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Study on Programme for Infrastructure Development in Africa (PIDA)

AFRICA'S INFRASTRUCTURE OUTLOOKS 2040

SOFRECO

in consortium with

Ascon Africa, sofrecom, Nathan Associates Inc., SYSTRA, CabIRA, MWH

CORRIDORS OF GROWTH: THE REGIONAL INFRASTRUCTURE THAT AFRICA NEEDS THROUGH 2040

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ACRONYMS AND ABBREVIATIONS

$	All dollar amounts are in U.S. dollars unless otherwise indicated.
AfDB	African Development Bank
AICD	African Infrastructure Country Diagnostic
AU	African Union
AUC	African Union Commission
CAPP	Central African Power Pool
CEN-SAD	Community of Sahel-Saharan States
CICOS	Commission Internationale du Bassin du Congo-Oubangui-Sangha
COMELEC	Maghreb Committee for Electricity
COMESA	Common Market for Eastern and Southern Africa
EABN	East African Broadband Network (EABN)
EAC	East African Community
EAPP	East African Power Pool
EASSy	Eastern African Submarine Cable System
ECCAS	Economic Community of Central African States
ECOWAS	Economic Community for West African States
FAO	Food and Agriculture Organisation
GHG	greenhouse gas
GIS	geographic information system
GSM	global systems mobile
HIPSSA	Harmonisation of ICT Policies in Sub-Saharan Africa
ICA	Infrastructure Consortium for Africa
ICT	information and communication technology
IGAD	Intergovernmental Authority for Development
IMF	International Monetary Fund
LLC	landlocked country

L/RBOs	lake/river basin organisations
MDGs	Millennium Development Goals
NBI	Nile Basin Initiative
NEPAD	New Partnership for Africa's Development
NPCA	NEPAD Planning and Coordinating Agency
OECD	Organisation for Economic Co-operation and Development
OMVS	Organisation pour la Mise en Valeur du Fleuve Sénégal
PAP	Priority Action Plan
PIDA	Programme for infrastructure Development in Africa
PPP	public–private partnership
RBO	river basin organisation
REC	regional economic community
SADC	Southern African Development Community
SAPP	Southern African Power Pool
STAP	Short-Term Action Plan
TAH	Trans-African Highway
TEU	20-foot equivalent unit
TWR	transboundary water resources
TWRM	transboundary water resources management
UMA	Arab Maghreb Union
UN	United Nations
UNECA	United Nations Economic Commission for Africa
VoIP	Voice over Internet Protocol
WAPP	West African Power Pool
WiMAX	Worldwide Interoperability for Microwave Access

1. INTRODUCTION TO THE PIDA STUDY

This report summarizes the findings of Phase 1 of the Study of the Programme for Infrastructure Development in Africa (PIDA), a programme dedicated to facilitating continental integration in Africa through improved regional infrastructure. Designed to support implementation of the African Union Abuja Treaty and the creation of the African Economic Community, PIDA is a joint initiative of the African Union Commission (AUC), the New Partnership for Africa's Development Planning and Coordination Agency (NPCA), and the African Development Bank (AfDB).

The study covers the following infrastructure services:

- *Transport*. The study focuses on the African Regional Transport Infrastructure Network (ARTIN), which consists of the Trans-African Highways plus 40 key corridors carrying 40% of Africa's international trade, 19 ports handling 70% of the continent's international trade, and 53 airports handling 90% of the continent's air traffic.
- *Energy*. In examining all transmission lines above 110kV and all generation plants above 50 MW, the PIDA power study covers more than 90% of power transport and generation on the continent.
- *Transboundary water resources* (TRW). The 10 river basins and 3 aquifers included in the study cover 80% of the area of Africa's international basins. Approximately 80% of Africa's freshwater resources are transboundary.
- *Information and communication technology* (ICT). The study focuses on intercontinental and regional connectivity accounting for 90% of Africa's voice and data traffic.

The study will produce three outputs:

- A strategic framework for the development of regional and continental infrastructure across the four target sectors based on long-term social and economic development visions, strategic objectives, and sector policies;
- An infrastructure development programme that articulates short- (2020), medium- (2030), and long-term (2040) priorities for meeting identified infrastructure gaps in a manner consistent with the strategic framework; and
- An implementation strategy and processes for the Priority Action Plan (PAP), 2012–20.

1.1 The rationale for PIDA

Infrastructure plays a key role in economic growth and poverty reduction. Conversely, the lack of infrastructure affects productivity and raises production and transaction costs, which hinders growth by reducing the competitiveness of businesses and the ability of governments to pursue economic and social development policies. Deficient infrastructure in today's Africa has been found to sap growth by as much as 2% a year (Calderón 2008). This is a continental problem that requires a continental solution.

The lack of infrastructure in Africa is widely recognised. The road access rate is only 34%, compared with 50% in other parts of the developing world, and transport costs are higher by up to 100%. Only 30% of the population has access to electricity, compared to 70–90% in other parts of the developing world. Water resources are underused. Current levels of water withdrawal are low, with only 3.8% of water resources developed for water supply, irrigation and hydropower use, and with only about 18% of the continent's irrigation potential being exploited. The Internet penetration rate is only about 6%, compared to an average of 40% elsewhere in the developing world.[1]

Deficits like these have a clear impact on African competitiveness: African countries, particularly those south of the Sahara, are among the least competitive in the world, and infrastructure appears to be one of the most important factors holding them back.

PIDA will help Africa to address these problems. The PAP will be immediately actionable and will be reviewed periodically as individual projects are completed and new gaps in regional infrastructure appear. The first PAP, which extends to 2020, will supersede the AU/NEPAD Action Plan (AAP).

1.2 General approach to the study

PIDA is grounded in regional and continental master plans and action plans as well as other relevant studies undertaken by the African Union (AU), the regional economic communities (RECs), the regional and continental technical agencies (including the lake and river basin organizations (L/RBO) and power pools (PP)), and the concerned countries.

PIDA is a long-term planning study structured in three phases:

- Phase 1—Diagnosis: a review of all pertinent policies, existing and planned infrastructure projects, macroeconomic sector assessments over time, and gap analysis.
- Phase 2—Programming: compiling the priority investments for each sector through discussion of Phase 1 findings among stakeholders and preparing the PAP.
- Phase 3—Consensus: building consensus among stakeholders to establish buy-in and commitment to finalise the strategic framework and implementation plans for short-, medium-, and long-term projects.

The completed PIDA study will enable African stakeholders to speak with one voice for continental and regional infrastructure development based on a common vision and agenda.

[1] At present Africa has caught up with other developing parts of the world in mobile telephony.

2. A GROWING AFRICA

Africa has about 20% of the world's land mass and 16% of its population, but only 2.5% of its gross domestic product (GDP). The United Nations Development Programme (UNDP 2011) summarises the continent's socioeconomic situation as follows:

- Africa is endowed with rich resources. African economies are growing quickly, subdued recently only by the impacts of multiple crises. Africa has minerals, oil, and a resilient labour force that in difficult circumstances delivers innovation and growth.
- Yet Africa faces multiple challenges. It is highly fragmented, with a large number of landlocked countries and generally poor transport and communication infrastructure—particularly in central Africa. Africa is home to over two-thirds of the world's least developed countries, 12 of which have no access to the sea.

Africa ranks lowest of all continents on the UNDP's Human Development Index (UNDP 2010). Of the 50 African countries for which the HDI is computed, 35 are in the low human development group and only 4 are in the high human development group.

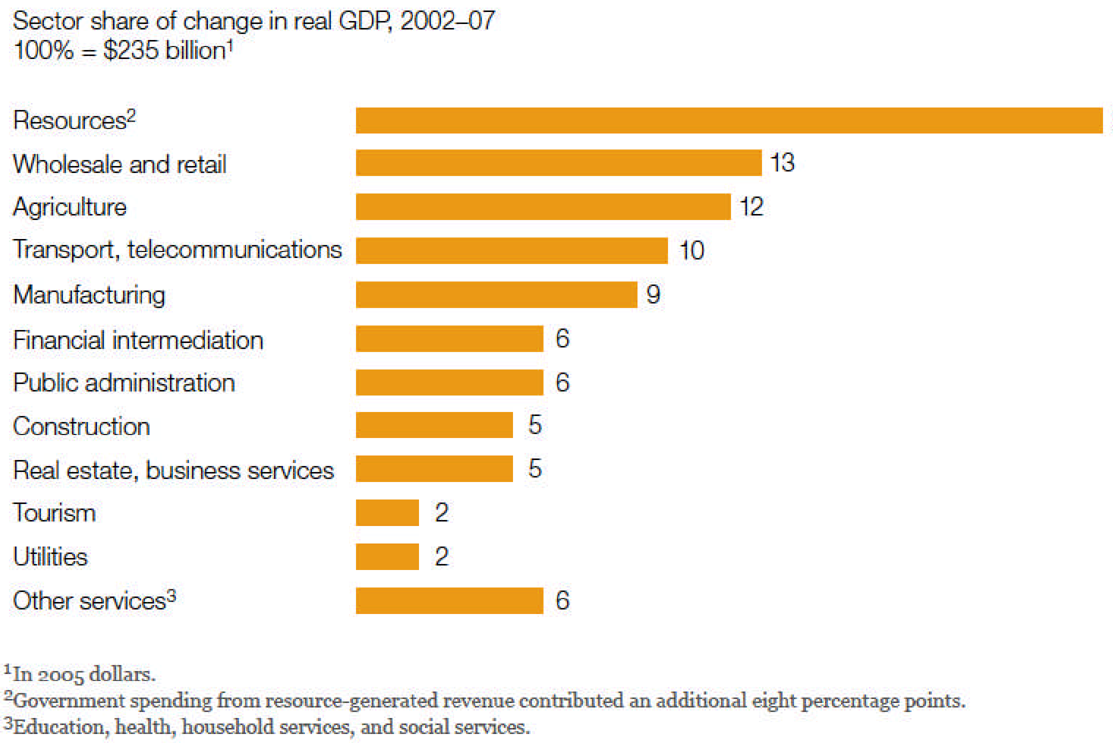
But among Africa's 53 countries (excluding the new South Sudan) there is broad socioeconomic variation. In 2007, 23 countries had very low per capita GDP, below $2,000 in purchasing power parity (PPP), while 6 had per capita GDP in excess of $10,000. Equatorial Guinea leads the continent with a per capita GDP of more than $20,000, while the Democratic Republic of Congo and Liberia bring up the rear with earnings of less than $400.

Other indicators confirm the diversity of the African continent. The World Bank's *Doing Business* report for 2011 ranks 183 countries on 5 dimensions of friendliness toward the private sector. Mauritius ranks 20th, ahead of Germany, Switzerland and Luxembourg and eight other African countries rank in the first 100 (World Bank 2010). Three African countries—Rwanda, Zambia, and Cape Verde—are recognised among the 10 "top reformers."

2.1 Drivers of Africa's recent and future growth

Historically, a key driver of Africa's growth has been its richness in natural resources. Resource wealth has been the springboard for the continent's current momentum, catalysed by government spending (based on resource income), structural reforms, the winding down of many conflicts and civil wars, and economic diversification across many sectors—wholesale, retail, transportation, telecommunications and manufacturing (Figure 2.1). Among the countries taking great advantage of economic diversification based on natural resources are Nigeria, Côte d'Ivoire, and South Africa.

