), foreign direct investment (FDI), portfolio investment inflows and remittance flows to Africa.

OECD countries have advocated Aid for Trade as a more holistic mechanism to create an enabling environment for infrastructure investment and attract private sector financing in Africa. Africa's biggest five Aid for Trade donors are the World Bank, the EU (EU) institutions, Germany, the AfDB and Japan. 'The sectoral breakdown of Aid for Trade disbursements to Africa – economic infrastructure funding is distributed evenly between transport and storage (26 per cent of total) and energy (27 per cent). Over 71 per cent of the funds towards transport go into road transport, while around 10 percent for rail transport, with water and air transport receiving around 5 per cent each' (ECA & WTO, 2017, p. 9). In that respect, Aid for Trade has become an important source of support to African countries in the development of not just their transport infrastructure but also their trade and productive capacity. However, to ensure that it supports Africa's development in a sustainable and efficient manner, it has to be aligned to Africa's development priorities. It has also built the capacity of African governments to develop infrastructural projects that donors can successfully consider.

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Africa has the potential to adopt more sustainable and environmentally friendly modes of transportation. In March 2018, during Africa Clean Mobility Week, 42 African governments, the East African Community (EAC) and the Economic Community of West African States (ECOWAS) agreed to integrate sustainable transport policies into their wider transport agenda. The agenda included promoting the import of cleaner, more fuel-efficient vehicles; promoting electric mobility in the region; creating mechanisms to regulate the import of clean, used vehicles; and the overall planning and financing of non-motorised transport and public transport in the region (UNEP, 2018). Zero-emission electric buses have been operating in Marrakesh, Morocco, since 2017 and in Cairo, Egypt, since 2019. In both countries, Chinese firms, such as Shanghai Wanxiang Automobile and Yangtze, supplied the electric buses – making China the leading supplier of electric public transport buses in Africa.

Electric vehicles are still a rarity in Africa. However, there are opportunities for electrified two- and three-wheeler taxis, which are common in African cities. Potentially, they may attract private investors better due their cost-saving impact. Micro-mobility also presents investment potential in Africa. Generally, African mobility services are increasingly digitising – by 2024, 60 per cent of the services will be online (Statista, 2020). Earnings from ride hailing and taxi services are set to increase as global ride sharing companies, such as Uber and Bolt, add options to use small cars, minivans, auto rickshaws and motorcycles. A few local ride-hailing companies compete with global giants or apply the technology in other ways. For example, in Nigeria, a new social enterprise, HELLO TRACTOR, offers small-scale farmers a platform to request and pay for tractor services from tractor owners via SMS and paying with mobile money.

Not enough efforts are directed toward creating a market-based platform for raising sustainable project funding from global players.

The policy and investment environment of transport connectivity

TO ENHANCE TRANSPORT connectivity, Africa needs a robust and harmonised state, regional and continental transport regulatory and institutional framework. At present, transport policies and regulatory environments in Africa are weak and fragmented, thus constraining transport connectivity far more than the poor transport infrastructure. For instance, African governments have not implemented several sub-regional agreements relating to the construction, funding and operation of the Trans-Africa Highway network despite agreeing to them. This is partly due to no mechanisms for enforcing compliance and an absence of a secretariat to oversee the programme's implementation. RECs also lack enforcement or compliance enforcement capacities. Furthermore, RECs often alter the original plans of the Trans-Africa Highway to suit their economic and social interests, and most importantly, the political interests of their member states. In part, there seem to be a conflict of interest between member states, RECs and regional organisations such as the AU, hence most states revert to bilateral and national regulations.

In addition, because governments ultimately fund regional and sub-regional transport infrastructure projects, they consider issues relating to such projects as matters of national interest. National projects prevail over regional or international ones. Governments often assent

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Three-wheeler taxis are waiting for passengers in front of a shopping centre in Dar es Salaam, Tanzania.

to the technical requirements of the regional projects but act unilaterally on the implementation of the projects. The result is unequal implementation of regional transport infrastructure projects, which inhibits efforts toward transport connectivity and regional integration.

To harmonise and standardise regulations, frameworks, standards and policies, RECs need to play a central role because they are in close contact with their member states. RECs, such as the Southern African Development Community (SADC), have tried to balance regional and national interests as well as foster the harmonisation of transport regulations, such as the standardisation of axle widths, ton size, road shoulders and signage. With the help of THE United Nations Environment Programme (UNEP), 15 ECOWAS member countries are heading towards a low-emission future with the harmonisation and standardisation of fuel and vehicle standards. Apart from SADC and ECOWAS, other RECs are still a long way from the harmonisation of regulations and transport policies.

The harmonisation of policies and regulatory frameworks should extend to supporting infrastructures, such as those related to customs and border crossings. Across Africa, countries apply varied border and customs rules and procedures, which leads to processing delays at borders and a lack of uniformity of immigration and customs documents. To deal with these challenges, the AfDB is supporting OSBPs in Africa to enhance efficiency, reduce waiting periods and lower logistics costs. For instance, the OSBP at the Chirundu Border Post between Zimbabwe and Zambia reduced the travel time across the border by a day or more (from five days to four days). Now, according to the AU-PIDA website, there are approximately 76 OSBPs at various stages of development in Africa. In addition, NEPAD and ECA are developing a framework to harmonise policies, laws and regulations related to infrastructure investment.

Furthermore, African countries have struggled to attract private sector investment in transport infrastructure due to lack of clarity on legislation, the enforcement of commercial law and transparency in procurement. 'The absence of enabling legislation and regulations, a lack of local skills and a poor understanding of public–private partnership (PPP) risk allocation are all bottlenecks currently preventing many countries from fully unlocking private sector interest, particularly on regional projects' (AUC et al., 2012, p. 7). Accordingly, soft projects – such as supporting the harmonisation of transport procedures and regulations, the better management of cross-border infrastructures (such as customs clearance) and the capacity building of authorities in specific transport sectors – can potentially reduce transit costs, increase cross-border trade and enhance productivity.

Recommendations for Finland and the EU related to supporting transport connectivity

FINLAND AND THE EU can support Africa in achieving its connectivity goals, involving itself, the EU and the rest of the world in a financially, socially and environmentally sustainable manner. The recommendations are the following:

– **Support a connectivity agenda that promotes African regional integration**. This can be done by providing direct support to African connectivity priorities. Of importance is the **Action Plan for Boosting Intra-African Trade,** which was adopted by the Assembly of the Heads of State and Government of the African Union in January 2012, sets eight priorities for Africa, namely, trade policy, trade facilitation, productive capacity clusters, trade-related infrastructure, trade finance, trade information and factor-market integration. Under *trade-related infrastructure,* the **Action Plan** sets to undertake the following activities: (1) implementing PIDA, (2) mobilising resources for multi-country projects, (3) creating an enabling environment for private sector participation and (4) developing innovative mechanisms (such as legal and financial mechanisms) for multi-country projects. External support to RECs and governments to develop innovative legal, financial and other mechanisms for multi-country infrastructure and industrial projects, as well as to manage these projects from inception to operation, is essential. In

Collaborate with key stakeholders – such as the AfDB, AU and regional financial institutions – to encourage the development of market-driven modes of financing

addition, providing technical support for the standardisation and harmonisation of resource mobilisation policies and transport regulatory frameworks, which remain fragmented across African regions, can be fruitful. The expansion of the Trans-European Transport Network (TEN-T) into North Africa provides a suitable pilot for enhanced EU-Africa cooperation on transport and connectivity.

- **Promote financial sustainability in addressing the transport infrastructure investment gap.** To develop models for cooperation with Africa regarding transport infrastructure development, there is need to align the interests of the private sector and external stakeholders (such as the EU and Finland) in regard to Africa's regional and sub-regional transport infrastructure goals. The EU's external investment plan and the Africa–EU Alliance's already focus on boosting strategic investment and strengthening the role of the private sector, as well as focussing on investment in economic integration and trade, in order to provide an essential foundation for strengthening the EU's cooperation with Africa in regard to infrastructure development. In particular, building the capacity of Africa to diversify infrastructure funding through public–private partnerships is important.
- **Collaborate with key stakeholders – such as the AfDB, AU and regional financial institutions – to encourage the development of market-driven modes of financing** that will make infrastructure financing more transparent, efficient, competitive and secure. This may involve building the pan-African capital market capabilities in order to raise funds for infrastructure in which continental Africa, the diaspora, the EU, China, the US and others can participate openly.
- **Encourage Africa's transition towards clean and sustainable mobility.** Leveraging the EU's leadership and influence in order to push the global agenda and discussion on clean fuel- and fuel-efficient used car imports in order to challenge the status quo and make strides in following the Paris Agreement. Europe and North Africa are already cooperating on green hydrogen projects and expanding gas infrastructure and storage for hydrogen transport – the expansion of these initiatives to sub-Saharan Africa will not only be essential for enhancing the transition to clean energy but will also have the potential for addressing Africa's energy deficit. Europe could leverage its experience and expertise in urban development and become an important partner to Africa in urban mobility. Finally, supporting private sector involvement and partnership in sustainable mobility and climate change resilience, especially support in sensitising local innovations and solutions for climate-related problems, is important.