Figure 2.1. Widespread growth across sectors



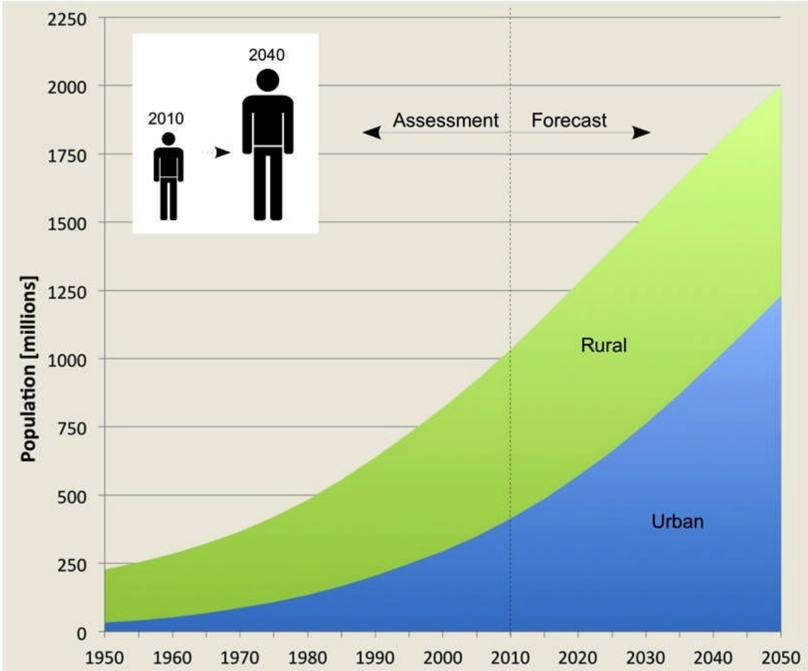
Source : Leke et al., 2010.

Africa's population is the other major driver of growth. The continent's population is projected to increase from 1 billion in 2010 to about 1.8 billion in 2040 (Figure 2.2)—much faster rate than for other continents—and to pass those of China in 2025 and India in 2030.

Urbanisation will increase from 40% in 2010 to 56% in 2040, approaching but not reaching China's anticipated level of 68%. In 2010 Africa had 51 cities with more than a million inhabitants, and one city (Cairo) with more than 10 million. In 2040 it is expected to have more than 100 cities of more than one million inhabitants and 7 cities of more than 10 million. The largest city is projected to be Kinshasa, where the population is expected to reach 24 million. Overall, the continent's population is concentrated along the Mediterranean coast, along the Gulf of Guinea, through the Sahel, and in Central Africa (Figure 2.3).

By 2040 the proportion of Africans aged 15–64 years, prime ages for consumption and production, in the world's population of this age group will reach 20%, second only to Asia (with 60%) and well ahead of Europe (8%) and the Americas (12%). Africa is poised to become a manpower reservoir for the world economy.

Figure 2.2. Historical and forecast population in Africa



Source: United Nations, 2011.

After a dismal performance in the 1980s, when real annual growth of GDP averaged only 1.87%, Sub-Saharan Africa's annual growth rate improved steadily, averaging 2.27% in the 1990s, 4% for 2000–08, and in excess of 6% for 2005–08 (Table 2.1). Weathering the 2008 global financial and raw materials crisis better than most other regions, Africa achieved aggregate GDP growth of 4.7% in 2010 and is expected to finish 2011 with 5% growth (UNECA 2011).

Eight African countries were among the world's 20 fastest-growing countries during 2005–09: Angola (1), Ethiopia (3), Uganda (6), Rwanda (9), Sudan (10), Mozambique (15), Tanzania (16), and Malawi (20) (IMF 2011). Short-term prospects through 2015 exceed 5%.[2]

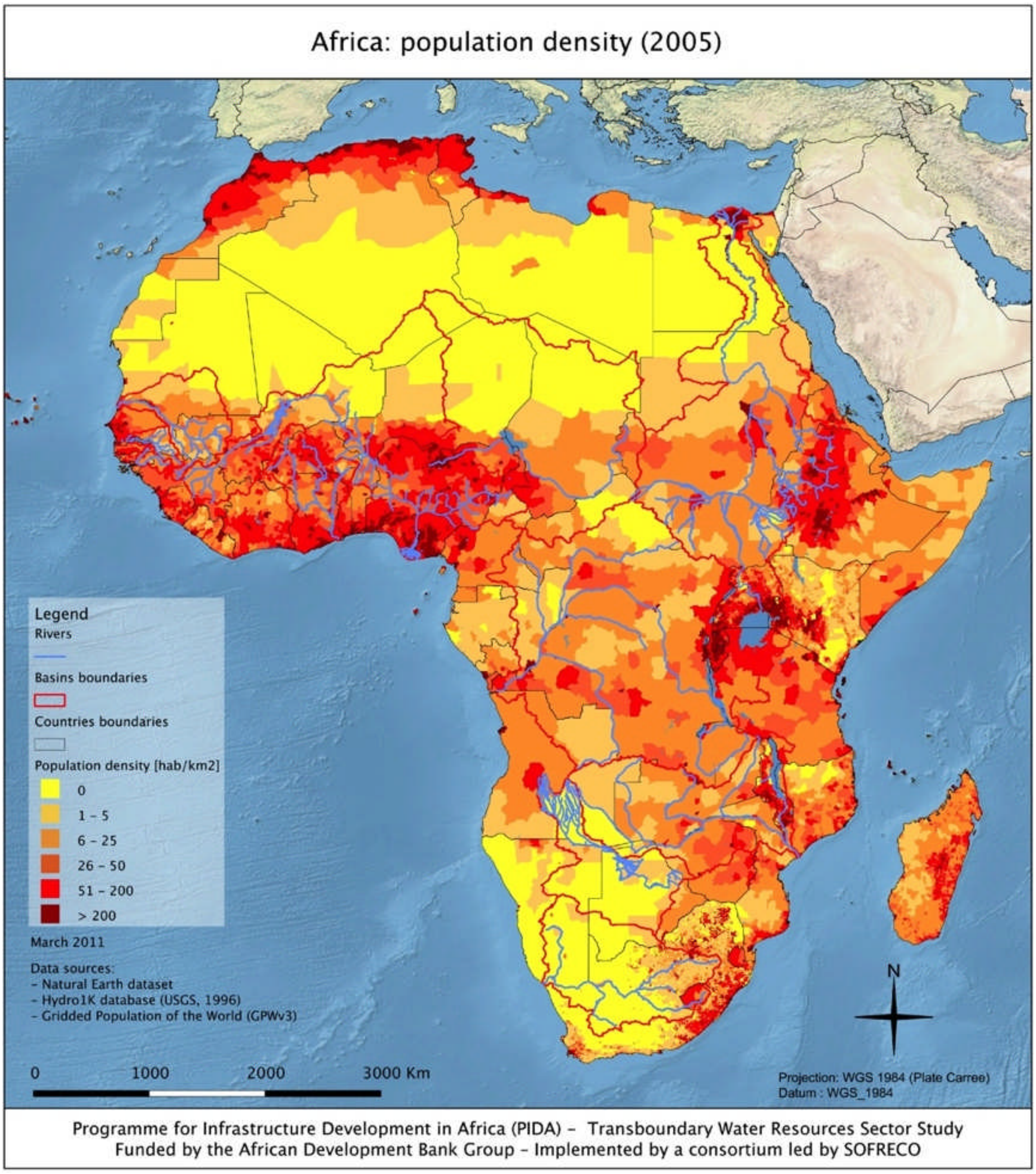
Table 2.1. GDP in Sub-Saharan Africa and other countries

	GDP constant, average annual growth rate (%)				GDP per capita (constant at 2000 US$ prices)			
	1980–90	1990–2000	2000–08	**1980–2008**	1980	1990	2000	**2008**
Sub-Saharan Africa	1.87	2.27	3.99	**2.90**	587	531	510	**618**
India	5.55	5.46	5.92	**6.06**	229	318	453	**718**
Brazil	1.55	2.54	2.85	**2.48**	3,539	3,355	3,701	**4,448**
Malaysia	5.98	7.11	4.02	**6.11**	1,919	2,608	4,030	**5,151**

Source: World Bank, World Data Bank.

[2] The International Monetary Fund (IMF 2011) expects Africa to grow at a rate of 5.2% in 2011 and 6% in 2012. The AfDB also projects 5.2% growth in 2011.

Figure 2.3. Population density in Africa



Data source: Gridded Population of the World, GPWv3, 2005.

2.2 GDP growth prospects to 2040

The PIDA study envisages an outlook for the future based on a "stretch" macroeconomic scenario that mirrors the outstanding performance of countries such as India and Malaysia over the last 30 years and of Africa in recent years (see table 2,1 above). Such a scenario would be consistent with the assumption behind the Abuja Treaty, namely, that Africa will solve its major sector policy challenges in a satisfactory manner in the next few years and achieve continental integration as well as integration in the world economy.

Africa's potential for growth is indeed quite high. Using a methodology based on the Augmented Solow Growth Model, the PIDA consultant estimates that the average growth rate for 53 African countries (GDP-weighted and expressed in U.S. dollars PPP) will be 6.2% per year between 2010 and 2040.[3] A 6.2% rate of growth for Africa implies that over 30 years, the GDP of African countries will on average be multiplied six-fold (Table 3.1).

Thirty-seven countries should exhibit a growth rate higher than 5% per year on average for the period 2008–40. Twenty-six African countries should record an average growth higher than the continental average, led by Ethiopia and Nigeria, with estimated rates of 7.8% and 7.6% per year, respectively, for the period, followed by Malawi (7.5%), Tanzania (7.3%), Mozambique and Benin (7.2%), and Angola (7.1%).

Eight countries will exhibit an average growth rate of between 5% and 6% per year. At the back of the pack, seven countries are expected to grow at a rate of less than 4% per year—among them Guinea, Mauritius, Zimbabwe, Eritrea, and Equatorial Guinea.

Table 3.1. Projections of population and gross domestic product in Africa, 2010–40

	2010	2020	2030	2040
Population (millions)	1,033	1,276	1,524	1,770
Urban population (millions)	413	569	761	986
GDP (2005 PPP$ billions)	3,300	6.010	11,639	20,334
GDP/per capita (2005 PPP$ billions)	3,190	4,709	7,636	11,490

[3] The analysis was performed before South Sudan became Africa's 54th country.

3. WITH GROWTH, SWELLING DEMAND FOR INFRASTRUCTURE

On the basis of these GDP projections, the consultant determined each sector's demand for services through 2040 (or 2020 in the case of ICT), making it possible to assess the likely size of the gap between demand and supply at each step of the way. The consultant also carried out a sensitivity analysis (assuming an annual rate of growth of 4%). The conclusion is that the infrastructure gaps identified for 2030 under the "stretch" scenario would be reached in 2040 under the alternative scenario.

Efficiency gains from improved operation of existing continental and regional infrastructure and the completion of projects under implementation will fill a portion of the gaps identified below. The projects that PIDA will recommend in the next phase of its work will be designed to fill the remainder.

3.1 Demand for transport infrastructure through 2040

Growth in Africa's population, economic output, and trade flows will combine through 2040 to raise demand at the regional and continental levels for freight transport, port facilities, and air passenger transport. The growth in demand is likely to outstrip development of the present African Regional Transport Infrastructure Network (ARTIN), opening up gaps between demand and supply that will retard future growth if allowed to persist.