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03

DIGITAL CONNECTIVITY

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Summary

DIGITAL CONNECTIVITY refers to the infrastructure and services that transform society by fast and reliable access to people, data and the internet of things. While the growing and young population of Africa poses a demand for digital connectivity, the base of society has remained largely unconnected for reasons such as pricing and irrelevant services. Finland, as a part of the EU, should focus its contribution on enhancing digital entrepreneurship, innovation and skills that empower Africans to use and co-design open digital services that foster their inclusive growth for their own good, livelihood, and employment. Based on its own experience, expertise and narrative in digital connectivity, Finland can act beyond its actual size, together with African partners co-building digital success stories, champions and models to be scaled up and mainstreamed regionally in line with the global strategies of the African Union, the World Bank, the EU, and the UN.

Finland can act beyond its actual size, together with African partners co-building digital success stories, champions and models to be scaled up and mainstreamed regionally in line with the global strategies.

Current understanding of digital connectivity in Africa

DIGITAL CONNECTIVITY combines the three processes of digitisation, digitalisation and digital transformation. Digitisation represents data and related services in a digital form, digitalisation integrates or connects the data and services into everyday life, and digital transformation refers to the way that individuals' lives and societies get transformed by the means of digital connectivity. Besides connectivity, referring to the access of data by people and things, all the three aspects require advanced computational solutions, provided by data science, machine learning, artificial intelligence and the internet of things. In order to benefit people and make a positive difference at the grassroots of society, the three processes also need culturally relevant interaction design.

The current state of digital connectivity in Africa can be portrayed from diverse perspectives. Box 1 illustrates the situation by the figures of mobile connectivity, based on the most recent report of the GSM Association (GSMA, 2019).

Digital connectivity combines the three processes of digitisation, digitalisation and digital transformation.

DIGITAL CONNECTIVITY IN SUB-SAHARAN AFRICA: KEY FIGURES

Mobile coverage. Seventy per cent of the population in sub-Saharan Africa were covered by a 3G network in 2018 (52% in 2014). The coverage of 4G increased from 9 per cent in 2014 to 34 per cent in 2018. In the Middle East and North Africa, the 3G coverage increased from 65 per cent in 2014 to 88 per cent in 2018, and 4G increased from 2 per cent to 58 per cent in the same time period. However, 150 million people in sub-Saharan African still lack even 2G coverage.

Mobile internet connections. The mobile internet penetration reached 24 per cent of the population in sub-Saharan Africa by 2018 (worldwide 47%). However, while 30 per cent (worldwide: 10%) of the population in sub-Saharan Africa were outside the reach of a mobile broadband network, 46 per cent (worldwide: 43%) of the population could access a mobile broadband network but were not using it. In the Middle East and North Africa, the numbers were 40 per cent, 11 per cent and 49 per cent respectively.

Barriers for mobile internet use: factors and gaps within population. In Africa, the main factors hindering the use of mobile internet were lacking literacy and digital skills (34%), affordability (30%) and relevance (13%). The *rural gap*[2] in sub-Saharan Africa is the highest in the world; however, it decreased from 65 per cent in 2014 to 58 per cent in 2018 (in the Middle East and North Africa it decreased from 39% to 36%; globally, it decreased from 46% to 40%). The *gender gap*[3] in sub-Saharan Africa increased from 40 per cent in 2017 to 41 per cent in 2018 (in the Middle East and North Africa it decreased from 19% to 20%; the decrease in South Asia was from 67% to 58%; globally, it decreased from 5% to 4%).

Costs (in 2018). For the lower income quintile, 1 GB of data costs 39.3 per cent of the monthly GDP in sub-Saharan Africa and 8.2 per cent in the Middle East and North Africa. For the whole populations, the figures are 6.8 per cent and 1.6 per cent respectively. For high income countries, the average is less than 1 per cent. For the lower income quintile, an entry-level internet-enabled device costs 375 per cent of the monthly GDP in sub-Saharan Africa and 96 per cent in the Middle East and North Africa. For the whole populations, the figures are 69 per cent and 22 per cent respectively. For high income countries, the average is around 5 per cent.

Mobile connectivity index (2018). The GSMA has devised a mobile connectivity index to measure countries' performance in mobile internet use by considering four key enablers: infrastructure, affordability, consumer readiness, and content and services. The index categorises countries into *advanced, transitioners, emerging* and *discoverers*. In Africa, Mauritius is the only advanced country on this index, whereas Tunisia, Morocco, Egypt, Libya, Algeria, Ghana, Capo Verde and Kenya belong to transitioners. Ghana and Kenya joined the transitioners in 2018, whereas Benin, Sierra Leone and Ethiopia have moved from discoverers to emerging countries since 2017. Globally, Chad has the lowest score on the index. In addition, Mauritius, Tunisia, Morocco, Algeria, Kenya, Gabon, Côte d'Ivoire, Tanzania, Benin and Sierra Leone have advanced most compared to their score on the index since 2014. In sub-Saharan Africa, statistics from 2014 to 2018 indicates progress by all the enablers, as shown in Table 1.

2 The rural gap is defined as $1 - \frac{\text{mobile internet adoption in rural areas}}{\text{mobile internet adoption in urban areas}}$

3 The gender gap is defined as $1 - \frac{\text{mobile internet adoption by females}}{\text{mobile internet adoption by males}}$

TABLE 1. INDICATORS OF THE DIGITAL CONNECTIVITY PROGRESS IN 2014–2018 OF SUB-SAHARAN AFRICA ON THE GSMA MOBILE CONNECTIVITY INDEX.

Key enabler	Indicator	2014	2018
Infrastructure	Mobile internet penetration	13%	24%
	3G population coverage	52%	70%
	4G population coverage	9%	34%
	Average download speeds	2.5 Mbps	7.2 Mbps
Affordability	Average monthly cost of 1 GB of data (of monthly GDP)	13.2%	6.8%
	Average cost of entry-level internet-enabled device (of monthly GDP)	63.2%	68.5%
Consumer readiness	Adult literacy	63%	
	Average expected years of schooling	10.6 years	
	Mobile ownership	38%	45%
Content and services	Mobile social media penetration	5%	11%
	Online service index score for e-government	21%	40%

Reality. During the 2020 lockdown in Namibia, due to the COVID-19 pandemic, less than 2 per cent of pupils had access to online education (Iikela, 2020). At the same time, the number of mobile subscriptions is more than 100 per cent and over half of the population is using the internet according to the World Bank statistics from 2018. The plain numbers concretise the contrast between the potential and reality of digital connectivity when it comes to its functional use. Beyond the quantity, the question of the 2 per cent relates to the quality of the content services that pupils have access to: what kind of education is available online? How does it prepare them for future society, requiring the 21st century skills? Memorising the multiplication table will not suffice.

The needs for digital connectivity in Africa are best portrayed in the four recent global strategies (2019, 2020) based on analyses of available data, trends and political priorities. They commonly identify a set of key *pillars* of digital connectivity, integrated with *focus areas* and *principles* that should guide the digital connectivity for transformation. The guidelines reflect upon those identified as Principles for Digital Development (Principles for Digital Development, n.d.) in a 10+ year process between international donors, international organisations and the corporate sector. The principles are: design with the user; understand the existing ecosystem; design for scale; build for sustainability; be data driven; use open standards, open data, open source and open innovation; reuse and improve; address privacy and security; and be collaborative. The key strategies are as follows:

1. The World Bank's Digital Economy for Africa (DE4A) Initiative (World Bank, 2019) has identified five pillars: digital infrastructure, digital platforms, digital financial services, digital entrepreneurship and digital skills. Following the five principles of comprehensiveness, transformation, inclusion, homegrown-ness and collaboration, the pillars are particularly expected to strengthen e-governance applications, e-commerce, open banking by non-banks offering tailored services and data lockers for accessing selected services.
2. The EU-AU Digital Economy Task Force's report (EU-AU Digital Economy Task Force, 2019)

focuses on four goals that can be summarised as access to affordable broadband connectivity and digital infrastructure, digital skills, digital entrepreneurship and e-services in application areas such as finance government services, commerce and health.

3. The Digital Transformation Strategy for Africa (2020–2030) (African Union, 2020), approved by the AU in May 2020, is based on the interplay of founding pillars, critical sectors and cross-cutting themes. The five foundation pillars are enabling environment, policy and regulation, digital infrastructure, digital skills and human capacity, and digital innovation and entrepreneurship. The focus of the transformation is on the six critical sectors of digital industry, digital trade and financial services, digital government, digital education, digital health and digital agriculture. In all the sectors, the transformation takes place by integrating or fertilising them by technologies, activities or approaches that are called *cross-cutting themes*: digital content and applications, digital identity, emerging technologies, cybersecurity, privacy and personal data protection, and research and development. The values guiding the digital transformation are the principles of solidarity and cooperation, comprehensiveness, transformation, inclusion, homegrown-ness, a new mindset and safety.
4. Connecting Africa through Broadband, a report by the Broadband Commission of the International Telecommunication Union (ITU) and UNESCO (Broadband Commission, 2019), focuses on concrete examples.

During the 2020 lockdown in Namibia, due to the COVID-19 pandemic, less than 2 per cent of pupils had access to online education.

TABLE 2. THE PILLARS OF DIGITAL CONNECTIVITY IN AFRICA AS IDENTIFIED IN THE RECENT KEY STRATEGIES OF THE WORLD BANK, THE AU, THE EU AND THE BROADBAND COMMISSION OF THE ITU AND UNESCO.