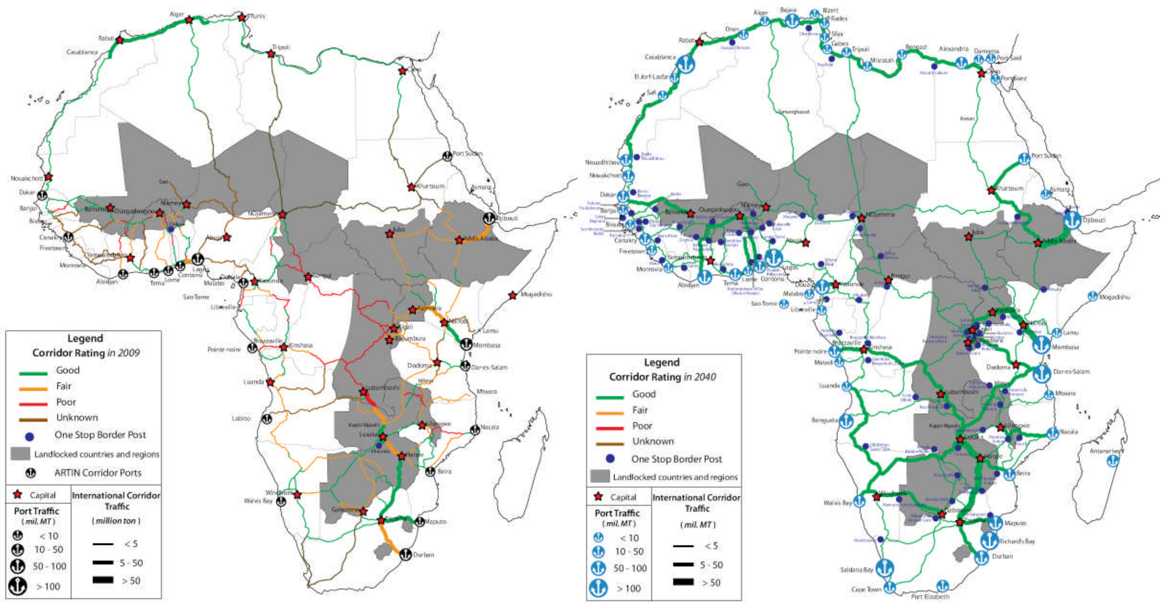
The key assumptions behind the PIDA transport forecasts are these:

- GDP will grow at an average of 6% per year for the continent (4% per year in the alternative scenario).
- Population will grow as forecast by the United Nations, with increasing urbanization.
- International trade will drive freight flows in ARTIN corridors.
- The ARTIN corridors will achieve good efficiency and traffic will migrate to the most efficient corridors.
- The ARTIN network will uses best practices from Africa and other regions of the world to reduce costs and increase service levels.

ARTIN's purpose is to link large African centres of consumption and production (large cities, mining centres, large agriculture production projects, and so on) with the rest of the world via modern and efficient regional transport infrastructure networks and gateways (Figure 3.1). Trade in ARTIN corridors is expected to grow faster than overall trade, expanding from 13% in 2009 to 18% of total trade in 2040.

The total cost of inefficiencies in ARTIN operations and lack of maintenance is estimated at close to $175 billion in 2009, with about half made up of increased annual costs to shippers and half in the value of suppressed demand.

Figure 3.1. The ARTIN Corridors in 2009 and 2040



a. 2009 b. 2040

Source: Africa Transport Outlook 2040, Annex 3.7.

Over the next three decades, Africa's transport planners will have to deal with important changes in the transport environment. Demand presently suppressed by inefficiencies in the transport system will be unlocked by improvements in the system. Steady advances in regional integration will cause a shift from overseas trade to trade between countries within the same REC. Structural change in African economies will foster more value-added industries, changing the profile of goods traded and increasing regional integration. Demand for air passenger services will rise with per capita incomes and urbanization. Containerized cargo will come to dominate port traffic and port traffic growth, increasing the importance of multimodal transport of containers along ARTIN corridors. Transit traffic from landlocked countries will increase more than tenfold over the next 30 years.

3.1.1 Future demand for freight transport

Future freight transport demand in Africa is tied to growth in international trade, which is expected to grow seven-fold (to 3.6 billion metric tons) over the next 30 years (Table 3.1) as countries increase the value added of their exports through processing, consumers with rising incomes import more-expensive goods, and manufacturing and mining businesses import more expensive processing equipment.

Future port tonnage is expected to grow at 6% to 6.8% per year, excluding large new mining projects and crude oil, and at 5.8 to 7.8% per year including new mining projects.

Growth in container traffic is expected to outpace total tonnage. Container growth will average 10.6% per year to 2020 (including some suppressed demand released by corridor improvements) and 7.9% from 2020 to 2040 on a sustained basis (with all suppressed demand released). The net result will be an increase in container traffic to 38 million 20-foot equivalent units (TEUs) by 2020 and 176 million TEUs by 2040, a 14-fold increase.

Bulk traffic growth will depend on mineral development, particularly iron ore and bauxite exploitation. New coal shipments are also expected in ARTIN corridors, as well as more copper metal from the Copper Belt countries, but at lower tonnages than for iron ore and bauxite, which will utilize special purpose-built transport facilities.

Although the trade increases vary across countries, with the poorer countries growing faster from a small base, future trade will still be dominated by five large countries (Algeria, Egypt, Morocco, Nigeria, and South Africa), which account for more than half of total African trade by volume.

For the five regions, trade forecasts show some variation in expected growth, with eastern Africa growing fastest and southern Africa growing slightly slower (from a larger base).

Table 3.1. Trade forecasts by region (millions of metric tons)

Region	2009	2020		2030		2040	
		Volume	Avg. growth (%)	Volume	Avg. growth (%)	Volume	Avg. growth (%)
North Africa	20	235	6.3	410	6.3	760	6.4
West Africa	7	176	6.7	300	6.0	556	6.3
Central Africa	21	43	6.8	77	6.4	145	6.5
East Africa	45	96	7.1	181	7.1	360	7.1
Southern Africa	240	408	4.9	617	4.7	1,001	5.0
Total Africa Base	**513**	**958**	5.8	**1,585**	5.7	**2,823**	5.9
With suppressed demand	**513**	**1,056**	6.3	**1,822**	6.1	**3,397**	6.4
With new minerals	**513**	**1,175**	7.8	**1,998**	5.5	**3,630**	6.2

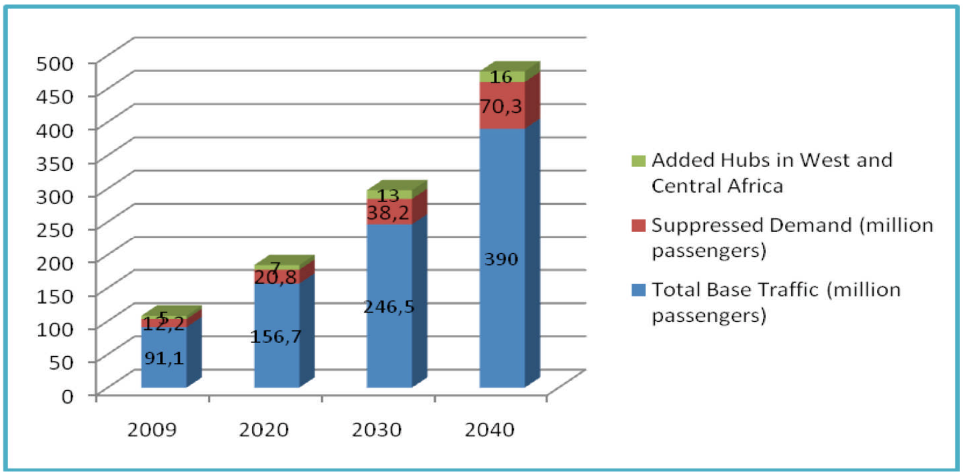
Source: Africa Transport Outlook 2040, Annex 3.2, excluding crude oil.

Transit traffic from landlocked countries is expected to increase 10–14 times over the next 30 years. In West Africa this transit traffic will rise from 6 million tons to 65 million tons in 2040. For Southern Africa, it will increase from 13 million to 148 million tons; and in East Africa from 10 million tons to 149 million tons as Southern Sudan exports through this region. Djibouti will face transit traffic increases from 9 million tons to 76 million tons. 2030 forecasts amount to a third to a half of the 2040 tonnages, but are still 4–5 times current traffic levels.

3.1.2 Future demand for air passenger transport

International air passenger flows are forecast to increase 40–90% by 2020 and by factors of 2.5 to 6 by 2040, including suppressed demand (Figure 3.2). Air passenger flows increase for all countries and RECs but will continue to be dominated by nine countries that are major tourist destinations and major regional air transport hubs. Demand for transport to Europe will be substantial for all RECs, with demand for transport to the Middle East strong for several RECS and to Asia and North America for a few.

Figure 3.2. Forecast air passenger traffic through 2040



Source: Africa Transport Outlook 2040, Annex 3.5.

If two additional regional air traffic hubs are established, one in West Africa and one in Central Africa, air passenger demand in these regions would increase substantially as regional hubbing increases regional air travel and more efficient connections to other regions inflate inter-REC and intercontinental air travel.

3.1.3 Anticipated gaps in transport infrastructure through 2040

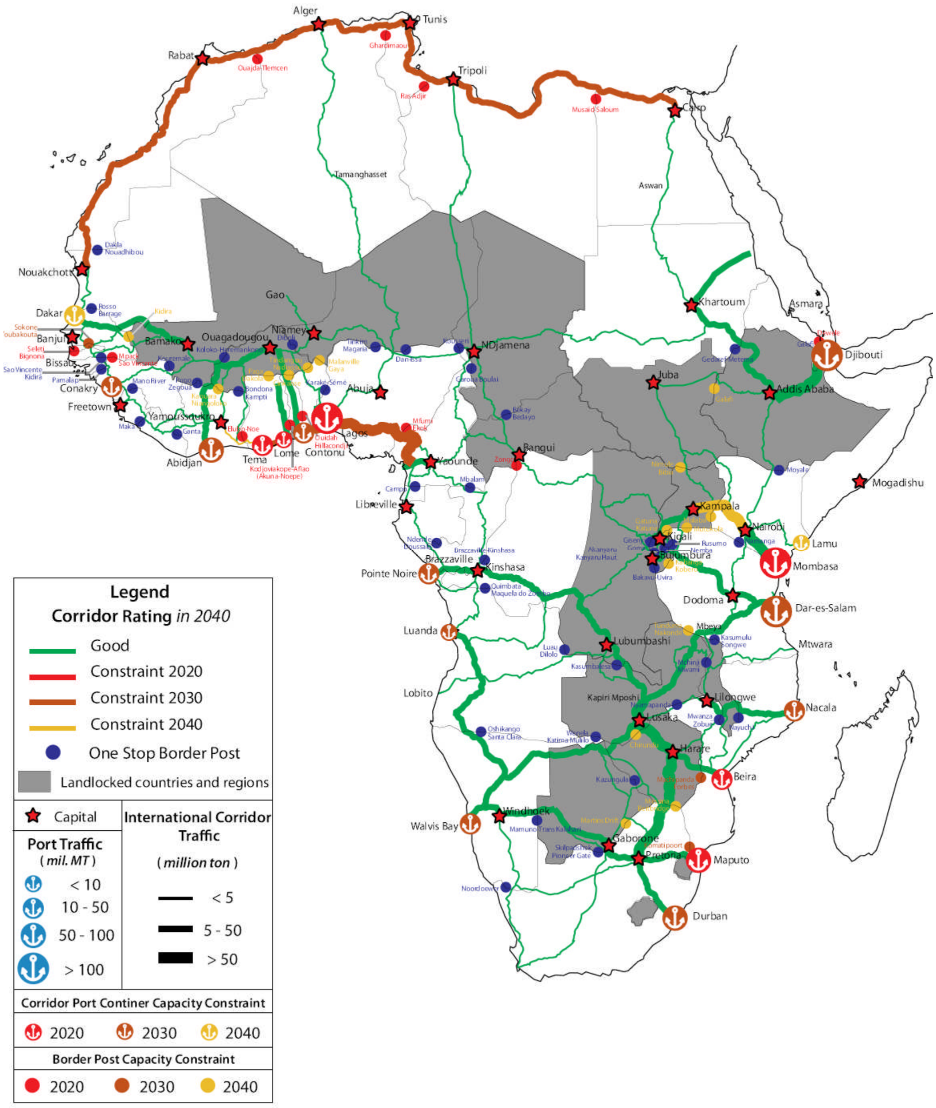
Forecast demand is expected to exceed capacity in all areas of the ARTIN corridors by 2040, even with the completion of planned improvement projects (Figure 3.3). Some gaps will appear as early as 2020. North Africa will be less affected than the rest of the continent, because transit corridors are less a factor in that region.

Improvements in policies, institutional practices, and IT systems have the potential to greatly increase the efficiency and capacity of border posts, ports, railways, and airports (Box 3.2).

Table 3.2. Potential gains in capacity from policy changes and institutional actions

Mode	Type of policy action	Type of Institutional change	% capacity increase
Ports and multimodal facilities	Eliminate constraints on containers for inland use and reduce stripping of containers in ports or inland depots	Developing inland container depots and dry ports to move container processing out of the ports, institute single window, re-engineer customs processes to reduce dwell times	10–30%
Railways	Restructure concession agreements to provide public funding for track improvement and rehabilitation.	Restructure concession agreements to support more equipment and rolling stock provision by private partners, and incentives for best practice management	100–500%
Border posts	Support single window, integrated border management and smart corridor technology to reduce border times	Implement One-Stop Border Posts and smart corridor technology	100–200%
Air navigation system / airports	Develop new means of financing for satellite-based air navigation system	Implement satellite-based air navigation system and change means of financing air navigation	10–30%

Figure 3.3. Forecast capacity gaps in ARTIN corridors



Source: Africa Transport Outlook 2040, Annexes 4.2 and 4.3.

Port capacity gaps

Six ARTIN corridors face short-term port container capacity gaps by 2020 even after currently planned port and terminal expansion projects are completed in West Africa (Tema and Lagos), East Africa (Mombasa), and southern Africa (all Mozambique ports).

In two of the three cases (East and West Africa), growth in domestic demand for port capacity will leave no room to meet the demand for transit traffic to and from landlocked countries. In the third case (southern Africa) domestic demand plus transit traffic will exceed available capacity in 2030, despite a major port expansion in Durban. By 2040 these three regions will have much larger gaps that will require both additional port expansion and new port development.

This situation calls for regional port master planning linked with the development of land transport (most likely through modern railways) to serve the landlocked countries from the new or expanded ports.

Road and border post infrastructure gaps

Four corridors face demand of more than 15,000 vehicles per day by 2030, which will require the construction of modern four-lane motorways. They are the Trans-Maghreb, Abidjan-Lagos, Lagos-Douala, and Maputo corridors.

Nine border crossings are expected to exceed 2,000 heavy goods vehicles (HGVs) per day by 2040, with three reaching that level by 2030. This level of HGV traffic requires special corridor development with modern motorways and special truck facilities. The three priority corridors are the Djibouti, Northern, and North-–South corridors.

The completion of TAH appears also to be a priority underlined by the Study. The best way to complete the TAH and a harmonization of their norms and standards should be tackled on a continental level.

Railway and rail border crossing infrastructure gaps

PIDA's analysis of freight-rail capacity on cross-border railway lines reveals that 6 of the 11 lines will need physical expansion by 2020 even if their operations and equipment are greatly improved to reach good efficiency before then. All 11 cross-border railways will need to be expanded by 2040 to meet demand with efficient mode shares for rail services.

There is scope for building new, modern rail lines in nine of the 11 corridors, where demand by 2040 is expected to exceed 10 million tons. These forecasts assume that the railways will be run as efficiently as Transnet railways in South Africa.

Regional rail master planning needs to be linked to new and expanded port development—a major departure from existing approach to rail planning. New rail connections (and efficient rail operations) will be required as new ports are built and existing ones are expanded, particularly where the expanded port will function as a regional port with significantly larger traffic flows. This approach applies in the Nacala, Lamu, and Lome-Ouagadougou/Niamey corridors.

North Africa faces a second type of railway gap—efficient interconnections across borders. North Africa has been planning for connectivity across the region (and even for a high-speed rail link to Europe), but it has not been achieved.

Gaps in the ARTIN air transport system

Surging demand will expose gaps in the ARTIN air transport system in the areas of air passenger service, air navigation systems, and airport capacity.

Seven airports face demand of more than 3 million air passengers per year by 2040 (over 2 million by 2030). They will need to be expanded. Two of these (Johannesburg and Cairo) may reach over 10 million passengers by 2040.

The capacity of 17 airports will be exceeded by 2020 under base case forecasts. Four are already programmed for expansion, but all airports on the continent will need to be expanded or supplemented by additional airports by 2040 in order to handle the anticipated growth in air traffic (350% to 600% over current air passenger levels).

The high-level air traffic control system will reach saturation between 2020 and 2030 and will need to be replaced with a satellite-based air traffic control system. Gaps in the communications systems at and between airports in many areas of the continent will have to be patched.

Africa's air traffic control and navigation systems suffer other major gaps with negative implications for air travel safety. Some areas are not equipped with traditional navigation aids (VOR, DME), and **the precision of vertical guidance during airport approaches is often poor**.

Achieve Upper Air space Integration by 2040 appears to be also an objective.

Many regional airports are not equipped to handle larger aircraft. Air traffic between Africa and Europe is impeded by differences in air navigation systems. All of these gaps could be addressed through the extension of the European EGNOS satellite navigation system.

3.2 Demand for energy through 2040

Africa's abundant energy resources in oil, gas, coal, and especially hydropower are unevenly distributed across a compartmentalized continent, resulting in underexploitation in some areas and scarcity and inordinately high expenses in others. As energy resources go unexploited, demand goes unserved, impeding Africa's human development and taxing its businesses.

Most known oil and gas reserves are in North and West Africa, while hydropower potential is strong in East, Central, and West Africa. The south has coal reserves; Morocco and Egypt can benefit from wind generation. Solar power is promising in North Africa. And the eastern part of the continent offers significant geothermal potential. Will these sources be enough to keep pace with growing demand?

Behind the underexploitation of energy resources lies poor capacity to mobilize financing for investment, especially from private sources, owing to the poor creditworthiness of countries and utilities and high political risks.

The whole of Africa has just 125 GW of generating capacity (comparable to that of the United Kingdom) and just 90,000 km of power transmission lines. The gas and petroleum product pipeline systems are limited.

Yet after taking into account the potential for energy efficiency gains energy demand in Africa is projected to increase by an average 5.7% annually through 2040 to 3,188 TWh, a 5.4 fold increase. The projected rate of increase in demand for electricity is much greater than in the past, when demand was heavily constrained by shortages and rationing.

The modernization of Africa's economies, coupled with social progress and a commitment to widening access to electricity, will boost the continent's per capita energy consumption in coming years, raising it from its present level of 612 kWh per capita in 2011, the lowest of any world region, to 1,757 kWh per capita by 2040. This translates to an unprecedented 3.7% increase per year.

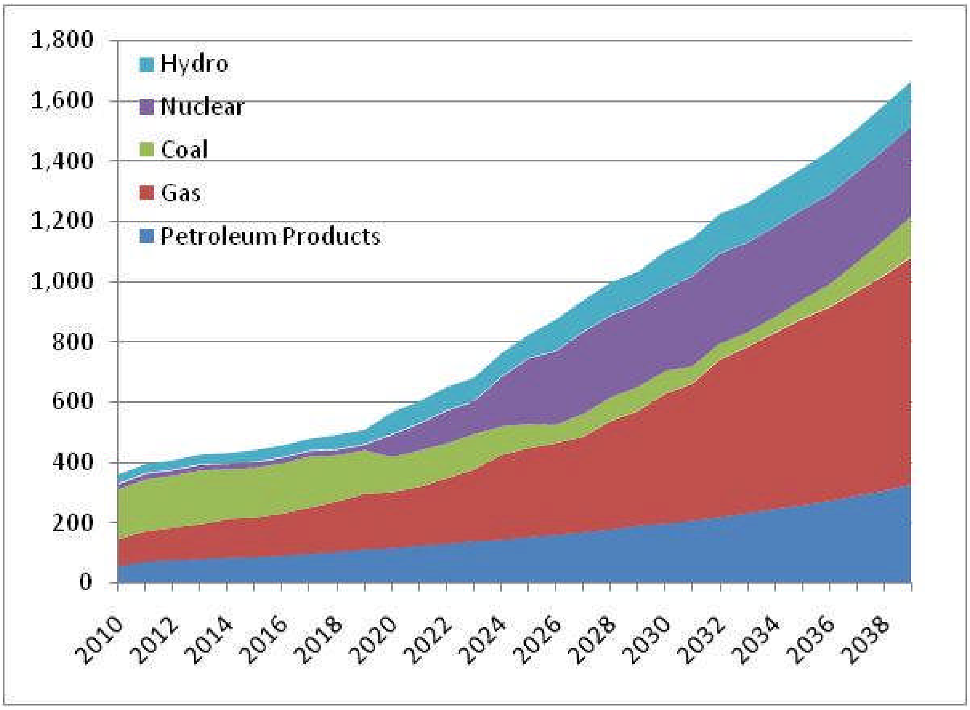
The total demand from industry is projected to increase from 431 TWh in 2011 to 1,806 TWh by 2040, an annual growth rate of 5.1%. This trend does not clash with the expected rapid development of extractive industries, as the bulk of the demand from these industries is projected to be met by self-generation.

To keep pace, generation capacity must increase by 6% per year to 694 GW in 2040, a six-fold increase. Energy efficiency policies are expected to save 139 MW (16.7%) in capacity needs and 634 TWh in energy produced (16.6%), highlighting the importance of diligent implementation of energy efficiency policies.

Even as nuclear power supplements existing energy sources and known hydropower potential is fully exploited, the continent will continue to rely on fossil fuels. Per capita consumption will increase at an unprecedented 3.7% per annum.

Africa's demand for primary energy (excluding biomass used by households) is expected to increase by 8.9% annually through 2040. The role of coal will fall, as gas and nuclear power are developed (Figure 3.4). The rapid increase in consumption of liquid petroleum products reflects growing transport demand.

Figure 3.4. Consumption fossil and hydro primary energy of Africa (in million TOE)



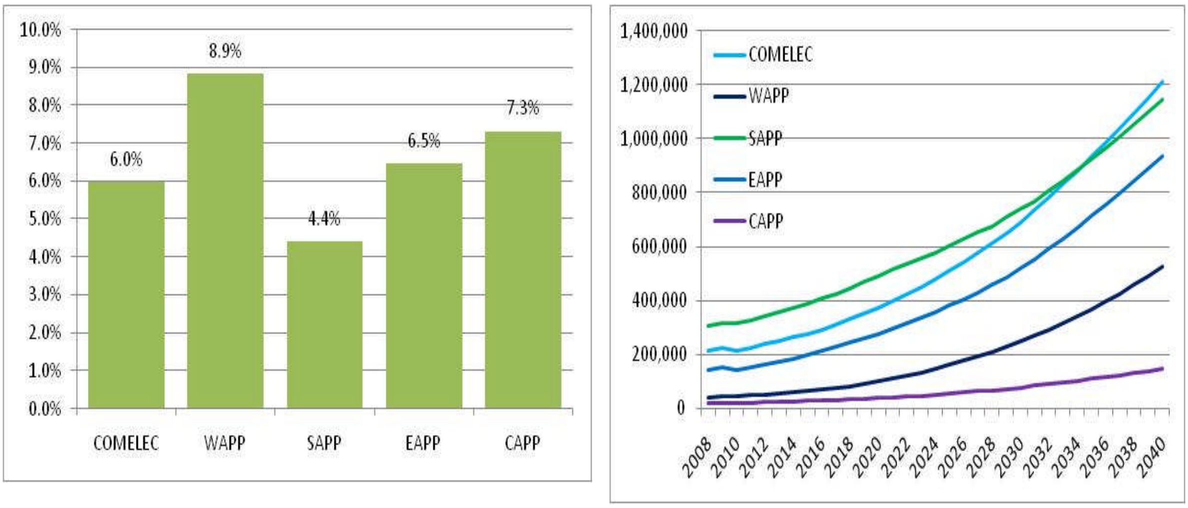
Source Africa Energy Outlook 2040

A major challenge for Africa will be to meet the continued and increasing dependence on petroleum products from continental resources through the development of refineries supplied by African crude, and of pipelines to transport increasing volumes of petroleum products.