Pillar	DE4A	Digital Economy Task Force	The Digital Transformation Strategy for Africa
	World Bank, 2019	EU-AU, 2019	African Union, 2020
Digital infrastructure	✓	✓ (focuses on affordable access)	✓
Digital platforms	✓	✓ (focuses on e-services for Sustainable Development Goals)	✓
Digital financial services	✓	✓	
Digital entrepreneurship	✓	✓	✓ (focuses on digital innovation)
Digital skills	✓	✓	✓ (focuses on human capacity)
Policy and regulation			✓

The following trends characterize digital connectivity in Africa (Song, 2020a).

Infrastructure. Mobile subscriptions are stabilising whereas fixed connections are on the increase. Undersea cable connections are developing fast, and countries are better connected to each other by terrestrial cables. Especially in remote rural areas, local, WiFi-based mobile operators have opportunities. Satellites also offer more connections. In regard to 5G, interestingly, even in the newest documents, 5G only gets marginal attention (if it gets any attention). The opportunities of 5G are related to (1) supporting the Fourth Industrial Revolution and thus needed in the advanced research, development and innovation pockets, (2) improving digital connectivity in business hubs or (3) implementing WiFi-based local mobile networks for densely populated poor areas. However, currently only 10 per cent of the 4G network's capacity is used (Gilbert, 2020). As an impact of the trends, division between the haves and have-nots gets wider and deeper.[4]

Platforms. Content services seem to not be based on the poor population's needs but on the demand of affluent consumers: instead of rescue food, the digital platforms show the way to nice restaurants. Open governmental data is provided more generally, which is a critical factor for transparency and the design of a range of digital consumer services.

As an impact of the trends, division between the haves and have-nots gets wider and deeper.

Financial services. Digital innovations born in Africa, such as mobile money and pay-as-you-go-solar (Adegoke, 2019), or PAYGo ('Pay-as-you-go Approaches (PAYGO),' n.d.), lead to the transformation of and access to financial services, including access for people who do not have traditional bank accounts or loan credibility.

Entrepreneurship and innovation. Innovation hubs and startup communities are expanding, especially in Nigeria, Eastern Africa and South Africa.

Skills. Because of the wide variance in the quality and relevance of training offerings in digital skills, whether in formal or informal education, digitalisation causes disconnectivity or separation rather than connectivity. The official emphasis on the Fourth Industrial Revolution rather than on consumer-oriented digitalisation might cause a bias towards professional skills rather than everyday skills.

Policy and regulation. Governments are making money by spectrum auctions, paving the way to monopolies and, thus, higher prices for connectivity. Areas with people who cannot pay for connectivity remain unconnected, causing emerging tensions between the urban areas and the remote rural areas. Increasing satellite connections start to divide the African sky, reminding of the colonial Partition of Africa on the ground.

NIGERIAN TEENS MAKING 3D SCI-FI FILMS

The case of Nigerian teens (Kottke, 2019) making use of smartphones and a Belgian online suite for 3D creation is a prime example of a functional integration of the aspects in Table 2. The teens created and produced 3D sci-fi films in their neighbourhood by a working internet connection (infrastructure) that gives them access to a European online platform (blender.org) that allows them to run their digital enterprise with which they can, quite naturally, utilise and develop their digital skills further. Getting their movies onto the market and earning income requires digital finance services that are regulated by policies, as are intellectual property rights (IPRs), privacy and other issues. Another example, from Ghana, shows how digital connectivity can transform the fashion design and marketing scene (Barnes, 2020).

4 On Steve Song's informed website (Song, 2020b) he is very critical of the costs related to setting up 5G networks as they only widen the gap between the haves and have nots by serving a very narrow clientele. He strongly suggests that efforts should be focused on open radio access networks that would pave the way for a diversity of service providers to serve rural and marginalised populations.

The policy and investment environment of digital connectivity

PRINCIPLES THAT GUIDE regulations and policies for digital connectivity are based on values. Table 3 shows the interdependency between values and the promotion of certain types of activities rooted in regulation and policies.

TABLE 3. VALUES ARE BASES FOR PRINCIPLES THAT ARE MATERIALISED IN LEGISLATION AND POLICIES FOR DIGITAL CONNECTIVITY.

Value	Principle	Law or regulation	Policy or incentive	Counter example
Inclusive (digital) growth	Doughnut economics	IPRs	Support for home-grown **innovations**	Profits made from exclusive, foreign-owned services
Social (digital) cohesion	Affordable access to the internet in order to avoid digital segregation	Spectrum rights The taxation of services and equipment	Support for developing standards and technologies for **open** networks	Investment in 5G at the cost of poor consumers' connectivity
Human (digital) rights	Free digital expression	Digital privacy	Promoting digital **skills**	Limited access to governmental data

Among the legislation and policies shown in Table 3, the taxation of digital technology and services poses challenges to the use of existing digital connectivity. For example, the Information Technology Agreement (World Trade Organization, n.d.) requires each participant to eliminate and bind customs duties at zero for all products specified in the agreement, but it has not been accepted in several African countries. The Universal Service and Access Fund (USAF) (Thakur & Potter, 2018), aimed at balancing the gender gap in making use of digital connectivity, is underused across Africa. The taxation of foreign internet companies, for example, in Kenya, might lead to less use of their services.

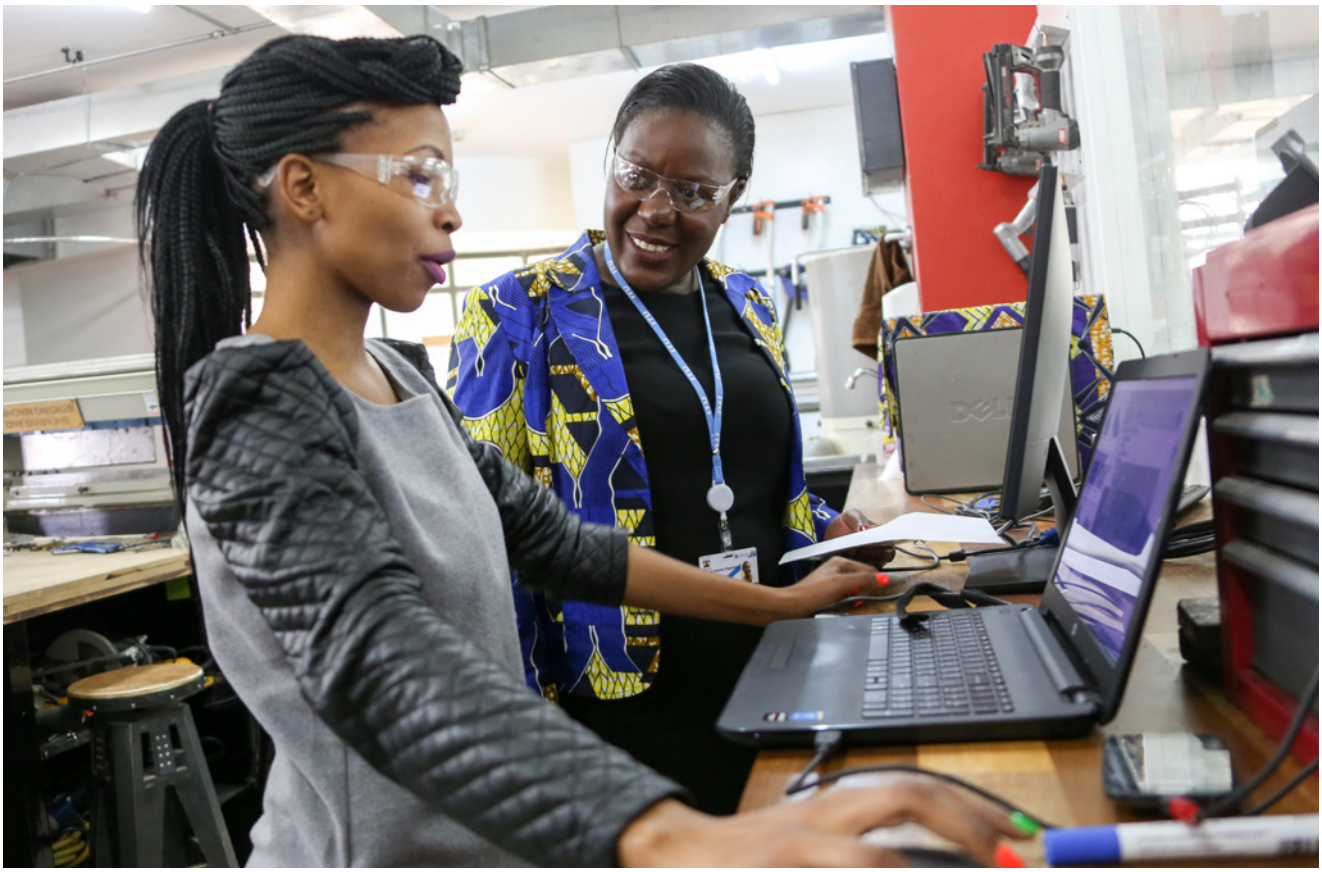
Regarding the legislation for e-commerce, a key factor referred to in each of the strategies, there is significant variance between regions in Africa, especially for e-transactions and cybercrime, with North Africa a clear leader. At the same time, West Africa leads in legislation which is more related to defending individuals: consumer protection and privacy legislation (African Union, 2020).

DISTRIBUTED AUTONOMOUS ORGANISATIONS OFFER DIGITAL CONNECTIVITY FOR THE SHARED ECONOMY

Distributed autonomous organisations (DAOs) provide a novel model for businesses where the profit is made by a diverse team. Each contributor's input is transparent and can be followed by block chain technology. A DAO requires relevant regulations that offer incentives and a reasonable taxation policy for informal businesses (say, a street kitchen using locally sourced ingredients, grown in a poor suburb) to use smart technology in order to integrate with a larger, formal ecosystem.

Africa–China collaboration in digital connectivity

A recent summary (Gong, Gu, & Teng, 2019) has made use of Chinese sources for identifying aspects of Africa–China collaboration in digital connectivity. The report's findings are collected in Table 4. They show how the Chinese collaboration has been very comprehensive, or as Secretary General Guterres mentioned, China targets connectivity 'among the peoples'. The digital silk road of the BRI has been integrated with the 2030 Agenda for Sustainable Development in a way that is concretised in local contexts with stakeholders.



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Digital connectivity is essential for people working at the iHub innovation centre in Nairobi, Kenya.

TABLE 4. DIGITAL CONNECTIVITY AS PROMOTED BY CHINESE PARTNERS (GONG ET AL., 2019).

Aspects of digital connectivity	Example
Infrastructure	There has been some Chinese government involvement, especially in cross-border digital infrastructure and collaboration with the ITU and regional communities (such as the East African Community for building information highways). Huawei has built more than 50,000 km of optical cables in more than 50 countries and more than 50% of the wireless towers in Africa. In Tanzania, China Telecom supported Tanzania in building a key optical cable network that has made Tanzania one of the digital hubs of East Africa while reducing consumer prices.
Platforms	Extending solutions that work in Chinese developing contexts to the rest of the Global South.
Financial services	Chinese financial services, like Alipay, are used to operate in contexts with low credit.
Entrepreneurship and innovation	Private companies have extensive R&D centre networks in Africa. The risk-prone approach of private investors encouraged them to work in settings where they were challenged by media or civil society.
Skills	A major investment in training, capacity building and South–South collaboration. There has been extensive training by private Chinese companies, like the Inspur group, related to learning Chinese best practices on the ground (Egypt, South Africa, Zimbabwe). Huawei runs a global talents training programme.
Policy and regulations	Using spatial information systems to monitor the adherence to regulations.

While the China–Africa collaboration is based on the BRI initiative and its integration into Agenda 2030, most of the concrete activities have been carried out by private Chinese companies. This might be partly due to the social obligations of Chinese enterprises. The Chinese government has mostly been involved in funding digital infrastructure, which has required significantly less money than similar investment in other infrastructure, like energy or transport infrastructure. In fact, the Chinese investment, by 2017, in digital infrastructure was 0.1 per cent of its total foreign investment in infrastructure.

Compared to the EU's or any Global North partner's collaboration with Africa, China has the advantage of being a Southern partner, applying solutions that already work at home in a developing context, supported by local communities and stakeholders, rather than advocating theoretical or inspiring models. While the EU is promoting its role as the world leader in technologies, models, standards and policies (European Union, 2020) that are to be adopted or followed by the rest of the world, China has only recently found out its pioneering role in technology. Hence, it has even been able to take an intermediary role, in an intersection of the designer and user communities, to integrate or root its own, homegrown solutions in Africa, validating their transformative power by the societal success stories made possible by technology. Through its position, it has been able to find its natural role in complex multi-partner consortia. For example, in 2017, the Chinese Inspur Group launched an alliance with Cisco, IBM, Diebold and Ericsson with the Export–Import Bank of China, China Development Bank, the China Export & Credit Insurance Corporation and the China–Africa Development Fund in order to set up state-of-the-art data centres for cloud services and solutions demanded by smart cities and smart enterprises. To sum up, while the EU calls on Africa to follow up and maybe behind, China is busy selling their solutions and influence to make a difference, or at least to fix the problem.

While the ethos of China's digital connectivity initiatives in Africa is integrated into sustainability as addressed in Agenda 2030, it is interesting to analyse the Chinese interventions, especially from the viewpoint of their interest in promoting open administration by spatial information systems. While the systems can apply the most advanced AI technologies to analyse spatially coded data in order to alert about challenges on the ground – events compromising the sustainable environment, economy or culture – the analysis of these data can compromise the ethical dimension (Heinonen, 2014) of sustainability. For example, collecting and analysing the data of people's movements in an urban setting might help in designing an ecological environment, decreasing commuting costs and guiding people's behaviour in a culturally appropriate way, but the system can also invade people's privacy and encourage unnecessary control. Thus, collecting and analysing the data can take place at the cost of digital human rights. However, the ownership, confidence and transparency of the data are key ethical issues to tackle and they require co-design approaches when designing digital connectivity with all the stakeholders at the levels of digital platforms, financial services, innovations, skills and regulations.

Recommendations for Finland and the EU related to supporting digital connectivity

THE SECTION IS organised by Table 2. We identify the challenges where Finland, independently but also as a pioneer within the EU, is able to make a significant contribution.[5] While Finland is a member state of the EU, it channels part of its support to digital connectivity in Africa via the EU[6]; we do not take stand on this. We focus on the concrete actions of Finland that will open up novel applications and materialisations of digital connectivity. The challenges and related recommended actions will be based on the following criteria:

1. Finland has expertise, strengths and success in related areas of digital connectivity from Finland.
2. Finland has experiences gained from earlier, related projects in information society, innovation, science and technology in Africa that can be scaled up for the whole continent.
3. Finland shares the values of the guiding principles identified in the relevant documents of the AU, EU, World Bank, and Broadband Commission.
4. Finland is a better fit for the challenges than other actors, organisations or agencies.

5 For example, in the earlier bilateral information society programmes with South Africa, such as COFISA and SAFIPA, Finland assumed a pioneering role in supporting concrete initiatives in science, technology and innovation as an example of what the EU can mainstream as EU–South Africa programmes with the EU's more extensive funds.

6 For example, related to digital skills, Finland contributes to the implementation of EU–Africa Strategic Partnership no 8 (STI, Information Society & Space) by investing in the strategic flagship project ALICT (Global e-Schools and Communities Initiative, n.d.) which trained a new cadre of policymakers and officials in innovation policy and strategy. As another example, for digital infrastructure, the EU co-funds the AfricaConnect research network (https://www.africaconnect3.net/) and its integration to the European GÉANT network.

Based on inclusion criterion 1, Finland is able to re-contextualise and rethink the models and practices that have led to the transformation of the Finnish civil society, or citizen society, by the brave, innovative, comprehensive and economically viable application of digital connectivity in sectors such as education; digital industry in emerging, globally demanded areas like games and cybersecurity; and e-governance (like payer-friendly taxation services). As a country with harsh nature, a small and aging population and vast rural areas, Finland has excelled in frugal innovation[7] in order to turn the few resources into sustainable wealth. Because of their home, far from European cultural hubs, Finns have traditionally championed homegrown, pragmatic inventions and been open to unconventional, heritage-independent solutions and crafts.

Regarding inclusion criterion 2, it is critical to root Finland's future contributions to digital connectivity in Finland's recognised, long-term presence in Africa for an innovative and inclusive knowledge economy to grow. Lessons learned and networks built within various innovation and entrepreneurship programmes focused on digital technologies – such as COFISA, SAFIPA, TANZICT, STIFIMO, BIOFISA and SAIS – will pave the way for future collaboration at bilateral and multilateral levels.

Based on the value-based criterion 3, it is easy for Finland to agree with the World Bank's principles of comprehensiveness, transformation, inclusion, homegrown-ness, and collaboration, which the AU's strategy for digital transformation has complemented with solidarity, new mindset and safety. These can be summarised as focusing digital connectivity to the have-nots in a way that empowers them to join in as the co-designers and entrepreneurs of digital solutions within a set of living labs in real-life settings. The principle of human rights, including digital rights (Bachelet, 2019) that allow everyone not only to access digital services but also to express themselves by digital means, calls for co-design teams that consist of diverse stakeholders from marginalised areas of society, whether geographically marginalised or otherwise marginalised.

Based on the exclusion criterion 4, we do not recommend that Finland commits its direct resources to the challenges of the digital infrastructure, digital platforms or services, or to regulations or policies. This is because Finland, both independently and as a member of the EU, has other instruments by which to indirectly strengthen these aspects of digital connectivity in Africa (through its support to the World Bank or AfDB). In addition, organisations like the United Nations Economic Commission for Africa (UNECA) and the ITU are already providing expertise for the policy and regulation aspects that are anyway fully legislated by the individual governments. However, regarding the design of individual online services or platforms, Finland should support a selection of inventive flagship activities that enhance digital skills and are initiated and maintained by local entrepreneurs, possibly with Finnish or European co-owners. It is essential that the services designed and developed are sustainable for local use but also upscalable from the outset.

Based on the analysis above, we recommend that Finland focuses its efforts on releasing the potential of digital connectivity by strengthening digital entrepreneurship and digital skills within innovative, inclusive and pragmatic interventions that take place with a selection of communities at the grassroots level. By functional arrangements and a relevant concept design, these efforts will lead to upscalable and sustainable solutions led by empowered and brave champions, instead of reducing to individual projects that will die with the end of funding.

In practice, the Finnish contribution for releasing the potential of digital connectivity, or operationalising the affordances of digital connectivity, should happen in digital entrepreneurship and innovation, digital skills and, to an extent, in RDI in open networks, their technologies, standards and services.