3.2.1 Energy outlook by region

Demand will increase faster in WAPP and CAPP than in the other pools because demand growth in large countries such as South Africa and Egypt is expected to be slower than in less-developed areas (Figure 3.5). In terms of consumption per capita, the rapid demographic growth of Sub-Saharan Africa will pull down the per capita consumption of electricity.

Figure 3.5. Annual growth rate (%) and increase in demand (in GWh) by power pool, 2011–40



Source Africa Energy Outlook 2040

Through 2040 COMELEC will experience an increase in demand by 6.2% per annum. Demand from new connections will be limited because access is already close to 95%. It is expected that 298 GW of capacity will have to be added.

Total demand in SAPP will increase by just 4.4% because of lagging growth in South Africa. The region will still have to add 129 GW in capacity (a 250% increase) to meet projected demand over the 2011–40 period. Access is expected to swell from 25% to 64%.

With rapid growth in WAPP's low-income countries, demand will increase rapidly (by 8.9% annually), requiring an additional 90 GW of capacity, a 1,200% increase from the current level. Access will rise from 45% to 67%, reflecting gains in Ghana and Nigeria.

Some 26 GW of new capacity (a 670% increase) will be needed to meet CAPP's growing demand for power. Access to electricity in the region will increase from 21% to 63%.

EAPP's demand is expected to grow by a moderate 6.5% per year because of relatively slow growth in Egypt. Meeting that demand will require 140 GW of new capacity, a 525% increase. The access rate will increase substantially from 37% to 68%, largely due to gains in Egypt.

The RECs will continue to have very diverse primary energy mixes, with COMELEC and EAPP (Egypt) relying heavily on gas and petroleum products, while WAPP will have a more balanced mix of petroleum products, gas, and coal. CAPP will rely essentially on petroleum products. SAPP will reduce its consumption of coal as nuclear energy expands.

3.2.2 Electricity investments and regional integration

The degree of regional integration achieved during the period will affect investment patterns, the energy mix, and energy costs. Greater Integration will lower fuel costs but require more capital investment because integration increases the economic viability of large hydropower plants, which are more expensive to build than thermal plants but produce cheaper power and cost less to maintain and operate.

Overall, full integration and unlimited trade in power would save $1.24 trillion over the 2011–40 period—$42 billion each year and fully 23% of the cost of the continent's electricity (Table 3.2).

But because full integration is not likely to be achieved during the study period, a more realistic integration scenario would still save $904 billion over the 2011–40 period—17% of the cost of electricity. The moderate scenario is considered the most realistic for planning purposes.

High and moderate integration scenarios lead to more thermal generation during the 2014–20 period, while hydro plants are being developed, but large savings in the 2020–40 period.

This expansion could be achieved by keeping energy tariffs in the $0.08–0.10 range.

Table 3.3. Effects of alternative trade scenarios on energy costs (US$ millions)

	Investment			O & M	Fuel cost	Total cost
	Generation	Access	Total			
Low trade	744,591	96,544	841,135	346,178	4,082,001	5,269,313
High trade	773,541	96,544	870,085	363,191	2,918,251	4,151,527
Moderate trade	861,725	96,544	958,269	357,556	3,091,826	4,407,654
Gain of full integration	–28,950	0	–28,950	–17,014	1,163,750	1,117,787
Gain of moderate integration	–117,133	0	–117,133	–11,378	990,171	861, 660
Loss of moderate integration compared with full integration	88,184	0	88,184	-5,635	173,579	256,127

3.3 Demand for transboundary water resources through 2040

Africa's water requirements are expected to increase significantly by 2040, with irrigated agriculture by far the largest consumer. Although much of Africa has abundant water resources, water requirements of the domestic, agricultural and industrial sectors are catching up with availability at the continental scale.

In some African basins water demand will soon outstrip available resources if no improvements in management and efficiency of use are made. As demand strains resources, the competition between water use sectors and the environment is likely to increase.

As Africa's population grows—it is expected to almost double between now and 2040—the demand for food (notably cereals such as wheat, maize, and rice) will double as well. Meeting that demand depends on successful expansion of irrigated agriculture, as well as improvements in rain-fed agricultural practices and increased cereal imports.

Presently, however, Africa has the lowest level of irrigated agriculture of any world region. Water storage (e.g., behind new hydroelectric dams) will have to increase if large-scale irrigation schemes are to succeed.

Investments in water infrastructure are highly dependent on integration with transport and energy networks. They can be effective only when integrated into coherent, cross-sectoral development strategies and infrastructure investment programmes.

3.3.1 Current and forecast water withdrawals and requirements at continental level

The water requirements reported here will vary with population growth and the degree of expansion of irrigation over the next three decades.[4] Those variations are the basis for alternate scenarios for the African continent. For each scenario, the gross volumes of water that must be withdrawn from the river system for domestic, industrial, and agricultural uses, and the amount lost to evaporation are shown in Figure 3.6. The total water withdrawals for the reference year 2005 are shown for comparative purposes.

Gross water requirements are the volumes of water withdrawn from rivers, reservoirs, and aquifer, whereas net water requirements refer to the amount used for actual consumption. The difference is made up of the combined losses that occur between point of abstraction and point of use.

In 2005, the volume of water withdrawn from river systems across Africa was about 265 km^3 per year, of which 66 km^3 was lost by evaporation losses from man-made reservoirs, 9 km^3/y was taken for industrial uses, 21 km^3 went for domestic uses, and 170 km^3 went to the agricultural sector.

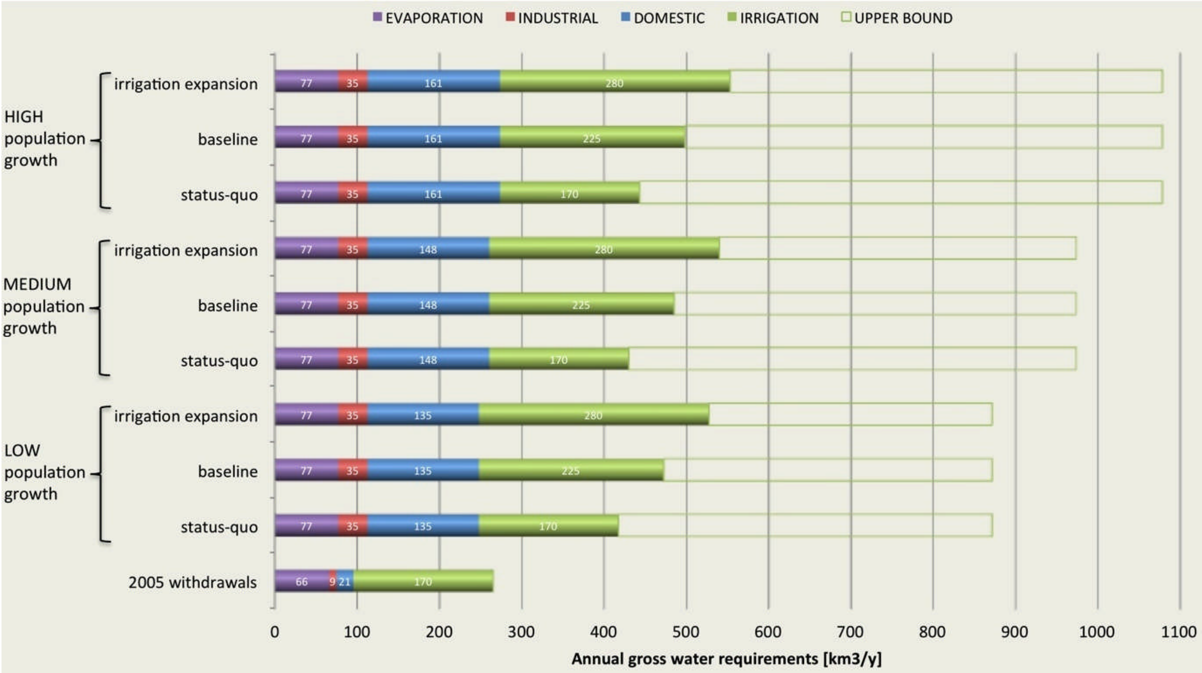
By 2040, the gross water requirement for domestic uses will range between 135 and 161 km^3 per year, depending on population growth. At the estimated annual GDP growth rate of 6.2%, gross water requirements for industrial use will total around 35 km^3 per year. Evaporation losses from man-made reservoirs, totalling around 77 km^3 per year, will be more than twice the requirement for industrial use.

By contrast, *net* consumption for the year 2005 was about 165 km3/y. By the year 2040, the forecasted net annual water requirement could range from 248 to 318 km3/y, depending on the development scenario considered, with an upper limit of around 580 km3 per year.

Actual water withdrawals for agriculture will depend on a series of economic, technical, climatic, and political choices and factors that are difficult to estimate. However, modelling the four scenarios for the development of irrigated agriculture provides a good indication of the expected order of magnitude of future withdrawals for irrigation. The scenarios begin with the status quo, in which the current situation in the irrigation sector remained unchanged through 2040, and end with the theoretical upper bound, in which irrigation expansion would account for 100% of increases in food requirements. Between these extremes lie a scenario ("business as usual") in which the rate of growth in irrigated area for the 30 years ending in 2008 remains constant through 2040, and another in which that rate of growth doubles. The four scenarios produce estimates of annual water requirements for irrigation in 2040 of between 170 km^3 and 580 km^3.

[4] The "low", "medium", and "high" variants of the World Population Prospects database are used. http://esa.un.org/unpp/index.asp?panel=3

Figure 3.6. Gross water requirements in Africa in 2005 and 2040 under various scenarios



Source: Africa TWR Outlook 2040

Under all but the upper-bound scenario, the gap between food production and demand would be filled by rain-fed agriculture and international imports.

In 2005 domestic (household) consumption accounted for 8% of total gross requirements, industry for 3%, and irrigation for 64.1%, with 25% lost to evaporation. In 2040 irrigation will still be the major water user in Africa. However, its share of the gross water requirement will decrease, while the shares of domestic and industrial users are likely to triple and double, respectively.

The picture is similar in the basins covered by the PIDA study.[5] In 2005, the total gross water requirement of the selected basins was 62% of that of the African continent (162 km^3 per year for the PIDA basins against 265 km^3 per year for the African continent).

The shares of water absorbed by households, industry, agriculture, and evaporation in the PIDA basins are comparable to the pattern for Africa as a whole.

The results presented above need to be interpreted with some caution. Although they are useful in indicating the challenges of the next three decades, additional factors must be considered when doing strategic planning at the basin level. For example, seasonal and inter-annual variability and environmental requirements must be factored in.