Regarding *digital entrepreneurship and innovation*, lessons learned from earlier Finnish-funded projects at bilateral and regional levels should be extended further. The measures require, for example, supporting innovation competitions

We recommend that Finland focuses its efforts on releasing the potential of digital connectivity by strengthening digital entrepreneurship and digital skills within innovative, inclusive and pragmatic interventions that take place with a selection of communities at the grassroots level.

7 Frugal innovation is pruned from unnecessary features (Mahmood, Kondis, & Stehli, 2014).

Finland should consider opening an African RDI lab co-designing technologies, standards and services for open networks. A fast-evolving landscape of consumers in suburban and rural settings creates huge potential for novel solutions aimed at vulnerable and marginalised groups.

at local and regional levels in order to strengthen the pipeline of early-stage innovation that includes the following:

- Enabling a set of African consortia that consist of business, academia, non-governmental organizations (NGOs) and governmental stakeholders that can co-design a solution for a given challenge with people in a network of interconnected real-life settings from different countries. A rural example is to design a functional application for affordable KaiOS phones to improve the life-cycle of subsistence farming across Africa. A sample suburban exercise is to design a set of services on a local mobile network that makes use of WiFi connections.
- The criteria for selection are based on the promise of stakeholders' prior ideas, the sustainability aimed for and the commitment of people in the real-life settings. Since the way from idea to implementation is long, the idea will be nurtured into a prototype with other financiers through validation and subsequent initial deployment.
- For the innovativeness and sustainability of the selected consortia, Finnish lessons learned from successful start-ups, enterprises founded by young people, and novel design and prototyping models, such as agile software development and hackathons, need to be contextualized for African settings, with African people.[8]

Regarding *digital skills*, Finland is in a good position to devise functional and upscalable methods for learning digital skills in context, for example, following learning-by-doing or phenomenon-based pedagogies. The COVID-19 pandemic

A EUROPEAN PLUG-IN CAMPUS

Recently, the University of Turku set up its first overseas campus (ftlab.utu.fi) in Africa. The Future Tech Lab expects to host African and European young people and companies in order to co-design solutions that make use of improving digital connectivity. The plug-in campus is an upscalable concept that brings academia to a real-life setting by using new remote presence technology that uses a reasonably broad connection (100 Mbps) to build an experience of shared reality between two physically remote places. The plug-in campus with remote presence brings RDI activities to the ground and renews the way that academia can solve challenges at the grassroots level.

8 The Finnish Ministry for Foreign Affairs funded SAIS Connected Hubs of the SAIS 2 programme has been doing this with local Southern African tech hubs and Slush (https://vc4a.com/sais/connected-hubs-boostup/). It is interesting to observe that there is a student-led independent initiative of the Nordic–African Ambitious Africa network (www.ambitious.africa) that aims 'to initiate and support Nordic and African youth-led large-scale grassroots projects with social impact in Africa'.

It is fair to presume that collaboration at the grassroots level in Africa will result in inventions that will also lead to economic benefits for Finland and Europe in the foreseeable future.

has shown that digital skills are easy to learn at the time of acute or authentic demand, in real contexts. Rather than integrated into formal education, digital skills should be learned in informal and non-formal settings. This is also aligned with doughnut economics, applied to learning: digital skills are learned in context for innovations that aim at inclusive growth for everyone rather than in contextually elitist degree programmes. Learning digital skills on focused, short and intense courses with industry actors allows Finnish industry to set up their offshoring units in Africa. A scalable model for supporting digital skills is the plug-in campus of the University of Turku in Windhoek (ftlab.utu.fi).

Regarding RDI in open networks, Finland should consider opening an African RDI lab co-designing technologies, standards and services for open networks. A fast-evolving landscape of consumers in suburban and rural settings creates huge potential for novel solutions aimed at vulnerable and marginalised groups.

Finnish initiatives in enhancing digital entrepreneurship and innovation, digital skills and novel solutions for open networks will ensure a focused and affordable transformation through digital connectivity that is based on demand. The following perspectives shall be kept in mind:

- *Feedback loops*. The feedback, experiences and suggestions from the initiatives need to be based on data collected. Evidence-based suggestions are to be communicated to (1) the policymakers and regulators of individual governments, the AU and other institutions at the continental level and (2) the operators of the digital infrastructure.
- *Mobility programmes*. Existing Finnish and European mobility programmes need to be aligned for a European–African experience exchange so that participants can work in the real-life settings described above.
- *An entrepreneurship focus*. Mobility programmes need to facilitate setting up joint business ventures between Finnish and African owners. More Finnish people are needed in Africa.
- *African orientation*. An African mindset and values, as expressed in the Ubuntu philosophy, are integrated to the initiatives.

The recommendations aim at Finland offering collaboration with Africa at the level of digital connectivity improving life in civil society, in a way that is complementary to that of the Chinese or US approaches. While China is extending its comprehensive BRI programme to Africa to expand its political influence[9] and trade, and the US private sector is providing Africa with increasingly broad connections, assumingly also for access to global data, the Finnish and European approach should start from the demands of African people and societies. As there are unexpectedly fast success stories of innovative companies that make functional uses of digital connectivity, it is fair to presume that collaboration at the grassroots level in Africa will result in inventions that will also lead to economic benefits for Finland and Europe in the foreseeable future.

9 There is extensive evidence of China and the US competing for influence in their operations in Africa. With its recent support of Africa in the COVID-19 pandemic, China referred to the importance of positive news in the media, which are more frequent in state-controlled media in one-party countries than in multiparty democracies. A 5G based broadband would advance the positive news even faster (Harding, 2020).

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04

RESEARCH AND INNOVATION CONNECTIVITY

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Summary

TO DEAL WITH THE complex challenges in Africa, research and innovation activities must be efficiently harnessed. Supporters and partners from outside the continent are necessary in order to add to and complement the internal resources. These connections have considerably increased during the recent years. They have also become more varied due to heightened interests of new partner countries and the private sector of the Global North.

The inherent intricacy of questions related to science, technology, innovation and higher education calls for in-depth knowledge and understanding of the field. A key to future success lies in widely strengthening the related human resources and capacity, from the top down to the grassroots level. There is a largely shared consensus that the technological solutions for most of the African challenges exist already. What matters is how these solutions will be adapted, adopted and efficiently put into use to improve welfare and sustainability. Here, institutional and organisational capacities and innovative solutions are the key for policymaking, business and local communities.

Africa will long remain the most youthful continent, with vibrant entrepreneurship and culture. People are its key asset. We conclude that the most important contribution to the African research and innovation communities, from the outside, is to facilitate building a solid knowledge base on policies and practices that support the inclusive and sustainable development of African local communities. These efforts would preferably most often take place in interdisciplinary, cross-sectoral, transnational networks.

Institutional and organizational capacities and innovative solutions are the key.

Current understanding of research and innovation connectivity in Africa

FOSTERING POVERTY reduction, job creation, sustainable livelihoods and improved welfare sets a tremendous challenge for African research and innovation activities (cf. NEPAD, 2014). During recent decades, many nations around the world have been able to increase their level of prosperity based on a knowledge-driven strategy. There is indeed a correlation between a nation's innovativeness and competitiveness (UN Economic Commission for Africa, 2016, pp. 4–5). Nevertheless, economic growth alone is not sufficient to solve the problems of welfare and sustainability, as the United Nation's Sustainable Development Goals remind us. Wicked problems are only to be solved through means provided by science, technology and innovation. Furthermore, there is mounting research evidence showing that, for the success of sustainability transitions in developing countries, experiments in which developing countries engage with transnational networks and infrastructures to gain access to various resources and markets are especially important (see Wieczorek [2018] for a large meta-analysis). Thus, connectivity is the key.

For the success of sustainability transitions in developing countries, experiments in which developing countries engage with transnational networks and infrastructures to gain access to various resources and markets are especially important.

Higher education is a case in point. International support for higher education and research in Africa has mostly taken place through the funding of joint research projects, fellowships and grants for African students to study abroad and through the direct support of organisations like the AU and the Association of African Universities (AAU).

And indeed, in the African context it is important to embrace a broad concept of innovation. We can elucidate this by identifying two simplified modes of innovation (Jensen et al., 2007). The Science–Technology–Innovation (STI) mode rests on developing advanced research and technology then applied to practical needs. The DUI (doing–using–interacting) mode builds on everyday needs and activities and draws on learning by doing, using technology and interacting between various actors possessing different types of practical and indigenous knowledge. The latter mode is less known, weakly captured by official statistics and, consequently, poorly understood and included in formal strategies (cf. Daniels, 2017). Yet successes in adopting technology to promote African welfare and sustainability are likely to follow from combining these two models.

To be successful, innovations do not necessarily need to represent high technological sophistication; instead, affordability and ease of adoption and use may be much more important features (frugal innovations) in Africa. A common problem is a lack of incentives, and the lack of capability and connections in organisations that are relevant for generating, adopting and deploying useful knowledge, participating in global markets and attracting foreign investments. These all are closely related to a country's educational level and scientific infrastructure. Let us next study the existing data, mostly related to the mentioned STI model, especially as seen from the connectivity point of view.