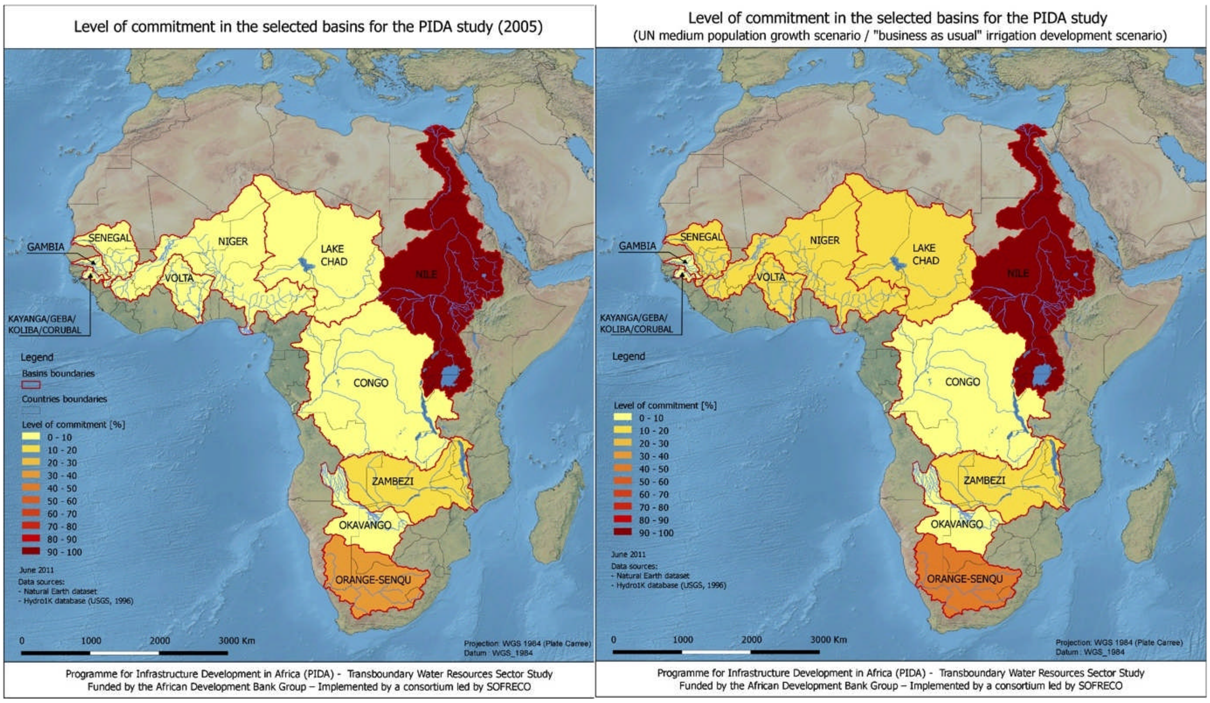
3.3.2 Gaps between net water requirements and available water resources

Under the irrigation-development scenarios, the residual volume in the Nile basin, now about 3 km^3/y, would fall to zero, as the water resources of the basin are already almost fully committed (Figure 3.7, left).[6] By 2040, the level of commitment of the other PIDA basins will

[5] The PIDA study focuses on 10 lake and river basins, namely Lake Chad, Congo, Gambia-Geba-Koliba, Niger, Nile, Okavango, Orange-Senqu, Senegal, Volta and Zambezi. The selected basins border on most of the African countries and account for 51.5% of African land area and 80% of the total area of the African international basins.
[6] The level of commitment of a river basin is the ratio between water consumption and the natural renewable resource available in the river basin.

range from a low of 0.8% in the Congo to 20% in the Volta and Zambezi basins (Figure 3.7, right).

Figure 3.7. Level of commitment of selected basins in 2005 (left) and in 2040 under a medium population growth scenario and the "business as usual" irrigation development scenario (right)



Although the Nile is the only basin where future requirements are likely to rapidly exceed the available resources, in several other basins it will be difficult to meet projected requirements without damaging the environment, which calls for well-informed political decisions. In the Niger basin, for example, the annual volume of water reaching the Gulf of Guinea will fall from 167.90 km^3/y currently to about 150 km^3/y in 2040 if future water requirements for industrial, domestic and irrigation uses are fully met.

The limits of hydropower

The current capacity of hydropower plants (operational and under construction) in the 10 basins selected for the PIDA study is estimated to be 15,800 MW. By 2040, the planning model of the PIDA consultant estimates that an additional 72,500 MW will have been commissioned in the selected basins, two-thirds in the Congo basin alone (Table 3.3).

Table 3.3. Hydropower capacity in 10 African basins

Basin	Operational	Under construction	Planned	Potential
Lake Chad	0	0	75	Unknown
Congo	840	0	46,957	123,600
Gambia-Geba-Koliba	0	0	120	4,000
Niger	2,068	0	1 054	6,000
Nile	5,407	185	13,404	45,000
Okavango	0	0	0	400
Orange-Senqu	625	0	77	Unknown
Senegal	216	0	609	2,000
Volta	1,511	0	538	2,500
Zambezi	4,904	0	9,729	16,000

Source Africa TWR Outlook 2040

Once this significant increase in hydropower production is realized, however, hydropower will represent only about 16% of peak power demand in 2040 (about 694 GW). Even if the full hydropower potential of the selected basins were exploited—unlikely for a variety of reasons ranging from social and environmental concerns to political instability and associated lack of security of investments—hydropower would cover no more than 35.1% of the forecast demand.

The limits of irrigation

In 2005, cereal consumption in Africa (production + imports – exports) was 192 million tons, of which 34 million tons were produced under irrigation. The difference was provided by rainfed agriculture (108 million tons) and net imports (50 million tons).

By 2040, under the "business as usual" irrigation-development scenario and assuming medium population growth, irrigated cereal production will be about 67 million tons against cereal requirements of about 319 million tons. As a consequence, 252 million tons of cereal will have to be provided by rainfed agriculture or imported.

Expanding irrigation is expensive. As water resources become more and more scarce, priority should be given to the production of high-value crops and maximizing the considerable potential for improved rain-fed agriculture, especially for small holders.

Intensifying food production will require raising agricultural productivity, finding the right balance between rainfed and irrigated agriculture, expanding irrigated areas where doing so is especially advantageous, increasing irrigation efficiency (e.g., through the use of drip systems), increasing the yield of stressed river basins, and weighing the possibility of interbasin water transfers.

3.4 Demand for information and communication technology through 2018

Africa's ICT sector will continue to grow rapidly over the coming decades, with the lion's share of investment coming from private enterprise. But if those investments are to generate the greatest possible economic benefit and if healthy competition is to bring prices down and expand access to millions more Africans, several conditions must be met.

First, operators in every country must have access to intercontinental bandwidth through competitive gateways to submarine cable landing stations. Second, the regional fibre optic infrastructure must be free of missing links. Third, Africa's countries must complete their telecommunications reforms at the national level, eradicating the vestiges of past monopolies, expanding competition in the widest array of services, and enabling the private sector to redouble its already considerable investment in Africa's ICT infrastructure. Fourth, the RECs must increase their capacity to help national governments harmonise their technical and regulatory practices along the lines already developed by the RECs. And fifth, Africa must strive to develop its own IXPs and data centres to lower bandwidth costs.

The continental and regional infrastructure discussed here is end-to-end fibre optic cable capable of carrying data traffic from one country to a submarine cable landing station in another country, as well as networks that use national infrastructure to obtain better connectivity between two or more countries. The goal in both cases is to improve international connectivity and improve broadband services for African consumers.

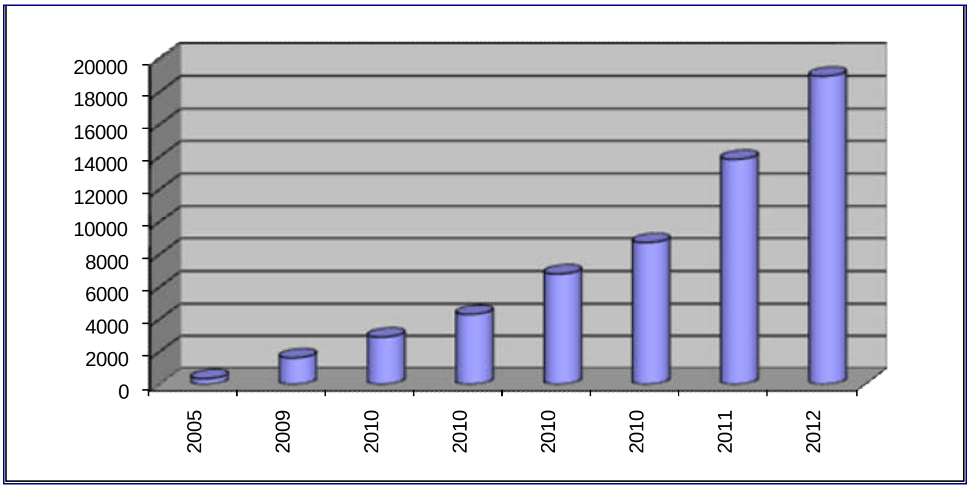
For regional infrastructure to meet the criteria of open access and promotion of competitiveness, it must possess an interconnection point where operators can physically connect their equipment to the regional infrastructure. It must have sites along its entire length that allow operators to install optic amplifiers or other equipment required for transmission. An interconnection catalogue must provide prices and technical specifications for the use of the regional infrastructure.

3.4.1 Requirements for broadband development

Africa was long deprived of access to submarine cables. But the rapid expansion of submarine cables off Africa's east and west coasts over the past several years has brought ample international bandwidth within easy reach of every country in Africa (Figure 3.8).

The bandwidth now or soon to be available to Sub-Saharan Africa is relatively well distributed between the east and west coasts, with hubs in several countries, including Nigeria, Senegal, Ghana, Angola, South Africa, and Djibouti.

Figure 3.8. Submarine cable bandwidth off Africa's coasts in Gbits, 2005–12



Source: Africa ICT Outlook 2030.

With intercontinental bandwidth waiting offshore, the expansion of access to high-speed Internet in Africa will depend on (i) the degree of competition in the delivery of that bandwidth to telecommunications companies, (ii) the presence of land-based optical infrastructure capable of moving large quantities of data between the submarine cable landing stations and the 3G/LTE transmitters that serve consumers in the absence of wired networks, and (iii) governments' willingness to grant 3G licenses to competitive telecommunications operators and to make spectrum available at an affordable price. The first two points are expanded below.

Access to intercontinental bandwidth on competitive terms. Broadband development cannot occur unless a large quantity of reliable intercontinental bandwidth is available to telecommunications companies *at a reasonable cost*. That requirement is sometimes impeded by de facto or de jure monopolies created or tolerated under a country's legal and regulatory framework. Where existing fibre optic infrastructure is controlled by the historical telecommunications incumbent, it is rarely offered to private operators at a reasonable price, a reflection of the absence of price regulation in the wholesale market.

Construction or expansion of optical backbone and backhaul networks. More than 90% of the infrastructure installed by mobile operators in Africa uses radio link technology, which has a technical capacity of several Mbps and requires closely spaced relays, especially if speed is to be maintained. Private operators have favoured radio technology because it is cheap and quickly installed, but also because they are generally prevented by regulations from using other land-based methods—a sticking point for 3G/LTE migration.

At present, no official inventory exists of the land-based fibre optic infrastructure deployed by operators. According to Africa Bandwidth Maps, a total of 300,000 km was operational in Africa in 2010, with another 50,000 km under construction and 80,000 km planned. Often that infrastructure is underused or not fully interconnected. The many missing links that remain in national fibre optic networks must be closed before the existing assets can contribute to a dynamic regional network.

Fibre optic infrastructure is unequally distributed on the continent. Only a few countries (Morocco, Tunisia, Senegal, Mauritius, and, to a less extent South Africa) have invested heavily in the land-based infrastructure needed to support wired and mobile broadband development. Countries with a favourable regulatory framework (e.g., Kenya, Nigeria, Morocco, Tunisia, and Uganda) have a portion of the necessary infrastructure. In other countries (such as Cameroon, Chad, the Democratic Republic of Congo, Gabon, and Togo) fibre optic infrastructure is practically nonexistent, often because of unfavourable laws, policies, and regulations.

Neither 2G base stations nor current radio links built to carry voice traffic will be able to support broadband development or migration to 3G (30–59 Mbps) or LTE (>300 Mbps). 3G stations quickly become saturated when 3G Internet service is offered as a replacement for ADSL-type fixed service. The unsuitability of the current infrastructure will erase much of the value of investments made over the past 5–7 years. Carried out primarily by private operators, with each building its own backbone, these deployments are largely duplicative. Only since 2010, aware of the need to optimise investments, have operators begun to share towers, often through specialised companies.