Higher education

Firstly, higher education contributing to the human resources in Africa is a basis on which a great deal of development capacity rests. There are close to 2000 HEIs in Africa. While there are a number of graduates from HEIs that become unemployed, there are shortages of skilled labour in the fields of engineering, science, agriculture and health in particular (International Institute for Water and Environmental Engineering, 2013; Montenegro & Patrinos, 2012; World Bank, 2007). This calls for an increased quantity and quality of graduates, created by investing in human resources and laboratories, especially for the above-mentioned disciplines. Other means include fostering international collaboration to raise quality and improving links with employers to raise the relevance of education.

The number of HEIs has grown rapidly. More than half of these are private universities. Particularly significant among them is the proliferation of for-profit institutions, although religious ones are still important. However, the quality of higher education has not grown at the same pace. The student-to-teacher ratio, research capacity and basic infrastructure are serious concerns all over the continent. South African universities are the best performers in the 2020 Times Higher Education ranking: the country had 8 out of the 19 best universities in Africa.

The gross enrolment ratio of the relevant age group in tertiary education is the lowest in the world: in 2018, it was 9 per cent in sub-Saharan Africa and 35 per cent in Northern Africa when the global average was 38 per cent (UIS.Stat, 2020). Thus, it is not surprising that Africans form the biggest and most rapidly growing group of internationally mobile students. The data available at the UNESCO Institute for Statistics (UIS), combined with the figures released by the Ministry of Education of China, suggest that the number of Africans studying abroad is close to 650,000, which represents about 11 per cent of the global number.

The patterns of this mobility are changing with new countries emerging among the top destinations, most importantly China, Malaysia and Saudi Arabia (see Table 5). For instance, the Forum on China–Africa Cooperation (FOCAC), as a framework for China's wider economic interests in Africa, provides scholarships to African students. Also, big Chinese cities and universities have established regional and institutional scholarships for African students. Saudi Arabia, like other Gulf countries, is spreading its cultural and political influence in Africa but also investing in the quality and rankings of their own higher education and research by increasing the numbers of international students. Malaysia, in turn, is an example of a country that has consciously developed its higher education sector with several international branch campuses in order for it to become an important source of export earnings. Interesting newcomers are Ukraine, Russia and Turkey. While Ukraine is another example of developing higher education as an industry, Russia and Turkey have strategic interests in Africa connected to educational cooperation.

North America and, to lesser extent, Australia and India remain important destinations for African students, but Europe is still on the top of the list, France and Germany in particular. African students, however, are also an import group of foreign students in smaller states as well. In Finland, for instance, they form 10 per cent of all foreign students (Finnish National Agency for Education. 2017).

TABLE 5. AFRICAN STUDENT MOBILITY: EXAMPLES

Destination	2015	2017
World	563,840	559,073***
Europe	212,710	235,994
France	97,990	112,217
United Kingdom	34,924	29,900
Germany	19,063	23 641
Finland	2,271	2,050
Ukraine	9,806	13,154*
China**	49,792	81,562*
United States of America	40,990	46,013
Malaysia	25,802	28,132*
Saudi Arabia	22,485	22,418*
Canada	18,309	22,845
Turkey	9,125	14,282
India	10,684	11,295*
Australia	7,306	9,749
Russia	6,132	9,118
Intra-Africa	131,397	132,227
Northern Africa	22,813	25,893
South Africa	35,495	36,281

DATA EXTRACTED ON 07 MAY 2020 FROM UIS.STAT, 'STATISTICAL REPORT ON INTERNATIONAL STUDENTS IN CHINA FOR 2018', MOE.GOV.CN, APRIL 18, 2019, 'THE SINO-AFRICAN HIGHER EDUCATIONAL EXCHANGE: HOW BIG IS IT AND WILL IT CONTINUE?', MARCH 7, 2017
*2018; **HONG KONG AND MACAU NOT INCLUDED; ***EXCLUDING CHINA

The number of higher education institutions has grown rapidly.

Differences between African countries are remarkable in regard to both the volumes and destinations of mobile students. France, for example, is most important for francophone Africa. About 30,000 Moroccan mobile students, 20,000 Algerian mobile students and 10,000 Tunisian mobile students go to France. Germany, Canada, the US and the UK come far below. France is among the top destinations for Egyptian students too. For Northern African students with skills in Arabic, the scholarships provided by Saudi Arabia are particularly lucrative. Chinese universities have reserved specific slots for students from individual African countries like Ghana (Gu, 2017). The most common destinations of Ghanaian, Ethiopian, Kenyan and Nigerian students are the US and UK. The linguistic ties bring Angolan and Mozambican students to Portugal or Brazil. Rwanda, in turn, sends most its mobile students to India.

> However, the quality of higher education has not grown at the same pace.

Within Africa, Egypt, Ghana, Morocco, Senegal and South Africa are the most popular host countries. Most of the mobile students of the DRC, for instance, go to South Africa. South Africa, in turn, sends students to the US, the UK, Canada and Australia. As the table shows, intra-African mobility is remarkable, however, there is potential for growth.

To enhance cooperation between African Higher Education Institutions with a supportive partner from EU member states the African Union and the EU have initiated the Intra-Africa Academic Mobility Scheme. The scheme has been running since 2016 with a total budget of EUR 9.8 million allowing around 350 mobility flows. One of the aims is the harmonisation of programmes and curricula within participating institutions.

CASE: THE EASTERN AFRICA UNIVERSITIES MATHEMATICS PROGRAMME (EAUMP) SUPPORTED BY THE INTERNATIONAL SCIENCE PROGRAMME (ISP) AT UPPSALA UNIVERSITY, SWEDEN.

ISP cooperation, that already started in 1961, has been based on a 'sandwich' (PhD) model, where students from Africa get training partly at their home university and partly at a Swedish university. The co-operation involves long-term collaboration and joint investments in research environments in Africa. Maintaining the connections to the home university enhances research of local relevance and prevents brain drain. The ISP is funded by the Swedish government through the Swedish Development Cooperation Agency (Sida). It has subprogrammes in physical sciences, chemical sciences and mathematics. The EAUMP, established in 2002, brings together the departments of Mathematics at the University of Nairobi, the University of Dar es Salaam, Makerere University in Uganda, the University of Rwanda and the University of Zambia. ISP support to EAUMP 2002–2016 was EUR 2.99 M. According to an independent evaluation, in a short time the EAUMP has played a 'transformative role' in mathematics research and teaching capacity throughout Eastern Africa. In addition to postgraduate training, the objective is to strengthen the collaborating departments in terms of equipment and literature (International Science Programme, 2020).

Research and innovation

Regarding innovation activities, it is worth noting that the African economies are to a great extent based on informal economic activities (ILO, 2012). Likewise, informal innovation activities and learning in everyday activities (the DUI model discussed previously) represent a large majority of advances in African society. Therefore, data on R&D activities in African countries represents only the 'tip of the iceberg' (cf. Kraemer-Mbula & Wamae, 2010). According to African Innovation Outlook III (AUDA-NEPAD, 2019), there is not yet any reliable data to cover all the African countries. Nevertheless, significant progress has been made in that direction by introducing African science, technology and innovation indicators (ASTII) and by making efforts to harmonise survey methodologies. So far 26 countries have provided data for the latest compilation, only seven covering all the four sectors (private, government, higher education and private non-profit sectors) needed to calculate the gross expenditure on research and development (GERD).

Overall, Africa's gross expenditure on R&D as a proportion of GDP can be estimated to stand at about 0.5 per cent. During 2016–2018, the share of GERD for sub-Saharan Africa was 0.38 per cent, for North Africa it was 0.61 per cent, for South Africa it was 0.82 per cent and for Egypt it was 0.72 per cent. The world average was 1.72 per cent (UIS, 2020).
The higher education sector usually has the highest share of the national 'cake' of R&D spending. According to ASTII III (AUDA-NEPAD, 2019), this ranges from South Africa's 28 per cent to Ethiopia's 74 per cent. Governments are usually also considerable performers of R&D, with spending ranging typically from

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25 per cent to almost 50 per cent of the total GERD. Out of the seven countries with reliable data on all four sectors' expenditure, business expenditure on R&D (BERD) is only strong in South Africa where it stands at 0.34 per cent, though this is below the average among the OECD countries (1.67%). South African total expenditure for R&D (close to USD 7 billion) is on about the same level as that of Finland, although South Africa has a ten times larger population than Finland.

Increasing R&D spending alone will not help. Innovation is about complementarities: to nurture a successful product or process needs management capacity and other human and organisational capital. A favourable innovation environment also calls for the relative ease and low cost of doing business, the protection and enforcement of intellectual property rights and favourable trade policies, among many other things. On a local level, innovations must be born out of co-creation processes where their expected users are engaged from the beginning. In other words, a truly systemic perspective on innovation and innovation policies is needed. An important call for innovation policies is to understand the complex nature of innovation, specifically in the African context (Daniels, 2017).

Concerning the African scientific and technological output (WIPO, 2019) the last two decades have indicated a relatively high increase in terms of scientific publications (from 1.1% of the world total from 2000 to 2004 to 1.8% from 2015 to 2017) whereas the share of patenting fell (from 0.3% of the world total from 2000 to 2004 to 0.2% from 2015 to 2017). Patenting shows a high concentration on a few countries in Africa, namely Egypt and South Africa. Since the 1970s, African collaboration with inventors outside of the continent has become more versatile: from domination by Western Europe it now also comprises the USA and China in particular.

The Global Innovation Index (GII; WIPO, 2019) states that 'Africa shines in terms of innovation relative to level of development. Out of the 18 innovation achievers identified in the GII 2019, 'six (the most from any one region) are from the Sub-Saharan African region. Importantly, Kenya, Rwanda, Mozambique, Malawi and Madagascar stand out for being innovation achievers at least three times in the previous eight years'. Of the larger African countries, South Africa ranks as the 63rd, Morocco the 74th, Kenya the 77th, Egypt the 92nd, Tanzania the 97th, Ethiopia the 111th, Algeria the 113th and Nigeria the 114th. However, the *Global Innovation Index 2019* (p. 3) report also states that 'Sub-Saharan Africa continues to have low levels of R&D investments compared to what other world regions spend'. It is important to note that GII indicators broadly comprise the various dimensions of innovation and creativity, as well as aspects of investments and infrastructure. Among African top innovation achievers, Kenya and Mozambique, for example, have scored well in categories related to

cultural and creative industries. These are among the many industries that typically do not invest a lot in formal R&D, but their innovation patterns are less easily captured in statistics.

There has been a boom of the start-up culture in several entrepreneurial and innovative hotspots in Africa. In 2010, there were altogether only about USD 20 million in VC investment to Africa, while nine years later, the estimation is that this figure will be as high as USD 1.5 billion. In parallell, there has been a boom of innovation hubs. A recent survey of the African hubs (Afrilabs & Briter Bridges, 2019) found as many as 643 hubs, ranging from co-working spaces, incubators and accelerators to those affiliated with governmental, university or corporate organisations. For these, affordable shared office space, fast internet connections and reliable electricity sources are crucial as these are still largely in short supply in Africa. Other important aspects are, of course, related to business development: skills, networking and funding. The report identified 110 hubs that had discontinued their operations in recent years due to, for example, bankruptcy or the expiration of their mandate. There is as also a considerable variation between African countries. International investors and donors usually play an important role in many innovation hubs. For example, the large Afrilabs network of tech hubs is backed up by partnerships with European donor organisations and US corporations, such as Facebook and Microsoft.

Entrepreneurship in general is key: as much as 22 per cent of the working-age population is starting a business in Africa, which is the highest share among all the continents. However, approximately one third of these new ventures were necessity-driven, not based on a clear business idea (African Development Bank Group, 2017).

A recent survey conducted in ten African countries indicated that approximately 59 per cent of the firms employing at least ten people were innovative, meaning that they had introduced new or significantly improved products, processes, organisation and/or the marketing method during the last three years (African Innovation Outlook III, pp. 110–111). The survey indicated that universities and public agencies were usually only important sources of innovation among less than 10 per cent of innovative companies. Instead, customers and various kinds of suppliers, together with internal sources, were the most important. This shows that practical everyday activities (the DUI model) most often provokes ideas and provides information to come up with considerable changes in products and processes.

Strengthening value added taking place in the African continent by African actors would have a powerful impact on African innovations.

A great majority of the value added that is generated in production chains occurs outside of Africa. As is well known, most of the natural resources produced in Africa are refined elsewhere or by foreign companies, hence providing only limited opportunities for African value added and innovativeness. Therefore, strengthening value added taking place in the African continent by African actors would have a powerful impact on African innovations.

CASE: GLOBELICS – AN INTERNATIONAL SCHOLARLY ASSOCIATION FOR INNOVATION AND DEVELOPMENT

The Globelics research network connects the likeminded researchers around the world that are dedicated to improving understanding of how innovation and competence build links to economic development. Founded in 2002 by some of the most influential and renowned scholars of innovation studies, the network set its target of building research and policymaking capacity in the Global South. To date, more than 3000 scholars have attended Globelics conferences, organised in the Global South. In addition, there are more than 300 PhD students that have participated in the Globelics Academy. Globelics engages actively in dialogue with donor organisations, NGOs and the private sector, as well as policymakers, in order to find out how to best use and diffuse research findings and promote inclusive and sustainable development. From the beginning, Africa has had a special role in Globelics activities as the African community of scholars in the research field back then was very small. The collaboration of the African community and Globelics has helped to change the situation (https://www.globelics.org/).

Policy and investment environment of research and innovation connectivity

IN 2006, the AU endorsed raising its member countries' national budgets for science and technology to one per cent of the GDP. In 2015, the AU's Science, Technology and Innovation Strategy for Africa 2024 (STISA-2024) encouraged countries to 'take concrete actions to allocate at least 1% of GDP to R&D to ensure that Africa maximizes ownership and responsibility for its own developmental path'. As we saw in the previous section, this has not yet taken place in any of the African countries. External funding for formal R&D activities is important for many African countries.

China's R&D cooperation with African countries, measured as scientific co-authorships, has considerably increased during the 2000s, and the biggest growth has only taken place after 2009. Collaborative patenting, implying technological collaboration instead, has mostly been at a low level, partly explained by the overall low level of patenting activity in Africa (Muchie & Patra, 2019). Only a few African countries collaborate intensively with China, South Africa, Egypt and Morocco in particular.

In higher education, the AU–EU partnership supports the Harmonisation of African Higher Education Quality Assurance and Accreditation Initiative (HAQAA) in providing guidance for the general management of academic institutions and exchange between them. One important element in the provision of data concerns the volumes, resources and content of university teaching. The implementation of the first phase of

HAQAA involves the AAU and the European Association for Quality Assurance in Higher Education (ENQA) among others.

Concerning Finland, the FinCEAL Plus Bridges programme supports research collaboration between Finland and Africa. As far as innovation support is concerned, the most important current official programme is the Southern Africa Innovation Support Programme (SAIS, phase II) that covers Botswana, Namibia, South Africa, Tanzania and Zambia. The programme supports the growth of new businesses through strengthening innovation ecosystems and cross-border collaboration. It also gives support to competitively selected start-ups by business mentoring, product development and by linking the companies with investors.

CASE: NTAKA, AN AFFORDABLE EXPERT ON SOIL HEALTH

A Zambian company, ntaka, one of the recipients of the grants awarded by the SAIS programme, is established to strengthen the effectiveness of scientific and technical soil expertise. The company's offering, including a mobile soil spectroscopic laboratory, is targeted to a whole range of sub-Saharan farmers ranging from large-scale commercial farmers to small-scale subsistence farmers. A wide range of expert services are provided by ntaka in order to reduce farming inputs and to improve the reliability of yields by increasing an individual farmer's understanding of his or her soil's specific characteristics. This is increasingly important due to the climate change. The focal company is backed up by a transnational network of partners, including both academic expertise and competences in local grassroots engagement (https://ntaka.org/).

Africa-Europe STI collaboration needs a more innovative cooperative mechanisms.

Regarding the biggest EU research and innovation programme for 2014–2020, Horizon 2020, more than €123 million has been allocated to AU partners. The most active country is South Africa, followed by Kenya, Tunisia, Morocco and Egypt. In 2019 African partners had participated 617 times in 279 signed grants of collaborative Marie Skłodowska-Curie actions and European Research Council actions receiving 98.1 million euros of EU contribution while they contributed approximately 15 million euros; a total of 645 researchers with the nationality of an AU country had participated in MSCA actions (European Commission, 2019). The most important areas of these different kinds of partnerships are related to health and medicine, food and water, and security (ERAC/SFIC, 2020, p. 9).

Besides research collaboration, the EC launched the Africa–Europe Innovation Partnership in 2019. This initiative is meant to connect the African and European incubators and accelerators, foster technology transfer and build capacity, including that provided by African innovators' and entrepreneurs' access to capital.

Overall, there is already a dense web of official African–European networks and programmes on STI. Besides the EC's programmes, most of the European countries also maintain their own programmes with Africa. The SFIC Africa Task Force has recently highlighted the following constraints to Africa–Europe STI initiatives (ERAC/SFIC 2020; cf. European Commission, 2015):

- the lack of joint funding mechanisms
- the lack of science councils in most African countries
- challenges with the disbursement of STI funds once granted
- missing links between science, technology and innovation policy and other domains
- the low level of engagement between academia, the private sector and civil society/communities
- low SME participation.

Based on their analysis of outcomes from several studies, Cherry et al. (2018, pp. 143–144) stated that the institutional framework of Africa–Europe STI collaboration needs a radical rethinking in order to come up with more innovative cooperative mechanisms. They also call for more commercially oriented funding models and a mindset that is more strongly directed towards outcomes.

Recommendations for Finland and the EU to support research and innovation connectivity

THE FOLLOWING CITATION captures an essential viewpoint:

African countries […] need not to re-invent the wheel. They can use existing technology to address their development challenges simply by building the capacity to find, adapt and adopt mutually agreed-upon terms, and proven off-the-shelf technology developed elsewhere. (Africa Sustainable Development Report, 2018, p. 106; cf. UN STI Forum, 2019)

With a projected growth of population in Africa, the urgency of problems calls for policies of high impact. This means that, on the one hand, there is need for local human capacity everywhere in Africa to work towards the goals of welfare and sustainability, requesting HEIs to respond to the most pressing societal needs. On the other hand, African research do not have to dwell on a long and lonely journey in order to find answers to the continent's tremendous challenges. Instead, research performers need to orientate research towards collaborating with civil society and the private sector. In addition, they should be able to seamlessly collaborate in transnational networks in order to conduct experiments for sustainable transitions in their countries.