Since 2010 alternative carrier-to-carrier operators have begun to emerge in some countries (including Morocco and Nigeria) and regions (EAC, COMESA, SADC) following changes in national regulations.[7]

3.4.2 Bandwidth projections (2015–18)

Although projecting bandwidth needs even a few years into the future is an uncertain business, there is no doubt that broadband connectivity and traffic are growing rapidly, following the trail blazed by mobile voice services. Continental demand for intercontinental bandwidth is likely to swell by a factor of 20 from the 308 Gbps used in 2009 to more 6,000 Gbps (Table 3.4 and Figure 3.9).

The bandwidth demand projections presented here assume that intercontinental bandwidth will be available in sufficient quantity (60 kbps per connection) in all countries at a competitive price. By the end of 2012 ample intercontinental bandwidth is indeed likely to be available to all coastal countries, leaving only the key questions of price and competition to be resolved.

The projections are also based on the assumption that land-based backbone and backhaul infrastructure sufficient to carry national and international bandwidth reliably and economically will be put in place. Finally, it is assumed that 3G/LTE service will be available in densely populated areas (capitals, large cities) and that high-speed service will be affordable enough to attract 10% of the population, with 20–30% having at least reasonable access to the Internet. Plan prices will depend on the costs of licenses and frequency.

The digital divide between Egypt and the Maghreb, on the one hand, and Sub-Saharan Africa, on the other, is evident from the table, as is the divide between the landlocked countries and ECCAS, on the one hand, and the rest of the continent, on the other. ECCAS's lag is explained by the subregion's tardiness in enacting even minimum reform of the legal and regulatory framework and the monopoly over SAT3 services in most countries of the region. IGAD's deficit is smaller thanks to the presence of an international hub in Djibouti and legal reforms in Kenya.

Table 3.4. Projected international bandwidth by REC and for Africa as a whole

International bandwidth	Africa	COMESA	SADC	EAC	ECOWAS	CEEAC	UMA	LLC	IGAD
2009 (Gbps)	308	125	42	15	26	4	118	6	20
2015–18 (Gbps)	6 000	3 000	2 000	800	2 000	800	500	1 500	500
Growth factor	20	24	50	50	80	200	4	250	25

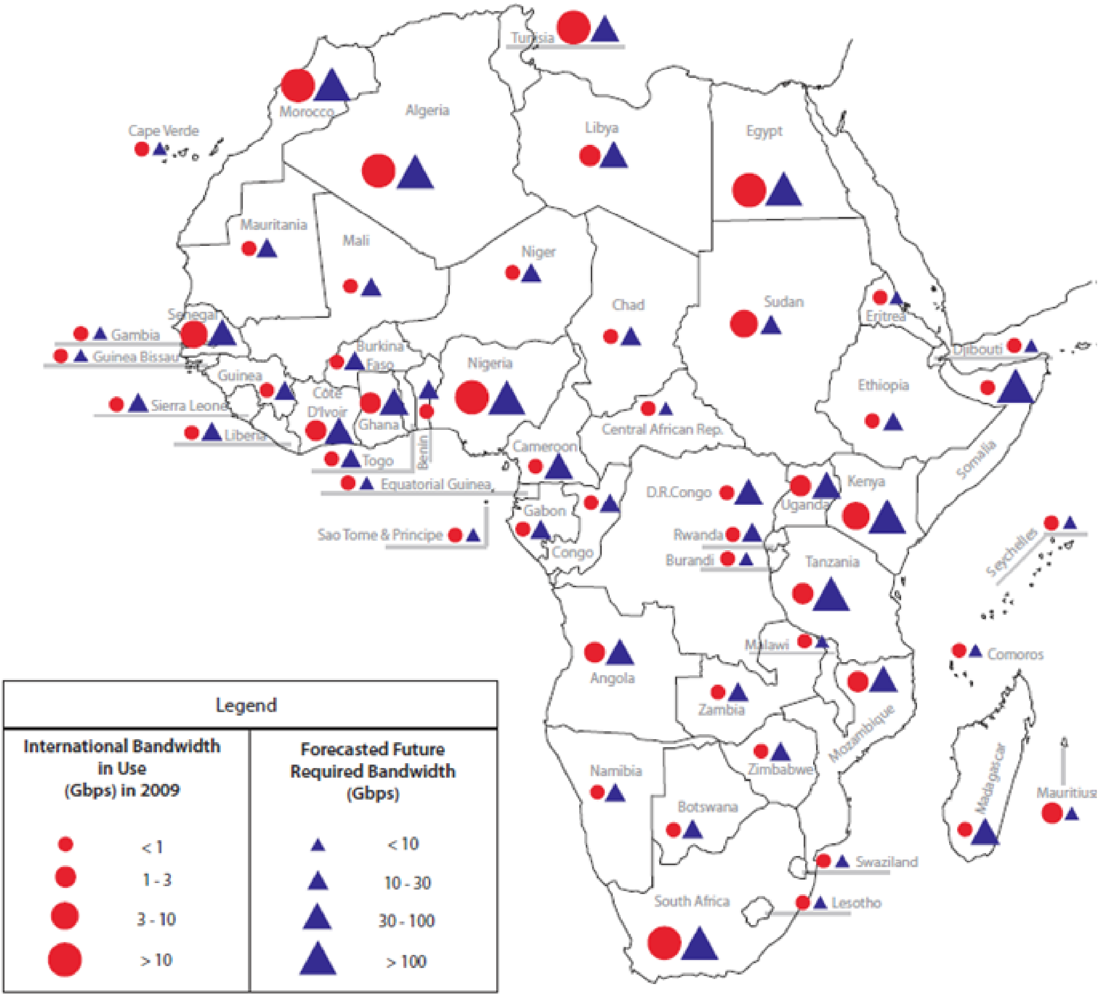
Source: Africa ICT Outlook 2030.

Note: LLC = landlocked countries.

[7] See Phase I report on privately operated fibre optic infrastructure.

The projections offered here are realistic objectives for African leaders. The most advanced or determined countries could meet the objective by 2012–14, whereas those that have the farthest to go in reforming their legal and regulatory framework or in building their national backbone and backhaul infrastructure may need until 2015–18 to reach it.

Figure 3.9. International bandwidth usage by country, 2009 and projected (2018)



Source: Africa ICT Outlook 2030.

3.4.3 Facets of Internet demand in Africa

Lessons already apparent from the growth of Internet usage in African countries offer hints about the likely profile of future demand.

Household traffic is becoming more important than business traffic in countries where operators offer high-speed Internet access in residential areas. Traffic peaks are created by residential usage, showing that the Internet has become an important part of consumers' life.[8]

In other respects as well telecommunications consumers in Africa are very similar to those in the rest of the world, although the near-absence in Africa of wired Internet services, coupled with the high expense of satellite-based services, has resulted in pent-up demand that manifests itself as soon as affordable services are made available.

[8] Peak bandwidth is the value that operators use to determine the capacity of their equipment.

There is great similarity between the bandwidth consumed by African users of mobile high-speed Internet and users of ADSL in the advanced countries. Africa's broadband users want 40–80 kbits of intercontinental bandwidth and 2–3 times more in onNet, particularly if part of a VoIP and TV package.

As elsewhere, African consumers are very sensitive to the terms and plans offered by companies. In those African countries that have the best access to high-speed Internet (ADSL2+, VDSL, Box 3G, and Clé 3G in Morocco, Senegal, Tunisia), the bandwidth per user allotted by operators is very similar to that offered in the industrialised world.

High-speed 3G box Internet double-play plans offering VoIP access have, along with single-play plans, assumed the role of similar schemes in industrialised countries based on ADSL or cable-modem technologies, with similar usage patterns. Their uptake by African consumers has been much faster, however, given the pressure of pent-up demand. In Africa, offerings of mobile high-speed Internet are not correlated with 3G voice and smartphone offerings, as they are in the advanced countries, because in Africa the former are a substitute for (unavailable) land-based services.

3.4.4 Conclusion

Africa's late entry into the Internet race may prove an opportunity by allowing the continent to avoid overinvestment, bad investments, and the burden of legacy infrastructure while skipping ahead to the next generation of technologies.

Taking advantage of that opportunity will require legal and regulatory reform in many countries, both to attract new investment and to optimize the use of existing infrastructure.

Governments and regulators must rededicate themselves to the task of creating and maintaining a favourable framework for investment and competition, while eschewing the role of managing the roll-out of communications networks. Their role includes that of ensuring (through subsidies and other incentives) that isolated parts of their territories are not forgotten.

Free and nondiscriminatory access to submarine cable landing stations must be assured for all operators, including those in land-locked countries that must pass through coastal countries to reach landing stations.

The construction of cross-border infrastructures such as fibre-optic backbones must be facilitated by further liberalisation and an agreement that binds all of the continent's countries to simplify the process of installing infrastructure.

The goal of ICT policy in the advanced countries is no longer access to broadband but universal access to services offering speeds of 30 to 100 Mbps through the use of new infrastructure, particularly FTTH technology, capable of carrying the rapidly growing data streams generated by new applications used on an exploding base of new digital devices.

Europe has its Digital Agenda for Europe–2020; Australia its RNHD programme. The United States, Korea, Japan, and Singapore all have strategies to achieve very high speed coverage between 2020 and 2030. Africa, too, should pursue the goal of very high speed broadband, so as to allow it to close the digital divide more quickly, leapfrogging over existing technologies. By ensuring that even short-term investments are consistent with the longer-term goal of very high speed access it should be possible to lower overall investment costs over the 2020–30 horizon.

4. BRIDGING INFRASTRUCTURE GAPS: THE PROMISE AND CHALLENGE OF REGIONAL INTEGRATION

Ensuring that growing demand for regional infrastructure is met, and that infrastructure deficits do not choke off growth, will require a determinedly coordinated regional approach. Because Africa's economic geography is particularly challenging, regional integration is the best, perhaps the only, way for Africa to realize its growth potential, participate effectively in the global economy, and share the benefits of globalisation. Getting there presents major challenges, as recent experience has shown, but promises ample rewards.

4.1 The promise of regional integration

Many of Africa's 54 countries are very small, with populations of fewer than 20 million and economies smaller than $10 billion—too small to grow on their own. Their infrastructure systems, like their borders, are reflections of the continent's colonial past, with roads, ports, and railroads built for resource extraction and political control, rather than to bind territories together economically or socially.

Integration was a goal of the continent's leaders in the struggle for independence. Kwame Nkrumah established the short-lived United States of Africa in the late 1950s, followed by the Organisation of African Unity (1963–2002), which was succeeded by the AU (2002–present). The process of economic integration gained traction with the 1991 Abuja Treaty that established the African Economic Community. Its article 28 proposed the creation of the RECs as the building blocks of African integration with continental integration to be achieved by 2028.

Integration efforts in Africa, including regional infrastructure, have already resulted in increased trade, as they have in other regions that followed a similar path (Box 4.1). Intra-African (and intra-REC) trade grew significantly from 2000 to 2009 in coastal and landlocked countries alike. But as a share of Africa's total imports, intra-African imports stagnated at 9% over the period 2000–07, during a time when Africa's share in world exports was growing (from 2.4% to 2.9%) (UNECA 2010).

The essential benefit of regional infrastructure is to make possible the formation of large, competitive markets in place of the present collection of small, isolated, and inefficient ones. Regional infrastructure does this by *slashing transport costs* (in particular to and from hinterlands and landlocked countries); *establishing connectivity* so that goods can reach markets and people can exchange information and reach jobs; *providing lower-cost energy* for expanding agricultural, industrial and mining production; and developing and sharing water resources in ways that simultaneously increase food production, generate electricity, and protect the continent's natural environment.

Shared regional infrastructure is the only solution to problems of small scale and adverse location. Economies of scale are particularly important in the power and ICT sectors. Big hydropower projects that would not be economically viable for a single country make sense when neighbours share their benefits. Connecting countries to submarine cables requires large up-front investments in cross-border backbone infrastructure. Regional air and seaports are a necessity for a continent with so many small and land-locked countries.

An important but underappreciated benefit of regional infrastructure is its effect on trade within Africa. As regional integration improves the competitiveness of African producers and brings millions more consumers within their reach, Africa will see a swelling of intra- and inter-regional trade as a share of all trade.

Regional infrastructure also exploits and advances synergies among sectors. One salient example is multipurpose dams that store water for irrigation, domestic and industrial consumption, hydropower generation, navigation, environmental needs, and flood control. Another example of synergy is provided by power transmission lines that carry fibre-optic cables and road projects that incorporate the laying of communications cables. A third is that of “virtual water trade strategies” (Box 4.2). Only planning performed on a regional level can focus on and fully exploit such synergies.

Box 4.1. Regional integration around the world

Successful examples of regional integration elsewhere in the world include the knitting together of the far-flung United States during and following its expansion. The interstate highway system begun in the 1950s fuelled a rapid increase in continental trade and honed the competitiveness of American firms.

The European Union, mapped out in the Treaty of Rome of 1957, is another example of the benefits of economic integration. The EU provides valuable guidance on how the essential concept of subsidiarity can be effectively implemented. Subsidiarity holds that each aspect of infrastructure (or any other policy matter) should be dealt with at the most appropriate level—continental, regional, subregional, or national.

Since its inception in 2000, the Initiative for the Integration of Regional Infrastructure in South America, which has many similarities with PIDA, has identified 514 infrastructure projects, totalling $69 billon, financed for 21% by local public funds, 25% by IFIs, 35% through PPP, and 19% by the private sector.

Box 4.2. Regional integration and cross-sector synergies—The example of "virtual water"

Water resources are unevenly distributed across Africa. For that reason, some countries must continue to rely on food imports while others have huge potential to become food exporters (even when using mostly rain-fed agriculture).

In this context the possibility of so-called "virtual water trade strategies" should be explored. Virtual water refers to the quantity of water used in the production of a product. Trade in virtual water would allow water-scarce countries to mitigate their scarcity by importing large amounts of virtual water instead of building new water supply infrastructure. In other words, water-scarce countries could import grain (which requires significant amounts of water during production) instead of producing it locally. By exporting foodstuffs, on the other hand, water-rich countries could make use of their water abundance by exporting water-intensive goods, primarily agricultural products. While such virtual water trade is already practised, its implementation on a regional scale within Africa has just begun to be considered. The Nile Basin Initiative (NBI) has recently commissioned a study exploring the possibility of a virtual water trade strategy for Nile basin states.

Any trade-based solution, whether virtual water trade or other strategies, requires significant improvements in trade regimes and supporting infrastructure, mainly transport. Even if the countries with high export potential were able to produce enough foodstuffs for export interregional grain trade would be impeded by the numerous trade barriers still in place. Despite the establishment of free-trade areas (for example, the launch of a regional trade bloc comprising the members of SADC, EAC, and COMESA in June 2011), the elimination of tariff and non-tariff barrier has been neglected. Likewise, where large volumes of cereal must be moved, high transport costs will toll heavily on competitiveness. Africa's agricultural producers already have to overcome disadvantages resulting from the distorted nature of international agricultural trade (largely related to agricultural subsidies in major developed economies). Regional initiatives to build a functioning and cost-effective regional transport network must be intensified to overcome these disadvantages by exploiting transport synergies.

Similar synergies are apparent in the links between investments in water infrastructure and energy. Water, used to generate hydropower, is already a substantial component of the continent's overall energy generation capacity and could become much greater. Because investments in irrigated agriculture are highly dependent on the availability of (cheap) energy for the pumping of water, exploitation of the continent's hydropower potential becomes that much more important.

In sum, investments in water infrastructure need to be well integrated into coordinated, cross-sectoral investment and infrastructure plans (primarily transport and energy) in order to achieve the desired outcomes.

Source: Africa TWR Outlook 2040

4.2 The challenges of regional integration

The challenges of regional integration are illustrated by the pitfalls encountered in implementing regional infrastructure policies to date, as well as by the mixed experience of infrastructure and regional projects under preparation and implementation.

4.2.1 Lack of harmonisation of infrastructure policies

Although Africa's framework of continental and regional policies is fundamentally sound, those policies have not been thoroughly and consistently written into national legislation, even after treaties are signed and ratified. Where regional and continental infrastructure policies do appear in national legislation, too often they are not enforced.

The iconic example is the axle load limit for trucks. Without a harmonised and enforced rule, international movement of trucks from a country or region with a higher load limit damages roads in countries with a lower load limit. Similarly, in ICT, the lack of harmonised regulation is a major obstacle to the construction of needed regional backbones by private operators.

At bottom, continental and regional policies approved by ministerial committees or conferences of heads of state are no more than declarations of intent—intent to improve the delivery of common goods through continental integration; intent to facilitate trade and connectivity through harmonised standards and regulations; intent to cooperate on planning and delivering essential parts of regional networks that all agree are desirable.

But at every step, harmonisation is voluntary. In the absence of formal legal authority to see that continental and regional policies are written into effective national laws and regulations and to compel national authorities and utilities to follow through on their commitments, the regional institutions must rely on cooperation, consensus, and good will, which too often are in short supply.

Missing, as a result, are consistent national policies, regulations, and norms among countries that share regional infrastructure. The result is a profound lack of harmonisation of laws, standards, and regulations that complicates the processes of planning and financing vital regional projects while impeding cross-border economic activity.

The transport sector provides a striking illustration of the economic impact of lack of harmonisation that goes way beyond the axle load limit problem. Conflicting policies and practices hinder international trade, compounding the impact of poor physical infrastructure. As a result, transport costs in Africa are up to 100% higher than in other world regions.

Policy harmonization is a problem affecting all regional groupings, including the European Union and the Association of Southeast Asian Nations (ASEAN). Short of the judicial processes used extensively in Europe to achieve harmonization but not available in African regional groupings, a solution lies with peer review. Both the EU (under the Maastricht Treaty) and ASEAN are using the peer review process with a degree of success. NEPAD has experience with the African Peer Review Mechanism (APRM). An analogous approach may be useful in ensuring policy harmonization in infrastructure across African countries.

4.2.2 Failure to align priorities; doubts about the reliability of financial commitments

To find entry points through which to break the vicious cycle that has prevented regional infrastructure projects from reaching their potential, the PIDA Study assembled a panel of case studies of the efficiency of current regional infrastructure in each sector. The consultant also reviewed 20 regional projects under preparation or under implementation and 10 ongoing basin development programs. The case studies include some REC-sponsored projects in ICT and projects under the NEPAD's short-term action plan for infrastructure (STAP).

The consultant's review revealed that the lack of alignment and financial problems were the principal drags on efficiency.

Lack of alignment with national and regional priorities is a primary failure factor, as good ideas become orphan projects. For example, segments of the Trans-African Highways that correspond to the priorities of the country involved have been built, but segments that do not fit country priorities have stagnated.

Finding financing is another problem. Raising finance and reaching financial closure are complicated for regional projects (even those undertaken in the public sector with grant financing) because of the number of actors involved. At every turn, there is the risk that the interest of one partner will waver or that a commitment will not be met. Experienced project promoters and developers are needed to bring projects to financial closure.

Financial distress bedevils regional projects in the transport and power sectors. Regional railways, even those under private concession, earn revenue that is insufficient to cover operating expenses, provide maintenance, or support expansion. Road maintenance suffers from lack of financing even where roads funds have been established. Cash-starved utilities make unreliable offtakers for fledgling regional projects (Box 4.3). The result has been steady deterioration of existing infrastructure to the point where portions of the network have become unusable.

There are exceptions to this dismal picture. Participants in the ICT sector enforce strict payment discipline through prepayment of services. Other examples are the well-maintained Maputo corridor (built and operated by a private group) and regional facilities (such as container ports) that cater to creditworthy clients.

Box 4.3. Poor coordination, payment delays compromise regional projects: The case of the OMVS's Manantali dam

The Organisation pour la Mise en Valeur du Fleuve Senegal (OMVS) illustrates the impact of national utilities' financial difficulties on the efficiency of operation of regional power infrastructure. While the Manantali Dam was completed in 1986, its electromechanical equipment and transmission lines to Dakar, Nouakchott, and Bamako were completed only in 2000. The main causes of the delay were the difficulty the member states had in agreeing on the routing of the power lines and in mobilizing financing. Since operation of the electrical facility started, OMVS has been plagued by the poor payment habits of client utilities, themselves suffering from arrears in payments from governments and the public sector.

5. RISKS TO PIDA—AND TO AFRICA

Capturing the considerable potential benefits of regional infrastructure will require political consensus, effective regional institutions and regulatory frameworks, an agreed list of regional investment priorities, and measures to facilitate project preparation and cross-border project financing. Acting in concert, Africa will have to mobilize sizable funds to build the PIDA infrastructure needed to accommodate and sustain growth. Continental and regional policies will have to be written into national codes—and enforced. Bureaucratic battles must cease.

Regional infrastructure involves a high level of trust between countries, not least because of the implied dependence on neighbours for key resources such as water and energy. That trust must be built.

The major risk faced by PIDA relates to difficulties in achieving consensus among the stakeholders on the location of urgently needed transport infrastructure (in particular hub ports and airports). Political consensus is needed because political obstacles and expediencies often trump the economic case.

In the absence of consensus, PIDA is doomed to become a "top down" theoretical exercise poorly aligned with the priorities of the RECs and their member countries and unlikely to generate the needed infrastructure investment.

Africa has an extensive architecture of *regional political and technical bodies*, but these face problems because of overlapping memberships, limited technical capacity, and limited enforcement powers. Physical integration of infrastructure networks will be effective only with *harmonised regulatory frameworks* and administrative procedures to allow the free flow of services across national borders.

Given the daunting investment agenda, better sequencing and *priority setting for regional projects* is essential, but it has been elusive. The complexity of regional infrastructure projects makes them costly and time-consuming to prepare. This is particularly true when projects are large in relation to the size of the host economy and essentially depend on payment for services from consumers downstream.

Success can be achieved if in the coming years certain major recognised policy weaknesses across infrastructure sectors will be resolved.

- *Transport*. All the corridors must reach full efficiency through successful implementation of well-documented and generally accepted trade facilitation measures such as one-stop border posts and "smart" corridors; restoration of the creditworthiness of railways and road-maintenance institutions; and full implementation of the 1999 Yamoussoukro Decision.[9]
- *Energy*. The creditworthiness of electricity utilities must be restored and payment discipline enforced.

[9] The Yamoussoukro Decision of 1999 was an effort to liberalize international air travel within Africa. Although implementation has varied significantly from region to region, liberalization has generally been successful. Two-thirds of African countries have applied the standards to some extent.

- *Transboundary water resources*. The African countries that share international rivers, lakes, and aquifers must display the political will to support their basin organisations in the preparation, implementation, and operation of joint investments.
- *ICT*. Monopoly control must end on land-based infrastructure and international gateways, with "right of way" provisions for landlocked countries to reach submarine cable landing stations.

Provided these policy changes are timely and effective, the projections presented in this report paint a plausible future for Africa and its regional infrastructure. The findings of the PIDA study provide the RECs with a detailed roadmap for action in the infrastructure sectors. As important as the individual projects identified by the study and the initial consensus surrounding their prioritisation are a credible and effective monitoring mechanism (based on peer review) tracked by Africa's heads of state.

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