For capacity building, sustained long-term institutional co-operation is

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Start-up pitching event in Windhoek, Namibia.

needed. We recommend the following aspects to be considered in particular:

- Europe must, for its part, ensure that the policy instruments in its African co-operation are focused on outcomes, have long-term commitment and will form a coherent, impactful entity. Cross-sectoral and interdisciplinary problem-oriented programmes that target the Sustainable Development Goals (SDGs) should have priority. Programmes that integrate basic and applied research with concrete experiments on the grassroots level would help the crucial research outcomes to find their needy audience.
- International and intra-African networking and mobility for the quality of higher education and research training requires proceeding with the harmonisation of degrees and the collection of and access to accurate data on higher education in African countries.
- While academic communities are encouraged to collaborate with external stakeholders, their academic freedom must be safeguarded to guarantee that the scientific communities can voice their opinions and find their own ways to collaborate.
- In the sphere of STI and HEI policies, the capacity of policymakers and of policymaking bodies is of outmost importance due to the many complexities of the fields. Therefore, educating present and future policymakers to understand the intricacies of those fields of policy should be one of the key priorities. Policymakers may or may not enable novel development.

Another important point to note is that even though many African countries aspire to focus on the growth of their manufacturing sector, services are not to be underestimated. To increase value added and productivity, many services have a crucial role to play, including those related to digitalisation and financial and business services. In addition, many of those services that can be digitised, and thus sold over the internet, can themselves be high value-added exports. This includes those mentioned, as well as cultural and creative industries.

During the last ten years, many African cities have witnessed a boom of start-ups and techno-entrepreneurs. Various kinds of innovation hubs have mushroomed around Africa. Increasingly there are resources available for African scholars, innovators and grassroots movements. There are numerous ongoing experiments engaging the civil society. If anyone, bottom-up activities and local communities are the ones solving the African challenges.

Research and innovation connectivity in and with Africa has taken many steps during recent decades, along a growing recognition of Africa's strategic importance, vibrant entrepreneurship and culture. Without inclusive and sustainable development of African local communities there is a risk of losing this crucial field of collaboration into a realm of conflicting interests of the world powers while poverty, inequality, unemployment and environmental hazards keeps mounting in Africa.

We conclude that facilitating the knowledge base of policies and practices supporting the local level is also the best way to enhance the African research and innovation capacity for sustainable development.

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05

CONCLUDING WORDS

Eva Nilsson

THIS REPORT HAS discussed the possibilities for improving Africa's connectivity. It has shown that a lot remains to be done in order to better connect African countries and Africans with each other and with the rest of the world in a sustainable and just manner. It has also shown positive trends that have been taking place in the past few decades. Investments into infrastructure, education and innovation are increasing. However, more investments are needed to keep up with the current pace of population growth.

In all chapters in this report – whether referring to transport, energy, digitalisation or research and innovation – people-centeredness has been raised as being at the core. Any solution to enhance Africa's connectivity has to be done by or with Africans, based on their will and needs. New innovations and digital solutions have to be co-created with the people who are affected by them and serve their inclusion in society. Energy investments have to spur Africa's private sector development, and electrification has to reach people who currently lack access to electricity. Transport networks have to support people's mobility, whether it is rural, urban or cross-border mobility. Human resources have to be strengthened through investments into higher education, research and innovation.

In the energy sector, continued support for a sustainable transformation to a zero-carbon economy is needed. Investments into solar, wind, biomass, hydro and geothermal energy are still too few. For investments and support measures to be successful, they should support local employment, skills, operators, entrepreneurs and knowledge. Furthermore, as technology is developing fast, access to electricity plays a crucial role for inclusion in society. Increasing the electricity connectivity of the millions of Africans who live under the grid in growing urban areas is important. In addition to grid connectivity, decentralised, renewable energy-based off-grid solutions can be important for providing access to rural populations and to commercial actors who suffer from grid unreliability and use diesel-powered generators. All energy investments should be socially and environmentally sustainable.

In terms of transport, there is a need to align the interests of the private sector and external stakeholders, such as the EU and Finland, with Africa's regional and sub-regional transport infrastructure goals, like the Action Plan for Boosting Intra-African Trade. The EU's external investment plan and the Africa–EU Alliance provide an essential foundation for strengthening EU cooperation with Africa on infrastructure development. In particular, building the capacity of Africa to

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diversify infrastructure funding through Public Private Partnerships is important.

While the growing and young population of Africa poses a demand for digital connectivity, the base of society has remained largely unconnected, for reasons such as pricing and irrelevant services. Finland, as a part of the EU, should focus its contribution on enhancing digital entrepreneurship, innovation and skills that empower Africans to use and co-design digital services that foster inclusive growth for their own good, livelihood, and employment. Based on its own experience, expertise and narrative in digital connectivity, Finland can act beyond its actual size, co-building success stories, champions and models that can later be scaled up and mainstreamed by individual African governments, the corporate sectors and academia, linking them up with the strategies and principles of the AU, the World Bank, the EU and the ITU.

Finally, to deal with the complex challenges in Africa, research and innovation activities must be efficiently harnessed. A key to future success lies in widely strengthening related human resources and capacity, from the top down to the grassroots level. There is a largely shared consensus that the technological solutions for most of the African challenges already exist. What matters is how these solutions will be adapted, adopted and efficiently put into use in order to improve welfare and sustainability. The most important contribution to the African research and innovation communities, from the outside, is to facilitate building a solid knowledge base on policies and practices that support the inclusive and sustainable development of African communities. Africa will long remain the most youthful continent with vibrant entrepreneurship and culture. People are its key asset.

The Covid-19 pandemic and connectivity

The work on this study started at the same time as the COVID-19 pandemic led to lockdowns across the world, including Africa. We do not yet know what the world will look like when the pandemic is over and what its effects on Africa will be. What we do know, however, is that connectivity is very much at the core of the pandemic and the way we look at connectivity in the future will be heavily affected by COVID-19. It is useful to turn the lessons learned during the past months into opportunities for strengthening and transforming Africa's connectivity.

Apart from economic recession and its consequences, the trade balance will worsen, jobs and livelihoods will be lost, countries will face a debt crisis, inequalities will increase and political unrest might occur. The UN Economic Commission for Africa has predicted that the COVID-19 pandemic will cause a decline of Africa's GDP, dropping from a projected 4.1 per cent to 1.1 per cent in the best-case scenario and to -2.6 per cent in the worst-case scenario. The pandemic has caused falling demand for Africa's commodities, capital flight and a virtual collapse of tourism and air transport due to lockdowns and border closures. The start of the African Continental Free Trade Area will be postponed from July 2020, which delays prospects for increased intra-African trade (UNECA, 2020).

COVID-19 has brought the world's digital divide to the surface. The sudden dependence on digital technology has created deeper inequality between the connected and the unconnected. Those with a fast broadband connection have been able to work, study, keep entertained and stay connected to family and friends. It has kept people informed and employed. Those without access are at the risk of facing heavy economic and social distress. Online education has not even been a remote possibility for millions of unconnected children in Africa. Mobile connectivity, although faster to roll out, offers lower transmission rates than fixed networks. Furthermore, businesses in the informal economy have not necessarily had the capacity to digitalise their services and move into e-commerce

or digital food delivery apps. In sub-Saharan Africa one gigabit of data costs nearly 40 per cent of the average monthly wage (ITU/UNESCO, 2019).

The pandemic has also shown that access to health care is a pressing problem in African countries. Even in health care, connectivity is an obstacle. Only 34 per cent of hospitals have reliable electricity access and about 58 per cent of health facilities have no electricity at all (UNEP, 2017). Health centres mainly rely on unreliable grid electricity or diesel-based generators. This means, for example, that where there are ventilators, they might not function reliably and that vaccine cold chains are not solid. Delivering a vaccine to people living in remote areas will increase the energy demand for refrigeration, transportation, and health and storage facilities. Different renewable energy solutions, such as solar micro-grids, could be cost-effective ways to complement current electricity sources and to improve reliability. The African Union Commission, for instance, agreed to work with the International Renewable Energy Agency to advance renewable energy solutions in Africa's response to COVID-19.

Most significantly, the pandemic has affected mobility within Africa and between Africa and the rest of the world. Closed borders and travel bans have been imposed in over 40 countries, hampering the movement of people and goods, formal and informal economies and the transport sector as a whole. Responses to the pandemic have been nation-centric, challenging multilateralism and globalisation.

The crisis, however, can also be an impetus for the geographic diversification of global manufacturing, wherein African countries could seize the opportunity to diversify their economies. The drop in global oil prices could also incentivise the transformation towards low-carbon economies. This would require significant investments into connectivity – improved logistics, reliable access to electricity, investing in skills development and embracing digital technology.

Unfortunately, COVID-19 will change Africa's finance landscape. Many large infrastructure projects by China and other partners are expected to be delayed or even cancelled. Donor countries are likely to cut their foreign aid budgets due to heavily increased national spending. Africa's own resources have to tackle the health challenges related to COVID-19. Even though G-20 countries, the International Monetary Fund and the World Bank have agreed to suspend debt repayments until the end of year 2020, African countries will need more resources to counter the current health and economic crisis and to turn it into opportunities that will benefit Africans. This requires political will, enabling policies and regulation, and in addition to public funds, considerable amounts of private sector investment.

Despite the pandemic, Africa, jointly with its partners, has to quickly get back on track to improve Africa's connectivity in a sustainable and equitable manner. It is only through improved connectivity that the pandemic can bring out opportunities for Africans and the consequences of any future pandemic can be lighter.

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